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The Effect of Cross-Country Differences in Product Quality on the Direction of International Trade

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Abstract

Despite considerable theoretical work predicting that product quality plays an important role in determining the direction of international trade, there is no empirical evidence on the existence and magnitude of such a quality effect on trade. In this paper, I provide a framework to estimate the impact of cross-country differences in product quality on bilateral trade flows. The model allows countries to differ both in the quality of goods they produce and in their aggregate demand for quality. It also takes into account other determinants of international trade, such as differences in factor proportions. I estimate the model using cross-sectional data on bilateral trade flows at the sectoral level. The empirical results confirm the theoretical prediction: rich countries import relatively more from countries that produce high-quality goods. Even though traditional determinants of comparative advantage are still the main driving force of trade, quality differences between countries have a significant effect on the pattern of international trade flows.

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1 Introduction

Large differences across countries in the export price of similar goods [Schott (2002), Hummels and Klenow (2002)] suggest that countries differ in the quality of the products they export. The differences are systematic: rich countries export high-quality goods and poor countries export low-quality goods. While traditional theories of international trade neglect the existence of quality differences across countries, a substantial amount of theoretical work predicts that quality plays an important role in the determination of international trade flows.

Linder (1961) first noted the role of product quality on trade. He argued that richer countries have a comparative advantage in the production of high-quality goods. He also argued that they spend larger proportions of their income on high-quality goods. He then concluded that the congruence of production and consumption patterns leads countries with similar income per capita to trade more with one another. This is the Linder hypothesis, one of the earliest theories explaining the effects of quality differences on international trade flows. It has received considerable attention for its contrast with the standard Heckscher-Ohlin theory, which predicts trade intensity to be higher between countries of *dissimilar* income per capita –as the latter reflects differences in relative factor endowments. More recent theoretical work has developed models to formalize quality effects on trade patterns. The theoretical findings suggest that differences in product quality across countries play a substantial role in the determination of international trade flows.[1]

There is mounting evidence on the role of factor proportions, differences in technology, geography, and border barriers, among other factors, in determining trade patterns. In contrast, and despite the theoretical findings, there is no relevant empirical evidence on the role of cross-country differences in product quality as a determinant of the direction of trade.[2] What evidence exists comes indirectly from tests of the Linder hypothesis. This literature typically uses the gravity equation as a benchmark[3], and adds a "Linder term", a measure of income dissimilarity between pairs of countries. Even though the Linder hypothesis predicts a negative sign for the estimated co-

[1] See Falvey and Kierzkowski (1987), Flam and Helpman (1987), Stokey (1991), Murphy and Shleifer (1997), and Brooks (2001).

[2] Indeed, the most recent survey of the empirical evidence on the determinants of bilateral trade [Harrigan (2001)] cites no research on the role of quality.

[3] The gravity equation, in its traditional form, postulates a log-linear relationship between the volume of bilateral trade, the GDP of each country, and the distance between the two.

efficient on the Linder term, the empirical results on the sign of this coefficient are mixed.[4] There is nevertheless an even more fundamental problem than failure to confirm the Linder hypothesis: the empirical framework used by this literature cannot separately identify the role of quality from the role of other determinants of trade. First, the prediction that the intensity of trade is higher between countries with similar income per capita can also result from (inter-sectoral) non-homotheticities in demand, which are not related to quality. This is the case if income elasticities differ across sectors, and richer countries have a comparative advantage in sectors with high income elasticities.[5] Second, quality effects coexist with other traditional (inter-sectoral) determinants of trade, such as differences in factor proportions. But the gravity-equation framework does not nest these different forces. It is thus unable to isolate the role of quality from other inter-sectoral determinants of trade.

In this paper, I provide a testable framework to estimate the effect of quality on the direction of trade. The model yields predictions on bilateral trade flows at the sectoral level. By focusing on sectoral trade flows, the model embeds and controls for inter-sectoral determinants of comparative advantage. I describe the model in section 2. The demand side allows countries with different per-capita income to differ in their quality choices. In particular, it allows richer countries to spend a larger share of their income on high-quality goods. I do not model supply-side determinants of international production. Instead, I take the equilibrium in the world economy as given. In this equilibrium, countries differ in the quality of the goods they produce and in their pattern of sectoral specialization. Conditional on this equilibrium, the model generates an empirical specification with a clear prediction for the role of quality on the pattern of bilateral trade: if, as suggested by the theoretical literature, income per capita affects aggregate demand for quality, then the coefficient on a regressor capturing the interaction between the quality of the exporter's goods and the importer's income per capita should be positive. In contrast, under the null hypothesis that income per capita has no effect on the demand for quality, the coefficient should be zero.

To test this prediction, I use a cross-section of sectoral bilateral flows among 54 countries in 1995. A key variable in my analysis is the measure of quality for each sector and country. I construct quality indices based on cross-country differences in unit values of US imports at the 10-digit level. Section 3 describes the data and methodology used to construct the quality indices. I estimate

[4] See surveys in Deardorff (1984), Leamer and Levinsohn (1995), and McPherson, Redfearn, and Tieslau (2001).

[5] The role of this type of non-homotheticities has been addressed by Markusen (1986), Hunter and Markusen (1988), Bergstrand (1989), Hunter (1991), Deardorff (1998), and Matsuyama (2000).

the model in section 4. I first use OLS. But since the empirical specification is log-linear, bilateral country pairs with zero trade must be dropped from the sample. This may induce a selection bias in the estimation, casting doubts on the OLS estimates. I argue that fixed exporting costs explain the presence of zero values in bilateral trade. I model these fixed costs and derive the baseline empirical specification, which consists of two equations: the *Fixed Cost Equation* and the *Imports Equation*. The dependent variable in the *Fixed Cost Equation* acts as a censoring value in the *Imports Equation*. I estimate the system jointly using maximum likelihood. The results from the OLS estimation and those from the baseline specification are very similar. Both are consistent with the main prediction of the theoretical literature: richer countries import relatively more from countries that produce high-quality goods. For most sectors, the coefficient on the interaction term has the predicted sign, and it is statistically significant for more than half of the sectors.

In section 5, I investigate a key difference between my methodology and the typical test of the Linder hypothesis: the use of sectoral instead of aggregate data. When I estimate the model using trade flows aggregated across sectors, the results are reversed. Rich countries appear to import relatively more from countries that produce lower-quality goods. I show that this is the result of an aggregation bias. When trade flows are aggregated across sectors, we cannot control for inter-sectoral determinants of trade, such as differences in factor proportions. Therefore, the effect of quality cannot be separately identified from the effects of these inter-sectoral determinants, which tend to operate in the opposite direction.

In section 6, I use the estimates from section 4 to compare the economic importance of quality in determining the direction of trade with the role of more traditional (inter-sectoral) determinants of comparative advantage. In particular, I compare the opposite effects of these forces on the export destinations of a country that suddenly climbs the development ladder. First, as a country develops, it adopts the sectoral composition of exports of developed countries. For example, it exports more machinery and less apparel. But low-income countries are relatively large importers of machinery and high-income countries of apparel. As a result, the total share that this country exports to high-income countries decreases. This is an inter-sectoral effect, which is consistent with traditional theories of comparative advantage –such as the Heckscher-Ohlin theory. Second, as this country develops, it also adopts higher quality levels. Holding the sectoral composition of exports constant, higher quality levels induce larger shares of exports (within each sector) to high-income countries. This is the intra-sectoral quality effect, the focus of this paper. However, the previous (inter-sectoral) effect dominates the overall effect, contradicting the prediction of the Linder hypothesis on the direction of trade. As a country develops, the share exported to high-income countries falls while the share exported to low-income countries rises. These results suggest that even though international differences in product quality have a significant effect on the direction of trade, traditional (inter-sectoral) determinants of comparative advantage remain the dominant force driving international trade flows. In section 7, I summarize the results and briefly describe directions for further research.

2 Theoretical Framework

2.1 Demand

Demand in each country k is generated by a representative consumer with a two-tier utility function. The upper tier utility is weakly separable into subutility indices defined for each differentiated-good sector $z = 1, ..., Z$, and for each homogeneous-good sector $g = Z + 1, ..., G$,

$$U^k = U\left[u_1^k, ..., u_z^k, ..., u_Z^k, u_{Z+1}^k, ..., u_g^k, ..., u_G^k\right], \tag{1}$$

where u_g^k is a general function of the quantity consumed of good g and, for each differentiated-good sector z, the subutility index takes the specific form:

$$u_z^k = \left[\sum_{h \in H_z}\left(\theta_h^{\gamma_z^k} q_h\right)^{\alpha_z}\right]^{\frac{1}{\alpha_z}} \qquad 0 < \alpha_z < 1 \quad \forall z, \tag{2}$$

where u_z^k is defined over all varieties $h \in H_z$ in the sector. In (2), q_h and θ_h are the quantity and quality of variety h. The parameter γ_z^k is the intensity of preference for quality of country k, and it is allowed to be different across countries. None of the parameters of the model is restricted to be the same across sectors. Subindex z, however, will sometimes be omitted for expositional simplicity in the remainder of the paper.

The lower-tier subutility functions u_z^k are an augmented version of the Dixit-Stiglitz structure of preferences. This augmented version is able to capture income effects on the choice of quality. Differences in income can induce differences in demand through two different channels. First, income can affect taste parameters directly [Calvet and Common (2000), Nevo (2001)]. Second, given identical preferences, differences in income can induce different quality choices. In both cases, for a given shape of the income distribution, a country with higher average income will be expected to consume a larger proportion of high-quality goods. The parameter γ^k captures –in a reduced form– these income effects at the aggregate level. I next derive the demand system generated by this utility function and defend the use of this reduced-form approach in modeling the demand for quality.

The representative consumer uses two-stage budgeting. In the first stage, for a given expenditure allocation across sectors $E_1^k, ..., E_Z^k, ..., E_G^k$, expenditure on variety h in sector z is

$$p_h^k q_h^k = \frac{\left(\frac{p_h^k}{\theta_h^{\gamma_z^k}}\right)^{1-\sigma_z}}{\sum_{r\in H_z}\left(\frac{p_r^k}{\theta_r^{\gamma_z^k}}\right)^{1-\sigma_z}} E_z^k = s^k(h)E_z^k, \tag{3}$$

where $\sigma_z = 1/(1-\alpha_z)$ is the elasticity of substitution, and p_h^k is the price of h faced by consumers in country k. Equation (3) shows expenditure on h as a share $s^k(h)$ of total expenditure in sector z. This share depends on the value of γ^k, and it changes with this parameter according to:

$$\frac{\partial s^k(h)}{\partial \gamma_z^k} = \lambda_{hz}^k \left[\ln\theta_h - \sum_{r\in H_z} s(r)\ln\theta_r\right], \tag{4}$$

where

$$\lambda_{hz}^k = \frac{\left(\frac{p_h^k}{\theta_h^{\gamma_z^k}}\right)^{1-\sigma_z}(\sigma_z - 1)}{\sum_{r\in H_z}\left(\frac{p_r^k}{\theta_r^{\gamma_z^k}}\right)^{1-\sigma_z}} > 0.$$

For a variety h of above-average quality –the term in brackets in (4) is positive–, a higher γ^k implies a larger share spent on this variety. For a variety h of below-average quality, a higher γ^k implies a smaller share spent on h. Countries with higher (lower) γ^k will thus spend a larger share of their income on high- (low-) quality goods. Allowing γ^k to vary across countries, this demand system has the convenient property of accommodating in a simple form cross-country differences in the pattern of expenditures for goods of different quality.[6] A special case arises when γ^k is the same for every country. The demand system is then equivalent to the demand system generated

[6]I do not address the effects of differences in higher moments of the income distribution.

by the Dixit-Stiglitz structure of preferences, where there are no differences across countries in quality choices.[7] Since Dixit-Stiglitz preferences are a standard assumption in trade models with differentiated products, the proposed demand system has the additional advantage of providing a meaningful benchmark against which to assess the impact of quality on aggregate demand.

Appendix A presents an alternative to this reduced-form approach in which the demand system is derived from a discrete choice model. As often modeled in the empirical IO literature, income effects are captured by a coefficient on price that varies with income in the indirect utility function. This coefficient reflects a decreasing marginal utility of income. The empirical specification derived from this alternative model is identical to the baseline specification, except for the presence of additional interaction terms. The estimation of this alternative model gives very similar results to those of the baseline case.

2.2 Equilibrium bilateral trade flows

In the world equilibrium, countries differ in the quality of the goods they produce and in their pattern of sectoral specialization. I do not model the supply-side determinants of this equilibrium (e.g., different factor proportions). Instead, I take the equilibrium as given, and derive bilateral trade flows at the sectoral level under the null hypothesis that all countries share the same pattern of demand for quality products, and under the alternative that they do not.

Assume that all varieties produced by country i in sector z have the same quality and are sold at the same price.[8] Denote by N_{iz} the number of such varieties. Equation (3) shows the value of country k's demand for a particular variety produced by i in sector z. Given our symmetry assumption, this is also the value of demand for any variety in that sector. Hence, k's total imports from i in sector z is N_{iz} times the value of demand given by (3),

$$imp_{iz}^{k} = N_{iz} \frac{\left(\frac{p_{iz}\tau_{iz}^{k}}{\theta_{iz}^{\gamma_z^k}}\right)^{1-\sigma_z}}{\sum_{r \in H_z} \left(\frac{p_r \tau_r^k}{\theta_r^{\gamma_z^k}}\right)^{1-\sigma_z}} E_z^k, \qquad (5)$$

[7] In this case, quantity substitutes for quality at the same rate in every country. Quantities and prices can then be renormalized to "common-quality" units to obtain the typical Dixit-Stiglitz specification.

[8] This will not be a strong restriction so long as the variation of quality levels within countries is small compared with the variation of quality levels between countries.

where $p_{iz}\tau_{iz}^k = p_{iz}^k$, the import price equals the product of the export price and the trade cost factor between i and k.

Preferences of the Dixit-Stiglitz form impose a particular restriction on the relationship between bilateral flows. This restriction provides a key to identifing quality effects on trade. Using (5), consider US (country k) imports of Rubber Tires (sector z) from Germany (country i). Consider also US imports of tires from Turkey (country j) by replacing i with j in (5). The ratio between these two expressions indicates the ratio of US imports of tires from Germany relative to those from Turkey:

$$ratio_{ij}^k(z) = \frac{N_{iz}}{N_{jz}} \left(\frac{p_{iz}\tau_{iz}^k/\theta_{iz}^{\gamma_z^k}}{p_{jz}\tau_{jz}^k/\theta_{jz}^{\gamma_z^k}} \right)^{1-\sigma_z}, \tag{6}$$

where the ratio is independent of the expenditure level and the price index for tires in the US.

Replacing k with l in (6), we can look at this ratio for a different importer, Argentina (country l), and compare it with that for the US by taking the ratio of the ratios (6) for the two countries:

$$r_{ij}^{kl}(z) = \frac{ratio_{ij}^k(z)}{ratio_{ij}^l(z)} = \left(\frac{\tau_{iz}^k/\tau_{jz}^k}{\tau_{iz}^l/\tau_{jz}^l} \right)^{1-\sigma_z} \left[\frac{(\theta_{iz}/\theta_{jz})^{\gamma_z^k}}{(\theta_{iz}/\theta_{jz})^{\gamma_z^l}} \right]^{\sigma_z-1}. \tag{7}$$

To abstract from the impact of trade costs, assume for now that $\frac{\tau_{iz}^k/\tau_{jz}^k}{\tau_{iz}^l/\tau_{jz}^l} = 1$. Then,

$$r_{ij}^{kl}(z) = \left[\frac{(\theta_{iz}/\theta_{jz})^{\gamma_z^k}}{(\theta_{iz}/\theta_{jz})^{\gamma_z^l}} \right]^{\sigma_z-1}. \tag{8}$$

There are three possible cases in (8). The first one is trivial. If Germany and Turkey produce the same quality of tires ($\theta_i = \theta_j$), then relative imports from Germany and Turkey are the same for both the US and Argentina ($r_{ij}^{kl} = 1$). The second case is more interesting. Even if qualities are different ($\theta_i \neq \theta_j$), if the US and Argentina have the same intensity of preference for quality ($\gamma^k = \gamma^l$), then relative imports from Germany and Turkey will still be the same in both countries ($r_{ij}^{kl} = 1$). As argued before, typical Dixit-Stiglitz preferences can accommodate this case after an appropriate normalization to "common-quality" units. These preferences then impose the restriction that any two countries' relative imports from any other two countries are identical, i.e., $r_{ij}^{kl} = 1$.[9] This restriction does not neglect inter-sectoral determinants of trade. Suppose that Germany has a comparative advantage in producing tires (determined by factor

[9] In the more general case, this holds after controlling for differences in bilateral trade costs.

proportions or technology differences). Then, Germany will have many tire producers. N_{iz} will be large, and Germany will be a large exporter of tires.[10] But exports from Germany will be large to both the US and to Argentina without affecting r_{ij}^{kl}. Similarly, we can focus on an importer. Suppose that Argentina has a comparative advantage in producing tires. We then expect a large number of Argentine tire producers, leading to a low price index for tires in Argentina because domestic goods do not pay trade costs. Relative prices of imported varieties will then be high, discouraging Argentina's imports from both Germany and Turkey. But again r_{ij}^{kl} will not be affected. Finally, suppose that E_z^k is large for the US because of a combination of size and inter-sectoral non-homotheticities in demand. Again, this will affect US imports from both countries proportionally, but it will not affect the relative ratio r_{ij}^{kl}.

It is only in the third case, where both quality and the intensity of preference for quality are different ($\theta_i \neq \theta_j$ and $\gamma^k \neq \gamma^l$), that $r_{ij}^{kl} \neq 1$. If German quality is higher ($\theta_i > \theta_j$) and the US's intensity of preference for quality is higher ($\gamma^k > \gamma^l$), then the US will import relatively more from Germany while Argentina will import relatively more from Turkey. More generally, countries with higher γ^k will import relatively more from countries that produce higher-quality goods.

2.3 A testable prediction

Taking logs on both sides of (5) we obtain:

$$\begin{aligned} \log imp_{iz}^k \quad = \quad & \log N_{iz} - (\sigma_z - 1)\log p_{iz} - \log \sum_{r \in H_z} \left(\frac{p_r^k}{\theta_r^{\gamma_z^k}} \right)^{1-\sigma_z} + \log E_z^k \\ & -(\sigma_z - 1)\log \tau_{iz}^k + (\sigma_z - 1)\gamma_z^k \log \theta_{iz}. \end{aligned} \tag{9}$$

In a cross-section of bilateral trade flows, the first two terms on the RHS are specific to exporter i. These terms take the same value when i is the exporter, independent of importer k. Therefore, they can be captured with *exporting country* fixed effects. Similarly, the next two terms are specific to importer k, and take the same value independent of exporter i. These terms can be captured with *importing country* fixed effects. Following research in the gravity equation literature, I assume that trade costs are determined by the following equation:

$$\log \tau_{iz}^k = \eta_z \log Dist_i^k + \widetilde{\boldsymbol{\beta}}_z \mathbf{I}_{iz}^k \tag{10}$$

[10] Romalis (2001) derives the effect of comparative advantage on the number of firms in a Heckscher-Ohlin model that accounts for product-differentiation and trade costs.

where $Dist_i^k$ is the bilateral distance between each country pair, and $\widetilde{\boldsymbol{\beta}}_z$ is a vector of parameters associated with a vector of dummy variables $\mathbf{I}_{iz}^k$ indicating whether the country pair shares, respectively, a common border, a common language, a preferential trade agreement, a colonial relationship, or a common colonizer.[11] I also postulate a linear relationship between γ_z^k and the logarithm of income per capita of country k:

$$\gamma_z^k = \gamma_z + \mu_z \log y^k. \tag{11}$$

Under the null hypothesis that income per capita does not affect aggregate demand for quality, $\mu_z = 0$ (the Dixit-Stiglitz case) and γ_z^k is the same for every country. Under the alternative that it does, $\mu_z > 0$.

Combining (10) and (11) with (9), we obtain a testable prediction for sectoral bilateral trade:

$$\begin{aligned} \log imp_{iz}^k &= \varphi_{iz} + \psi_z^k - (\sigma_z - 1)\eta_z \log Dist_i^k + \boldsymbol{\beta}_z \mathbf{I}_{iz}^k \\ &\quad +(\sigma_z - 1)\mu_z \log y^k \log \theta_{iz}, \end{aligned} \tag{12}$$

where φ_{iz} and ψ_z^k are fixed effects for exporter and importer countries respectively, and $\boldsymbol{\beta}_z = -(\sigma_z - 1)\widetilde{\boldsymbol{\beta}}_z$. It will not be possible to independently identify σ_z and μ_z from (12). However, since $\sigma_z > 1$, the estimated sign of $(\sigma_z - 1)\mu_z$ will correspond to the sign of μ_z. Therefore, income effects on the demand for quality will result in a positive coefficient on the variable interacting exporter's quality and importer's income per capita.[12]

3 Data and Measurement of Quality

Since the theory underlying equation (12) is only valid for differentiated-good sectors, I restrict my analysis to these sectors in the estimation. Also, since (12) is only valid at the sectoral level, I estimate it sector by sector. An alternative would be to estimate jointly for all sectors, allowing some coefficients to vary and forcing others to be the same across sectors. However, this alternative is unappealing as there are no coefficients for which such a restriction can be reasonably imposed. On the one hand, the elasticity of substitution σ_z is presumed to be different across sectors, and

[11] The assumption of iceberg trade costs rules out "Alchian-Allen" effects. See Hummels and Skiba (2002) for evidence on this effect.

[12] The separate effect of these two variables is already embedded in the exporter and importer country fixed effects.

it enters the coefficients on all variables. On the other hand, the country dummies capture inter-sectoral determinants of comparative advantage, which are relevant at the sectoral level and cannot be forced to be equal across sectors.

3.1 Data and sample selection

I estimate (12) on a cross-section of bilateral trade flows for 1995. Trade flows data come from the CD-ROM "World Trade Flows, 1980-1997" compiled by Feenstra (2000), based on the World Trade Analyzer assembled by Statistics Canada. This database classifies goods down to the 4-digit SITC (Rev.2) level. However, since information at this level of disaggregation is incomplete, I define sectors at the 3-digit SITC level.

To select differentiated-good sectors I use Rauch's classification. Rauch (1999) classifies 4-digit SITC sectors into three categories. Homogeneous-good sectors include goods that are internationally traded in organized exchanges, with a well-defined price (e.g., wheat). Reference-priced sectors include goods that are not traded in organized exchanges, but have reference prices available in specialized publications (e.g., polyethylene). Differentiated-good sectors (D-sectors) are those sectors that do not satisfy any of the two previous criteria. Rauch uses two standards to make his classification, one "liberal" and one "conservative". I use the liberal standard because it is more stringent in the classification of goods as Differentiated. Some 3-digit sectors include 4-digit D-sectors together with 4-digit sectors that belong to one of the other two categories. In this case, I take for the 3-digit sector only the sum of trade in the 4-digit D-sectors, provided that trade reported in the residual category is negligible.

The sample consists of 54 countries. I include countries with a population larger than 5 million and with more than 2 billion-dollar imports of differentiated products. Hungary is additionally excluded because sectoral trade data is of poor quality, and Algeria, Iran, Libya, and the US are excluded because it is not possible to measure quality for these countries.[13]

In addition to the selection of D-sectors, I only keep sectors with total trade (within the 54 selected countries) of more than 2 billion dollars. There are 113 differentiated good sectors, listed in Table A1, which satisfy this requirement. The total sample consists of 323,406 observations (bilateral pairs), with 2,862 observations in each of the 113 sectors.

[13] The problem with measuring quality for the US will become clear shortly, as I use US imports to measure quality.

The distance variable corresponds to great circle distance between capital cities and was prepared by Howard Shatz (1997). Dummies for border, common language, colonizer-colony relationship, and common-colonizer relationship were constructed using the CIA Factbook. Colonial links are only considered if the colonizer-colony relationship was still in force after 1922. The Preferential Trade Agreements include the Andean Pact, ASEAN, the European Union, Mercosur, and Nafta. Data on GDP and per-capita GDP come from the World Bank WDI CD-ROM (Atlas Method).

3.2 Measurement of quality

We still need a measure of quality, θ_{iz}, for each country and 3-digit sector. The NBER Trade Database compiled by Feenstra (1996) classifies US imports by country of origin and type of good at the 10-digit level of the Harmonized Tariff Schedule (HTS). The 10-digit classification is the most detailed level of disaggregation for commodities in the HTS. It is the level at which import duties are defined. For each of these categories and source countries, the database provides information on the customs value and quantity of US imports.[14] It also provides the units in which quantities are measured. Examples of 10-digit categories are:

HTS Code	Description
1902112000	Uncooked pasta, not stuffed or otherwise prepared, containing eggs, exclusively pasta
5208292020	Woven fabrics of cotton, containing 85% or more by weight of cotton, weighing not more than 200g/m^2, bleached, sateens
6203492010	Men's trousers and breeches of artificial fibers
8413301000	Fuel-injection pumps for compression-ignition engines
8413702022	Centrifugal pumps for liquids, single-stage, single-suction, frame-mounted, with discharge outlet under 7.6 cm. in diameter
8418210010	Refrigerators of household type, compression type, having a refrigerated volume of under 184 liters

To measure quality, I use information on unit values of US imports in 1994. For each goods category, the unit value measures the ratio between the value and the quantity of imports. It is hence an average price. Unit value comparisons typically suffer from a composition problem. If a category includes different types of goods (with different prices), then differences in unit values

[14] Customs values do not include freight, and are used as the basis for duty assessment. They are intended to serve as arm's length transaction values for commodities.

do not merely reflect differences in prices but also differences in the composition of imports within the category. Moving into more narrowly defined categories reduces this problem. Hence, we can expect composition problems to be minimized using unit values calculated at the 10-digit level.

I infer cross-country differences in quality from cross-country differences in unit values.[15] More specifically, I assume that at the 10-digit level of disaggregation, cross-country differences in unit values reflect proportional differences in quality ($p_i = a\theta_i$). I therefore obtain quality indices at the 10-digit level and then use index number theory to aggregate them into indices at the 2-digit and 3-digit level. Appendix B describes the methodology used to construct such indices in further detail.

There are several caveats to the use of unit values for measuring quality levels. First, there is measurement error in the source database.[16] To deal with this problem, I remove extreme unit-value observations. Appendix B discusses the procedures used to identify and remove these observations. Second, aggregation problems may still be present at the 10-digit level. I cannot rule out this concern, but I expect these problems to be minimized at the 10-digit level of aggregation. Third, cross-country differences in relative costs can induce price dispersion even for goods of the same quality. If relative costs differ significantly, however, we would expect countries to be specialized in the production of goods of different qualities. For example, if higher qualities require a more intensive use of some factor (e.g., skilled labor), countries where this factor is relatively inexpensive (because it is abundantly available) would tend to specialize in the upper range of the quality ladder. In contrast, countries where this factor is relatively scarce would tend to specialize in the lower range. Fourth, mark-ups may differ across countries, in which case differences in prices would not reflect proportional differences in quality. The empirical specification is in fact robust to a more general elasticity of price with respect to quality ($p_i = a\theta_i^{\nu}$).[17] But there is no guarantee that a constant elasticity will capture the true relationship between prices and quality levels. In sum, even though building 3-digit level indices from differences in unit values at the 10-digit level minimizes

[15] See Bils and Klenow (2001) for a similar approach to measuring quality.

[16] The General Accounting Office (1995) conducted a detailed study of 8 specific 10-digit product categories. It found that wide dispersion among countries in unit values of US imports within the same product category is explained by two main factors: categories not including identical products (not a concern when this is due to differences in quality), and classification and data entry errors. Unfortunately, the GAO cannot assess the generality of these problems because its sample is not representative.

[17] Moreover, it cannot identify the magnitude of the parameter υ.

composition problems –the main shortcoming of this approach–, cross-country differences in unit values are still imperfect measures of quality differences. Despite these imperfections, this approach is useful so long as differences in quality levels are driving most of the cross-country variation in unit values.

It is not possible to calculate a 3-digit-level quality index for a country when this country has no reported exports to the US in that 3-digit sector. In those cases, observations with this country as the exporter have to be dropped. An alternative is to calculate quality indices at the 2-digit instead of at the 3-digit level, and to use the relevant 2-digit index for each 3-digit sector. This approach does not make use of information on quality differences between 3-digit sectors. Hovever, it has two advantages. First, a large fraction of trade observations for which an exporter has no available 3-digit quality measure can be kept in the sample. Second, if quality levels among 3-digit sectors in the same 2-digit category are similar, an index calculated at the 2-digit level will gain precision because there are more observations to average out measurement errors. I choose to use quality indices at the 2-digit level in the baseline case because measurement error is an important concern in this database and because the difference in the resulting sample size between the two alternatives is large.[18] Indices at the 3-digit level are used later to check the robustness of the results.

Table 1 provides summary statistics for the quality indices. I order countries by income per capita and report two summary measures. The first is the unweighted geometric average of the 2-digit quality indices across sectors. The second is the Overall Quality Index, an index calculated at the aggregate level that can be thought of as a weighted average of the 2-digit indices. Table A2 shows the indices for each 2-digit sector and country. They are normalized so that Canada has a value of 1 in every sector. Blanks correspond to missing values. The second to last row of the table shows, for each sector, the correlation between quality indices and income per capita. The correlation is positive for all sectors. The average correlation across sectors is 0.61.

Two features of these quality indices are worth mentioning. First, they are highly correlated with income per capita. This is consistent with the supply-side assumptions of most theoretical trade models accounting for vertical differentiation, and it confirms the strong correlation between

[18] The number of observations with missing quality indices at the 3-digit level is 82,627 (25.5% of the sample). The number of observations with missing quality indices at the 2-digit level is 31,641 (9.8% of the sample).

income per capita and unit values of exports found in Schott (2002) and Hummels and Klenow (2002). Second, despite this positive correlation, for a given country there is considerable variation of quality levels across sectors.

4 Estimation Results

4.1 OLS estimation

Based on the theoretical prediction given by (12), I first estimate sector by sector:

$$\begin{aligned} \log imp_{iz}^{k} &= \varphi_{iz} + \psi_{z}^{k} - (\sigma_z - 1)\eta_z \log Dist_i^k + \boldsymbol{\beta}_z \mathbf{I}_{iz}^{k} \\ &+ (\sigma_z - 1)\mu_z \log y^k \log \theta_{iz} + \varepsilon_{iz}^{k}, \end{aligned} \tag{13}$$

using ordinary least squares (OLS). Equation (13) includes a random disturbance ε_{iz}^{k}, which is assumed to be uncorrelated with the regressors. Since I cannot report detailed regression results for the 113 sectors, I provide summary results for the estimated coefficients in Table 2. The first two columns show, for each variable, the number of sectors with estimated positive and negative coefficients. The next three columns summarize the coefficients by their significance at the 5% level. The last column shows the average estimated coefficient (across sectors) for each variable.

The first row shows the results for the coefficient on the interaction term between exporter's quality and importer's per-capita income. In 94 out of 113 sectors this coefficient is positive. In more than half of the sectors –66 out of 113– it is positive and significant at the 5% level. In only 8 sectors it is negative and significant. The results are consistent with the theoretical prediction: rich countries import relatively more from countries that produce high-quality goods while poor countries import relatively more from countries that produce low-quality goods. Graph 1 shows a histogram with the frequency distribution of the estimated coefficient for the interaction term. The average magnitude of the coefficient across sectors is 0.063. The interpretation of this magnitude is related to the ratios in equation (6). Take an importer k with twice as much income per capita as importer l, and take an exporter i with a quality level twice as high as that of exporter j. The coefficient indicates the percentage difference in (6) between k and l. In section 6, the magnitude of the quality effect is addressed in more detail.

The estimated coefficients for the rest of the variables have the expected sign in most sectors.

Distance hinders trade, whereas Border, Common Language, Regional, Colonial relationships, and Common Colony relationships facilitate trade through a reduction in trade costs.

4.2 Fixed costs of exporting

4.2.1 Empirical specification

Almost half of all sectoral bilateral pairs in the sample report no trade. Since the estimated equation is based on the logarithm of bilateral trade, these observations must be discarded when using OLS. This may induce some selection bias and therefore casts doubts on the robustness of the results. Researchers working with the gravity equation have long acknowledged the problem of dropping observations with zero values.[19] This problem is more severe in a database of sectoral trade flows because the proportion of zeros is higher.[20] The approach I take in this paper is to use fixed costs of exporting to explain the overwhelming presence of zero values in bilateral trade. International trade only occurs when the profit it generates is enough to cover these fixed costs.

This is a censored data problem. However, the use of a typical censoring model for estimation is not convincing for two reasons. First, we do not know what the censoring value is. Second, fixed exporting costs are likely to vary across bilateral pairs. For example, we expect the fixed costs of exporting from France to Belgium to be lower than the fixed costs of exporting from Guatemala to Vietnam.

I assume that the fixed costs of exporting from country i to country k in sector z are determined by the following equation:

$$\log F_{iz}^{k} = \delta_{0z}' + \delta_{dz} \log Dist_{i}^{k} + \boldsymbol{\delta}_{z}\mathbf{I}_{iz}^{k} + \delta_{xz} \log GDP_{i} + \delta_{mz} \log GDP^{k} + u_{iz}^{k}, \tag{14}$$

where F_{iz}^{k} are the fixed costs, $\mathbf{I}_{iz}^{k}$ is the same vector of dummy variables as in (12), and u_{iz}^{k} is a normally distributed random disturbance. The inclusion of the exporter's GDP captures externalities in the exporting activity that spill over across sectors. Exporting firms generate public information on business conditions in foreign countries (such as demand patterns, existing competitors, alternative channels of distribution, regulations, the "way of doing business", etc.) that may reduce

[19] See Frankel (1997), ch.6.

[20] On the other hand, this problem is partially attenuated, because my sample only includes relatively large countries, and zero trade is more frequent among small countries.

fixed exporting costs for all firms in the economy. Moreover, governments often set up agencies to promote exports by gathering and distributing this information. The effect of these externalities is probably stronger in a large country because it is likely to export to a larger number of countries and from a wider variety of sectors.[21] Analogously, information about exporters can spill over across the importer economy, suggesting the inclusion of importer's GDP as an explanatory variable also.

Given the demand structure in (3), mark-ups are constant, and profits are a constant fraction of the value of exports: $\pi_{iz}^k = \frac{1}{\sigma_z} imp_{iz}^k$.[22] Countries trade if the profits that export sales generate are sufficient to cover the fixed costs. Hence, the decision to export follows this rule:[23]

$$\begin{aligned} \text{If } \pi_{iz}^k &> F_{iz}^k \longrightarrow \text{export} \\ \text{If } \pi_{iz}^k &\leq F_{iz}^k \longrightarrow \text{do not export} \end{aligned} \tag{15}$$

Substituting the equation for profits into (15), we only observe positive imports if

$$\log imp_{iz}^{*k} > \log F_{iz}^k + \log \sigma_z = \log c_{iz}^k, \tag{16}$$

where imp_{iz}^{*k} is a latent variable that denotes the amount of imports that would be observed in the absence of fixed costs, and c_{iz}^k is the censoring point. Substituting (14) into (16), we obtain the *Fixed Cost Equation*:[24]

$$\log c_{iz}^k = \delta_{0z} + \delta_{dz} \log Dist_i^k + \boldsymbol{\delta}_z \mathbf{I}_{iz}^k + \delta_{xz} \log GDP_i + \delta_{mz} \log GDP^k + u_{iz}^k. \tag{17}$$

The empirical specification is then a censoring model with two equations. The *Fixed Cost Equation* determines the (unobserved) censoring point. The *Imports Equation* is given by (13):

$$\begin{aligned} \log imp_{iz}^{*k} &= \varphi_{iz} + \psi_z^k - (\sigma_z - 1)\eta_z \log Dist_i^k + \boldsymbol{\beta}_z \mathbf{I}_{iz}^k \\ &\quad + (\sigma_z - 1)\mu_z \log y^k \log \theta_{iz} + \varepsilon_{iz}^k, \end{aligned} \tag{18}$$

[21] Total exports rather than total GDP better capture the effect of these externalities. I use total GDP to prevent endogeneity problems.

[22] As is well known, with a finite number of varieties this equation only holds as a limiting property.

[23] I model the decision to export at the country-sector level for simplicity. However, fixed exporting costs are mostly borne at the firm level.

[24] The RHS is identical to (14) except for the constant term.

where the LHS is now a latent variable. Given a censoring point, we observe non-zero imports only if $imp_{iz}^{*k} > c_{iz}^{k}$. That is,

$$\begin{aligned} \text{If } imp_{iz}^{*k} &> c_{iz}^{k} \longrightarrow imp_{iz}^{k} = imp_{iz}^{*k} \\ \text{If } imp_{iz}^{*k} &\leq c_{iz}^{k} \longrightarrow imp_{iz}^{k} = 0 \end{aligned} \tag{19}$$

Even though the censoring point is unobservable, the parameters of the *Imports Equation* and *Fixed Cost Equation* can be estimated jointly by maximum likelihood. The estimation is performed sector by sector, assuming a bivariate normal distribution for the random disturbances in the two equations.

4.2.2 Baseline results

Table 3 shows the estimation results. The upper part of the table shows results for the *Imports Equation*, which are directly comparable to those estimated under OLS. The lower part shows results for the *Fixed Cost Equation*.

The censoring model confirms the OLS results. The coefficient on the interaction term is positive in most of the sectors, and positive and significant in 64 out of 113 sectors.[25] The sign of the coefficient matches the sign obtained under OLS in every sector, except for 9 sectors in which the coefficient is statistically insignificant in both specifications. For most sectors, rich (poor) countries import relatively more from countries that produce high- (low-) quality goods. The average coefficient for the interaction term, however, has dropped to 0.037 from a value of 0.063 obtained using OLS. This is apparent in graph 2, which shows the frequency distribution relatively concentrated around zero. Even though dropping observations with zero trade does not affect the sign and statistical significance of the estimated coefficients, it appears to affect their magnitude.

Coefficients on the other variables in the *Imports Equation* have on average the expected sign. The effect of distance is negative and significant in all but one sector, and the effect of sharing a common language and a colonial tie is positive and significant in most sectors. Sharing a common border, a PTA, or a common colonizer enhances trade in most sectors, but not always significantly. The magnitude of the estimated coefficients is in the range of those typically found in the estimation of gravity equations.

[25] Likelihood ratio tests were also performed to determine the individual significance of the interaction term. The results are almost identical. In only one sector does the coefficient pass the 5% threshold for the p-value.

The lower part of the table shows the results for the *Fixed Costs Equation*. The coefficients are in general less precisely estimated than those in the *Imports Equation*. Except for Border, all variables have the expected sign in most sectors.[26] Distance has a positive and significant effect (in most sectors) on fixed exporting costs. A common language, a PTA, a common colonizer, and a colony-colonizer relationship all reduce the magnitude of fixed costs in most sectors, although in only a few of them is this effect statistically significant. In some sectors, it is not possible to obtain a finite point estimate of the coefficient on the Colonial dummy (and on other variables in later specifications). When all bilateral observations that share a colonial relationship have non-zero trade, the maximum likelihood estimate of the coefficient is $-\infty$. This brings the fixed cost of exporting down to almost zero for such observations, which maximizes the likelihood that we observe positive trade in all these country pairs.[27]

Exporter's GDP has a considerable negative and significant impact on fixed exporting costs. This suggests that the externality effects of the exporting activity are strong. On average, a 1% increase in GDP reduces the fixed costs of exporting by 0.3%. In contrast, these externalities are not strong at the importer level. That is, for a given exporter, exporting to a large country does not significantly reduce the fixed costs.[28] This may indicate that information spillovers at the exporter level are much stronger than at the importer level. But it is also a likely result of governments' targeting these spillovers in the export but not in the import activity. The last row in the table shows the (geometric) average predicted censoring point across all observations in all sectors. It is \$51,798. Assuming an elasticity of substitution of 5, the mark-up over price is 20%. The average predicted censoring point then implies an average fixed exporting cost close to \$10,000.

Table 4 groups the results for the interaction term obtained in the baseline case into 14 broader sectors. For two of these broader sectors, the results contradict the predicted effect of quality. In Office, Telecommunications and Sound Recording Machines, the coefficient is negative in 4 out of

[26] No clear theoretical reason predicts a positive effect of sharing a border on fixed exporting costs. This result needs further investigation. Taking out this variable from the *Fixed Cost Equation* has negligible effects on the results.

[27] For these sectors, the pairs with a colonial relationship do not play any role in the estimation of the coefficients on the remaining variables.

[28] An exporter is still more likely to export to a larger rather than to a smaller country, even if fixed costs are identical. The larger country (on average) has a larger demand for imports. It is thus more likely that exports to that country exceed the necessary threshold to cover the fixed costs.

5 3-digit sectors, and it is negative and significant in two of them.[29] In Apparel and Footwear, the coefficient is not significant in 5 out of 8 sectors, and it is negative and significant in two of the remaining three.[30] On the other hand, the quality effect is consistently estimated as positive and significant in Agricultural and Industrial Machinery, where the coefficient on the interaction term is positive in 18 out of 19 sectors and is significantly positive in 16 of them. For the rest of these broader sectors, however, the results closely follow the average results. Overall, there is no obvious systematic difference in results across more broadly-defined sectors.

5 Aggregation Bias

Estimating the system sector by sector allows me to identify quality effects on bilateral flows while controlling for inter-sectoral determinants of comparative advantage. This is in stark contrast to the literature testing the Linder hypothesis, which typically uses aggregate data. This section investigates how the use of aggregate instead of sectoral data affects the estimation results. Aggregating data across sectors introduces a bias, which turns out to be strong enough to reverse the estimated sign of the quality effect.

I first estimate the model using trade flows aggregated at the 2-digit instead of 3-digit level. Table 5 shows the results. The coefficient on the interaction term is still positive in a majority of sectors. However, it is now positive and significant in less than half of the sectors, and the magnitude of the average coefficient is smaller than in the baseline case. Aggregating data at the 2-digit level does not qualitatively change, but it does attenuate, the main results on the quality effect.

Aggregation into only one sector, however, reverses the results.[31] In Table 6, the effect of quality contradicts the theoretical prediction. The coefficient is not only negative but also significant at the 1% level. Morevoer, its magnitude is three times larger than the average estimated coefficient in the baseline case. There are also unexpected signs for the coefficients on other variables. Border and PTA have the wrong sign in the *Imports Equation*. Distance is no longer significant in the

[29] Office Machines (includes calculating machines, cash registers, typewriters, etc.) and Automatic Data Processing Machines and Units Thereof (basically computers).

[30] Outer Garments for Men, of Textile Fabrics, and Under Garments of Textile Fabrics.

[31] Aggregation is only over the 113 differentiated-goods sectors in the database. I use the Overall Quality Index, shown in the last column of Table 1, as the measure of quality for each country.

Fixed Cost Equation. Exporter's and importer's total GDP still have a negative impact on fixed costs, but the significance of these two variables is reversed: importer's GDP is significant while exporter's GDP is not.

These striking results are driven by a severe aggregation bias. When the system was estimated at the sectoral level, we could control for inter-sectoral determinants of comparative advantage. But when we aggregate trade flows across sectors, we fail to control for these determinants. The aggregation bias is not strong at lower levels of aggregation because the determinants of comparative advantage are similar among 3-digit sectors in the same 2-digit sector. But it is severe at higher levels of aggregation because these determinants may differ considerably between broader sectors. Appendix C discusses in detail the aggregation problem, and provides conditions on the parameters across sectors that would render aggregation an appropriate procedure.

A possible alternative reason for the similarity of results obtained based on trade flows at the 3-digit and at the 2-digit level is the use of quality indices calculated at the 2-digit level in both cases. To better address the effect of aggregation, I reestimate the model using 3-digit trade flows and 3-digit quality indices. Working with quality indices at the 3-digit level reduces the sample from 291,765 observations to 240,779 observations. Table 7 shows the results when the model is estimated using 3-digit quality indices. Despite the significant decrease in sample size, the results are not very different from those of the baseline case.[32] Next, using only those 240,779 observations for which 3-digit quality indices are available, I aggregate trade flows at the 2-digit level and re-estimate the model using 2-digit quality indices. Table 8 shows that, as in the baseline case, aggregating trade flows at the 2-digit level does not change the results substantially. The use of 2-digit quality indices is then not the reason for the similarity of results obtained based on trade flows at the 3-digit and 2-digit levels.[33]

5.1 Direction of the bias

The aggregation of trade flows into only one category introduces a severe aggregation bias. This bias is systematic and can be signed. I next provide a simple artificial example to convey the basic intuition for the direction of the aggregation bias. In section 6, I will provide evidence supporting

[32] In one sector, I could not obtain maximum likelihood estimates due to a large reduction in the sample size.

[33] This exercise further suggests the robustness of the estimated results to the level of aggregation at which the quality index is calculated.

the empirical relevance of this example.

Consider two exporters, Germany and China. Consider two importers, the US and India. Table 9 shows exports of Germany and China to the US and India in two sectors, Machinery and Apparel. This artificial example abstracts from trade costs and differences in size. Germany and the US have similar income per capita, and a comparative advantage in the same sector: Machinery. China and India have a comparative advantage in Apparel. Germany is therefore a large exporter of Machinery (relative to China) and China is a large exporter of Apparel (relative to Germany). Similarly, the US is a large importer of Apparel (relative to India) and India of Machinery (relative to the US). Germany's quality is higher in both sectors.

Focusing on Machinery, the quality effect is apparent: the US imports relatively more from Germany, and India imports relatively more from China. The ratio of the ratios (r_{ij}^{kl}) discussed in Section 2 takes the value of 1.5. In Apparel, the quality effect is also apparent. The ratio of the ratios is also 1.5 in this sector. However, when we aggregate trade flows in both sectors, the quality effect appears to be reversed: the US imports relatively more from China and India imports relatively more from Germany. Using the empirical framework of this paper, but applying it to aggregate trade, this pattern of trade would result in a misleading negative coefficient on the interaction term, as in the results of Table 6. The reason is the inadequate aggregation of trade flows across sectors, and the subsequent failure to control for inter-sectoral determinants of comparative advantage. In the aggregate, the US imports relatively more from China than from Germany, not because the US's demand is biased towards low-quality goods but because the US is a large importer of Apparel, the sector in which China is a large exporter. Similarly, India imports relatively more from Germany than from China, not because India's demand is biased towards high-quality goods, but because India is a large importer of Machinery, the sector in which Germany is a large exporter.

5.2 Comparative advantage in a sector: caveats

In traditional models of international trade, a sector is characterized from both the supply and the demand side. For example, on the supply side of the factor-proportions model, varieties within a sector share the same technology of production. On the demand side, varieties are either perfect substitutes (the homogeneous-goods case) or better substitutes for each other than for varieties in other sectors (the differentiated-goods case). The idea of a country with a comparative advantage in a sector is straightforward in this context. If a country has a comparative advantage in one variety, it also has a comparative advantage in all the varieties in that sector.

This is no longer true once we introduce differences in quality. A country may have a comparative advantage in producing low-quality varieties within a sector, but not high quality-ones. For example, if high-quality varieties are skill intensive, then skill-abundant countries will produce high-quality varieties and skill-scarce countries will produce low-quality varieties.[34] A sector is still well defined on the demand side. But on the supply side, varieties within a sector may have nothing in common. We can no longer say, for example, that poor countries have a comparative advantage in textiles, since they may have a comparative advantage in producing low-quality textiles, but a comparative disadvantage in producing high-quality textiles.[35] This problem poses the challenge of finding a meaningful redefinition of sectors in the context of trade models that include vertical differentiation. Since that is not the aim of this paper, I will instead simply posit that the idea of a country having a comparative advantage in a sector preserves some (limited) meaning in this context.

I classify the 54 countries in the sample into three equally-sized groups. Rich countries are those with income per capita above $14,000, middle-income countries are those with income per capita between $2,200 and $14,000, and poor countries are those with income per capita below $2,200. Apparel (2-digit SITC sector 84) represents 3% of the exports of rich countries, 11% of the exports of middle-income countries, and 32% of the exports of poor countries.[36] On average, poor and middle-income countries have positive trade balances in Apparel, while rich countries have negative trade balances in this sector. Even though countries with different per-capita income export different quality levels within Apparel, poor countries have a comparative advantage in a range of qualities that accounts for a fraction of world demand large enough to make them net exporters in this sector. On the other hand, Machinery (1-digit SITC sector 7) represents 57%

[34] This is an appealing explanation for the observed correlation between the quality of exports and per-capita income. In this paper, however, I do not investigate the underlying determinants of comparative advantage.

[35] Schott (2001) argues that we should consider goods of different qualities as different sectors. This approach, although appealing on the supply side, still needs to deal with the demand-side links between goods of different qualities.

[36] These are shares of total exports of differentiated goods. Percentages are calculated taking into account only trade flows included in the sample.

of the exports of rich countries, 40% of the exports of middle-income countries, and 15% of the exports of poor countries. Rich countries are net exporters of Machinery, while poor and middle-income countries are net importers of Machinery. Rich countries have a comparative advantage in a range of qualities within Machinery that accounts for a fraction of world demand large enough to make them net exporters in this sector. Poor countries do not. The notion of a country having a comparative advantage in a sector is still meaningful in this limited sense. Subject to these caveats, I keep the usual terminology in the remainder of the paper.

6 Magnitude of the Quality Effect

This paper has shown that quality differences between countries affect the direction of bilateral trade. Controlling for inter-sectoral determinants of comparative advantage, rich (poor) countries import relatively more from countries that produce high-(low-) quality goods. Since rich (poor) countries also tend to produce high-(low-) quality goods, the quality effect typically induces more rich-rich and poor-poor trade relative to rich-poor trade. This contrasts, for example, with the implications of the factor proportions model, which predicts more rich-poor trade as differences in income per capita reflect differences in relative factor endowments.[37] In this section, I investigate the relative magnitude of these opposing forces.

To accomplish this, I consider the change in export destinations of a hypothetical country that suddenly climbs the development ladder and becomes rich. The share exported to the group of rich countries –as defined in the previous section– gives a summary measure of export destinations. This group absorbs, on average, 74% of rich countries' exports, 62% of middle-income countries' exports, and 78% of poor countries' exports. This is shown in column (1) of Table 10. As our hypothetical country develops, does the share exported to the group of rich countries rise or fall?

There are many determinants of country growth, and I do not delve into them here. Instead, I simply assume that a country that develops adopts two characteristics of rich countries: their composition of exports across sectors and their quality levels. The adoption of these two characteristics is likely to occur simultaneously. For example, a country may become rich because it

[37] In a factor proportions model with both homogeneous and differentiated-good sectors, rich-rich (but not poor-poor) trade may be large because rich countries are specialized in the latter sectors [Helpman (1999)]. However, this effect cannot be present here since we are focusing only on differentiated-good sectors.

has accumulated skilled labor. It will then shift its export structure between sectors toward skill-intensive industries. But it will also shift it toward high-quality varieties within each sector, so long as high-quality varieties are skill intensive.

The effects of the between-sector and within-sector changes in export structure on the destination of exports are opposite to one another. First, consider the between-sector change, keeping quality levels constant. As will be shown shortly, if quality levels do not change, the destination structure of exports at the sectoral level does not change either. However, there is variation between sectors in export destinations. Hence, the destination of total exports will change in response to the between-sector change in export structure. The magnitude of this change is shown in columns (2) and (3). For an average poor country adopting the sectoral export structure of rich countries, this implies a decrease of 14.6 percentage points in the share exported to these countries. This is consistent with traditional theories of trade based on inter-sectoral differences in comparative advantage, and it is also consistent with the artificial example of Table 9. A (simplified) explanation is as follows. Rich (poor) countries are large importers of Apparel (Machinery) because they have a comparative disadvantage in that sector. Hence, for any source country, exports of Apparel (Machinery) are relatively tilted toward Rich (poor) countries. When our hypothetical country is poor, its exports are concentrated in Apparel, the sector in which poor countries have a comparative advantage. Since Apparel exports are tilted toward rich countries, a large share of our country's exports are sent to rich countries. As this country adopts the sectoral composition of exports of rich countries, it becomes a relatively large exporter of Machinery, a sector in which exports are tilted toward poor countries. As a result, a larger share of its total exports is now sent to poor countries.[38]

Second, adopting the quality levels of rich countries also changes export destinations. We now keep constant the sectoral composition of exports (the average export structure of rich countries) and evaluate, for each country, the additional impact in export destinations of the within-sector change in export structure, i.e., the change in quality levels. Differentiating (12), we obtain:

$$\widehat{imp}_{iz}^{k} = d\varphi_{iz} + (\sigma_z - 1)\mu_z \log y^k \widehat{\theta}_{iz}, \tag{20}$$

where hats denote proportional changes. The term $d\varphi_{iz}$ captures changes in the number of firms and

[38] Note that even though the factor proportions model was used to motivate this section, a sectoral change in export structure could result from other inter-sectoral determinants of trade such as Ricardian (technology) differences.

in the price at which they sell their products. This term induces a proportional change in exports to all countries, but it does not change the share of each country as a destination of exports. Only changes in quality levels can change the destination structure of exports, which can be calculated from (20) for every sector z and country i. To perform this calculation, I take the value of $(\sigma_z - 1)\mu_z$ from the estimated coefficient on the interaction term in the baseline case, while $\widehat{\theta}_{iz}$ is the change in quality required to match the average level of rich countries.

There are some caveats to this exercise. First, it is only valid for one country at a time. As a country changes its quality levels, its income also changes. If more countries change qualities simultaneously, then export destinations will not only change in response to the change in the exporter's quality but also in response to the change in the importer's income. Unless more structure is imposed on the model, it is not possible to obtain a measure of this latter change. Also, $d\psi_z^k$ is assumed to be zero in (20). Since $d\psi_z^k$ includes the price index of importer k, this term is almost zero only when the effect of price changes on this index is negligible, which is not the case if more countries change their qualities (and therefore, their prices) simultaneously. Second, embedded in this calculation is the strong assumption that there are no new bilateral pairs with positive trade. In fact, increases in quality could increase import demand to a level that renders new exports (paying the fixed cost) to some destinations profitable. However, I ignore this possibility because it would require knowing the magnitude of $d\varphi_{iz}$, which I do not have.

Column (4) of Table 10, then, shows the destination of exports after both characteristics of rich countries have been adopted. Column (5) shows the impact of the quality effect, which is larger for lower income countries. This is not surprising since these are the countries that require the largest upgrade to match rich countries' quality levels. Keeping constant the sectoral structure of exports, the quality upgrade increases rich countries' share of poor countries' exports by 2.1 percentage points, of middle-income countries' exports by 1.4 percentage points, and of rich countries' exports by 0.0 percentage points. As a country becomes rich, it exports more to other rich countries.

There are two effects at play. The first is an inter-sectoral effect: the change in the sectoral composition of exports. This effect is driven by traditional forces of comparative advantage, not related to quality.[39] The second is an intra-sectoral effect: the change in quality levels. The overall

[39] This includes supply-side determinants (factor proportions, Ricardo), and demand-side determinants (inter-sectoral non-homotheticities).

change in the destination of exports is given in the last column of Table 10. As is clear from the table, it is strongly dominated by the inter-sectoral effect. As a middle-income country becomes rich, the share exported to rich countries decreases by 8 percentage points. As a poor country becomes rich, this share falls by 12.5 percentage points. In contrast to the prediction of the Linder hypothesis on the direction of trade, as a country becomes rich, it exports relatively more to poor countries.

These results suggest that, even though cross-country differences in product quality have a significant effect on the patterns of trade, traditional determinants of comparative advantage are still the main driving force of international trade flows.

7 Conclusions and Further Comments

This paper provides a framework to estimate the effect of cross-country differences in product quality on the direction of international trade. The model yields testable predictions on bilateral trade flows at the sectoral level, which are estimated using cross-sectional data for 54 countries. The results are consistent with the theoretical prediction: rich (poor) countries import relatively more from countries that produce high- (low-) quality goods. However, relative to the magnitude of traditional (inter-sectoral) determinants of comparative advantage, the magnitude of the quality effect on bilateral trade is small.

The theoretical framework and empirical strategy of this paper suggest several areas for further exploration and improvement. First, beyond the theoretical concerns about the measurement of quality addressed in the paper, the reliability and accuracy of the import data on which this measurement is built are not completely satisfactory. Second, even though the framework developed in this paper combines simplicity with flexibility to capture income effects on quality choices, the demand system could be extended to allow for more flexible substitution patterns between varieties of different quality levels. Third, as suggested by the theoretical work on trade with vertical differentiation, it is not merely the mean but the whole distribution of income that matters as a determinant of international trade. Future research will determine whether the results of this paper on the direction and magnitude of the quality effect on trade survive these and other amendments.

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A Appendix: An alternative demand system from a discrete choice model

A discrete choice model generates an alternative to the demand system given by (3). Assume that the indirect utility of consumer k, conditional on choosing variety h in sector z, is:

$$u_h^k = \ln \theta_h - \gamma_z^k \ln p_h + \zeta_z^k + (1-\rho)\epsilon_h^k. \tag{21}$$

The disturbance ϵ_h^k is an identically and independently distributed extreme value variable. The random variable ζ_z^k is common to all varieties in sector z and has a distribution function that depends on ρ, with $0 \leq \rho < 1$. Following Cardell (1991), I assume that the distribution of ζ is the unique distribution with the property that, if ϵ is an extreme value random variable, then $[\zeta + (1-\rho)\epsilon]$ is also an extreme value random variable. These assumptions on the error structure generate the nested logit model.[40] As the parameter ρ approaches one (zero), the within sector correlation of utility levels goes to one (zero).

In this specification, consumers do not differ in their preferences for quality. Instead, they differ in their sensitivity to price. γ_z^k represents the marginal utility of income, which is a negative function of income.[41] In this framework, within-country consumer heterogeneity comes from the error terms but not from differences in income (income per capita is the measure of income for all consumers in country k). There are, however, differences in income per capita across countries, which affect consumer choices through the parameter γ_z^k.

The expenditure share of h in sector z is:

$$s^k(h) = \frac{p_h^{1-\frac{\gamma_z^k}{1-\rho}} \theta_h^{\frac{1}{1-\rho}}}{\sum_{r \in z} p_r^{1-\frac{\gamma_z^k}{1-\rho}} \theta_r^{\frac{1}{1-\rho}}}.$$

Assuming, as before, that all varieties in sector z and country i have identical quality and price, and using $p_{iz}^k = p_{iz}\tau_{iz}^k$, country k imports from i are:

$$imp_{iz}^k = N_{iz} \frac{p_{iz}^{1-\frac{\gamma_z^k}{1-\rho}} \tau_{iz}^{k^{1-\frac{\gamma_z^k}{1-\rho}}} \theta_{iz}^{\frac{1}{1-\rho}}}{\sum_{r \in z} p_r^{1-\frac{\gamma_z^k}{1-\rho}} \tau_r^{k^{1-\frac{\gamma_z^k}{1-\rho}}} \theta_r^{\frac{1}{1-\rho}}} E_z^k. \tag{22}$$

[40] See Berry (1994).

[41] This is how income effects on consumer choice are typically modeled in the empirical Industrial Organization literature [Berry, Levinsohn, and Pakes (1999, 2001), Nevo (2001), Petrin (2001)].

Taking logs of (22), most of the terms (those that depend only on either the exporter or the importer) are again captured with exporter and importer fixed effects. The remaining terms are:

$$(1 - \frac{\gamma_z^k}{1-\rho}) \log p_{iz} + (1 - \frac{\gamma_z^k}{1-\rho}) \log \tau_{iz}^k. \tag{23}$$

In this specification, there are two interaction terms instead of one. The importer's γ^k now interacts with both the exporter's supply price and trade costs.

The functional form assumptions for τ_{iz}^k and γ_z^k are again:

$$\log \tau_{iz}^k = \eta_z \log Dist_i^k + \beta_z \mathbf{I}_{iz}^k \tag{24}$$

$$\gamma_z^k = \gamma_z - \mu_z \log y^k \tag{25}$$

where a decreasing marginal utility of income implies $\mu_z > 0$.

Substituting (25) and (24) into (22) –in logs–, and including a random disturbance affecting the volume of trade, we obtain:

$$\begin{aligned} \log imp_{iz}^k \quad = \quad & \varphi_{iz} + \psi_z^k - a\eta_z \log Dist_i^k + a\boldsymbol{\beta}_z \mathbf{I}_{iz}^k + b \log y^k \log p_{iz} \\ & + b\eta_z \log y^k \log Dist_i^k + b\boldsymbol{\beta}_z \mathbf{I}_{iz}^k \log y^k + \varepsilon_{iz}^k, \end{aligned} \tag{26}$$

where $a = 1 - \frac{\gamma_z}{1-\rho}$, and $b = \frac{\mu_z}{1-\rho}$.

This specification is very similar to the specification derived from the baseline model. The first line of (26) reproduces that specification since quality was assumed proportional to the exporter price p_{iz}. But the second line includes additional interaction terms. Since income effects are now captured by cross-country differences in price sensitivity and not by differences in preference for quality, every variable that determines the import price –where quality is the most important but not the only variable– interacts with income per capita. For example, a longer distance increases transportation costs, and hence import prices. But a richer country will be less sensitive to "distance" than a poorer one, because it is not so sensitive to the effect of distance on the import price.

Table A3 shows estimation results for this model. Compared to the baseline results of Table 3, the coefficient on the interaction between exporter price (or quality) and income per capita has the same sign in most cases, but it changes from positive to negative in 9 of them. Also, it is now positive and significant in slightly less than half of the sectors, and its average magnitude is considerably lower. The coefficients on non-interacting variables in the *Imports Equation* keep their previous pattern, except for Colonial, which is now not significant in most sectors. Results for the new interaction variables are mixed. The interaction of importer per capita income with Distance, Common Language, and Colonial have the expected signs in most sectors, with significant coefficients in more than half of the sectors for the first two variables. But the coefficients on the rest of the interaction terms are in general not significantly different from zero. In the case of the *Fixed Cost Equation*, the results are similar to those in the baseline case but, as in the *Imports Equation*, the number of statistically significant coefficients is scarcer, probably due to the reduction in the degrees of freedom.

In sum, the effect of quality is slightly weaker under this alternative discrete choice model. However, the overall results are not drastically different from the baseline case, and they do not change the main conclusions of the paper.

B Appendix: Methodology of construction of quality indices

This appendix discusses in detail the methodology used to construct the quality indices. I assume that at the 10-digit level of disaggregation, cross-country differences in unit values reflect proportional differences in quality. Denoting v_{ij} the unit value of US imports of 10-digit category j from country i, θ_{ij} its quality, and $\overline{p}_j$ the common international price for a common measure of quality,

$$v_{ij} = \theta_{ij}\overline{p}_j \tag{27}$$

is a quality index at the 10-digit level. But since sectors z are defined at the 2 or 3-digit SITC level, we need an aggregate measure of these indices. This is a typical problem in price index theory. In this context, the objective is to decompose the value of imports for each 3-digit category into a quantity index and a quality index. To do that, we first find indices to decompose the value of imports into a quantity index and a unit value index:

$$IMP_{iz} = \sum_{j\in z} \frac{IMP_{ij}}{q_{ij}} q_{ij} = \sum_{j\in z} v_{ij} q_{ij} = V_{iz} Q_{iz}, \tag{28}$$

where q_{ij} is the quantity imported of category j from country i, V_{iz} is the unit value index for country i and sector z, and Q_{iz} is the quantity index. Even though the value of imports at the 10-digit level can be easily decomposed into a quantity and a price (unit value) component, the same decomposition at the aggregate level –the last equality in (28)– involves an arbitrary choice of index. I use the Eltetö, Köves, and Szulc (EKS).[42] The unit value index thus obtained can be interpreted as a quality index, which is what we are looking for. This is shown by noting that:

$$\begin{aligned} V_{iz}Q_{iz} &= \sum_{j\in z} v_{ij}q_{ij} = \sum_{j\in z} \left(\theta_{ij}\overline{p}_j\right) q_{ij} \\ &= \sum_{j\in z} \theta_{ij}\left(\overline{p}_j q_{ij}\right) = \sum_{j\in z} \theta_{ij}\widetilde{q}_{ij} = \theta_{iz}\widetilde{Q}_{iz}, \end{aligned} \tag{29}$$

where (27) was used in the first line and quantities have been re-scaled in the last line. The unit value index V_{iz} and the quality index θ_{ij} are proportional to each other because the method used to construct the unit value index satisfies the Invariance to Change in Units (or Commensurability) test. Therefore, for any two countries i and j, $\theta_{iz}/\theta_{jz} = V_{iz}/V_{jz}$.

I will now explain in detail the construction of the unit value (quality) indices V_{iz}. The objective is to obtain unit-value (quality) indices for the 37 2-digit SITC sectors in the sample.[43] Consider a generic 2-digit sector z. This sector includes 10-digit categories $n = 1, ..., N$. Dividing the customs value of imports by the quantity of imports, we obtain the unit value of imports for each country in category n. Since some of the 54 countries in the sample do not report exports to the US in any of the N categories, we cannot construct a quality index for these countries in sector z. These are the blanks in Table A2.

The source database contains many errors. I use the following procedure to detect and remove outliers and thus minimize the impact of these errors. For each category n, I calculate the mean and the standard deviation across countries of the log of imports, excluding the observations with maximum and minimum values. I remove observations where the deviation from the mean is greater than either 3.4 (i.e., the unit value is 30 times larger or smaller than the geometric mean) or five times the standard deviation.

I then take country j as a numeraire. For each other country i, I calculate the bilateral Fisher price index P_i^j and the implicit Fisher quantity index Q_i^j between i and j. These indices are calculated using unit values (prices) and quantities of imports for all 10-digit categories within a 2-digit sector z for which both i and j report positive exports to the US. I therefore obtain a vector

[42] See Diewart (1993), Ch.5, for an explanation of the properties of each index and the desirability of each property in different contexts.

[43] The same methodology is used to construct quality indices at the 3-digit level.

of quantity indices Q^j, with country j as the numeraire. I normalize this vector to sum up to 1. This vector, σ^j, gives the shares of world quantities using country j as the numeraire country.

This procedure is repeated taking alternatively all countries as numeraire, obtaining vectors σ^j, $j = 1, ..., C$, where C is the number of countries with positive exports to the US. The geometric weighted average of these indices:

$$\sigma_i = \prod_{j=1}^{C} \left(\sigma_i^j\right)^{w^j}, \tag{30}$$

where w^j is the share of country j in the total value (including only countries $1, ..., C$) of US imports of z, gives an average quantity index for i.

At this point, we could obtain implicit unit value (quality) indices for country i in sector z from the ratio between the US value of imports and this average quantity index. However, there is a problem in calculating (30) in only one step. When there is no category n with positive imports from both i and j ($\sigma_i^j = 0$), the vectors σ^j contain missing values. To deal with this problem, I follow a three-step procedure. In the first step, I calculate (30) using only vectors σ^j that are "complete".[44] I denote σ_i^1 the resulting average quantity share. In the second step, I include vectors σ^j that have at most five missing values. These vectors are re-normalized to sum up to $1 - m^j$, where m^j is the sum of quantity shares obtained in σ_i^1 for the missing elements (countries) in σ^j. Imputing the share σ_i^1 to the missing countries i, vectors σ^j now sum up to 1. I recalculate (30) using the complete vectors and the vectors with at most five missing shares. I denote σ_i^2 the resulting average share. Third, I repeat the procedure for the remaining vectors σ^j, imputing missing values according to the shares obtained in σ_i^2. I recalculate (30) using all vectors. Thus, I obtain the final average quantity shares σ_i. Using the total value of imports from each country and the quantity indices σ_i, I finally calculate the implicit unit value or quality index $\theta_{iz.}$[45]

C The aggregation problem

Consider two different sectors, a and b. Equation (5) and the *Imports Equation* (12) hold for each of these sectors separately. However, if we aggregate these sectors into sector c, these equations

[44] A numeraire country has a complete vector when it shares at least one common category n of exports to the US with any other country.

[45] An alternative quality measure can be obtained from the implicit unit-value index using σ_i^1 as the quantity index. The results are very similar.

only hold under the following restrictive conditions:

$$
\begin{gathered}
\sigma_a = \sigma_b, \qquad H_a = H_b, \\
\gamma_a^k = \gamma_b^k \quad \forall k, \qquad \tau_{ia}^k = \tau_{ib}^k \quad \forall i, k \\
p_{ia} = \kappa_1 p_{ib}, \quad \theta_{ia} = \kappa_2 \theta_{ib}, \quad N_{ia} = \kappa_3 N_{ib} \quad \forall i \\
E_a^k = \kappa_4 E_b^k \quad \forall k,
\end{gathered} \tag{31}
$$

where H is the number of available varieties in each sector and $\kappa_1, \kappa_2, \kappa_3$, and κ_4 are scalars. If conditions (31) are satisfied, the aggregation of sectors a and b into sector c results in:

$$
imp_{ic}^k = (1 + \kappa_3 \kappa_4) N_{ia} \frac{\left(\frac{p_{ia} \tau_{ia}^k}{\theta_{ia}^{\gamma_a^k}} \right)^{1-\sigma_s}}{\sum_{r \in a} \left(\frac{p_r \tau_r^k}{\theta_r^{\gamma_a^k}} \right)^{1-\sigma_a}} E_a^k, \tag{32}
$$

which is still consistent with the *Imports Equation* since the constant captures the additional term $(1 + \kappa_3 \kappa_4)$. A violation of conditions (31), however, leads to an aggregation bias.

An aggregation bias can exist even when we estimate the model for sectors defined at the 3-digit level. However, conditions (31) are more likely to be violated as we move towards higher levels of aggregation. For example, if a and b are 4-digit sectors within the same 3-digit category, varieties in these sectors probably require some common materials, need similar expertise, and share a similar production technology. Therefore, a country that produces high-quality varieties in sector a will also produce high-quality varieties in sector b. Similarly, a country that has a comparative advantage in sector a (and therefore has a relatively large number of firms in that sector), will also be expected to have a large number of firms in sector b because the determinants of comparative advantage are likely to be similar in both sectors. In contrast, conditions (31) can be seriously violated as we move toward higher levels of aggregation because determinants of comparative advantage, levels of quality, elasticities of substitution, and trade costs may change dramatically among more broadly defined sectors.

Table 1. Quality indices: summary results and correlation with income per capita

	Country	*GDP per capita*[a]	*Avg. of 2-digit quality indices*[b]	*Overall Quality Index*[c]
1	Switzerland	43658	1.62	1.45
2	Japan	40955	1.31	0.58
3	Denmark	34608	0.71	0.69
4	Germany	29425	1.54	1.14
5	Austria	28705	1.01	1.05
6	Singapore	27992	0.49	0.44
7	Belgium-Lux.	27619	1.00	1.14
8	France	26404	1.63	1.04
9	Sweden	26192	1.26	1.35
10	Netherlands	25768	1.32	1.11
11	Finland	24652	0.47	0.63
12	Hong Kong	22619	0.36	0.23
13	Australia	20206	0.85	1.03
14	Canada	19535	1.00	1.00
15	Italy	19019	1.28	0.83
16	United Kingdom	18890	1.11	1.11
17	Israel	15666	0.63	0.60
18	Spain	14273	1.06	0.80
19	Greece	11096	0.17	0.17
20	South Korea	10874	0.61	0.41
21	Taiwan	10601	0.43	0.30
22	Portugal	10545	0.38	0.46
23	Argentina	7429	0.45	0.61
24	Saudi Arabia	6735	0.11	0.07
25	Brazil	4418	0.44	0.33
26	Malaysia	4238	0.28	0.20
27	Chile	4176	0.18	0.23
28	Mexico	3986	0.54	0.38
29	South Africa	3863	0.42	0.36
30	Venezuela	3537	0.19	0.40
31	Poland	3274	0.24	0.34
32	Thailand	2830	0.28	0.23
33	Turkey	2805	0.17	0.28
34	Costa Rica	2705	0.11	0.10
35	Peru	2507	0.06	0.11
36	Colombia	2399	0.24	0.29
37	Tunisia	2008	0.03	0.06
38	Ecuador	1565	0.12	0.13
39	Bulgaria	1560	0.04	0.08
40	Dominican Rp	1526	0.11	0.13
41	Guatemala	1469	0.08	0.10
42	Romania	1448	0.12	0.14
43	Morocco	1250	0.07	0.09
44	Syrn Arab Rp	1173	0.03	0.01
45	Philippines	1055	0.25	0.28
46	Indonesia	1042	0.30	0.32
47	Egypt	1034	0.21	0.13
48	Sri Lanka	719	0.04	0.02
49	China	582	0.36	0.30
50	Pakistan	500	0.12	0.17
51	India	392	0.32	0.23
52	Bangladesh	314	0.08	0.02
53	Vietnam	277	0.02	0.01
54	Nigeria	253	0.02	0.14
Correlation with Income per Capita:			0.85	0.82

[a] In US dollars, 1995. [b] Unweighted geometric average of 2-digit quality indices.
[c] Quality Index at the aggregate level.

Table 2. OLS Estimation
Summary Results[a] (113 sectors)

			Statistical Significance[b]			*Average*
	Positive	*Negative*	*Positive*	*Not Sig.*	*Negative*	*Coefficient*
Imports Equation[cd]:						
Interaction term	94	19	66	39	8	0.063
Distance	0	113	0	0	113	-1.08
Border	91	22	27	84	2	0.25
Common Lang.	112	1	95	18	0	0.58
PTA	88	25	41	68	4	0.30
Colonial	109	4	79	34	0	0.82
Common Colony	84	29	24	86	3	0.29

[a] This table provides summary results for the estimation of the *Imports Equation* on 113 sectors. The first two columns show the number of sectors with estimated positive and negative coefficients. The next three columns summarize the coefficients by their significance at the 5% level. The last column is the average coefficient across sectors.
[b] Significant at the 5% level.
[c] The dependent variable is the log of sectoral bilateral imports. This equation is estimated by OLS, sector by sector.
[d] The Interaction term is the product of the log of exporter's quality and the log of importer's income per capita. Distance is the log of the bilateral distance. Border, Common Language, PTA, Colonial, and Common Colony are dummy variables indicating whether the bilateral country pair shares a border, a common language, a preferential trade agreement, a colonial relationship, and a common colonizer, respectively. Results for exporter and importer fixed effects are not reported.

Table 3. Baseline Estimation
Summary Results[a] (113 sectors)

	Positive	Negative	*Statistical Significance[b]* Positive	Not Sig.	Negative	*Average Coefficient*
Imports Equation[cd]:						
Interaction term	93	20	64	41	8	0.037
Distance	0	113	0	1	112	-1.18
Border	93	20	27	84	2	0.25
Common Lang.	112	1	98	15	0	0.61
PTA	67	46	28	72	13	0.11
Colonial	108	5	87	26	0	0.88
Common Colony	83	30	29	82	2	0.33
Fixed Cost Equation[c]:						
Distance	109	4	75	38	0	0.31
Border	96	17	28	85	0	0.55
Common Lang.	22	91	1	80	32	-0.31
PTA	39	74	3	91	19	-0.39
Colonial[e]	23	85	1	101	6	-1.45
Common Colony	43	70	1	102	10	-0.38
Exporter GDP	2	111	0	31	82	-0.29
Importer GDP	43	70	16	75	22	-0.02
Average Predicted Censoring Point[f]:	$ 51,798					

[a] This table provides summary results for the estimation of the baseline specification on 113 sectors. The first two columns show the number of sectors with estimated positive and negative coefficients. The next three columns summarize the coefficients by their significance at the 5% level. The last column is the average coefficient across sectors.
[b] Significant at the 5% level.
[c] The dependent variable in the *Imports Equation* is the log of sectoral bilateral imports. The dependent variable in the *Fixed Cost Equation* is the log of the bilateral fixed costs of exporting. The *Fixed Cost Equation* determines the threshold for censoring in the *Imports Equation*. Both equations are estimated simultaneously by maximum likelihood, sector by sector.
[d] The Interaction term is the product of the log of exporter's quality and the log of importer's income per capita. Distance is the log of the bilateral distance. Border, Common Language, PTA, Colonial, and Common Colony are dummy variables indicating whether the bilateral country pair shares a border, a common language, a preferential trade agreement, a colonial relationship, and a common colonizer, respectively. Exporter GDP and Importer GDP are the logs of the GDP levels for both exporter and importer. Results for the exporter and importer fixed effects in the *Imports Equation* and for the constant in the *Fixed Cost Equation* are not reported.
[e] The estimated coefficient is $-\infty$ in 5 sectors. These sectors are not included in the reported results for this variable.
[f] The average predicted censoring point is the geometric average of the predicted value of the *Fixed Cost Equation* across all observations in all sectors.

Table 4. Baseline Estimation
Sectoral pattern of results for the Interaction term[a]

Description	*Number of Sectors*			*Statistical Significance*[b]		
	Total	*Positive*	*Negative*	*Positive*	*Not Sig.*	*Negative*
Food & Beverages	7	7	0	3	4	0
Worked Wood	1	1	0	0	1	0
Chemicals	7	6	1	5	2	0
Leather, Rubber, Cork, Wood & Paper Manufactures	7	5	2	2	4	1
Textiles, except Apparel	9	8	1	3	6	0
Non-metalic Mineral Manufactures	6	5	1	4	2	0
Manufactures of Metal	10	8	2	8	2	0
Agricultural & Industrial Machinery	19	18	1	16	3	0
Office, Telecommunications & Sound Recording Machines	5	1	4	1	2	2
Electric Machinery	7	6	1	4	2	1
Road Vehicles & Transport Equipment	9	8	1	5	3	1
Apparel & Footwear	8	5	3	1	5	2
Professional, Scientific, Control, Photographic & Optical Apparatus	7	6	1	5	2	0
Miscellaneous Manufactures	11	9	2	7	3	1
Total	113	93	20	64	41	8

[a] This table groups the results for the Interaction term in the baseline specification into 14 broader sectors.
[b] Significant at the 5% level.

Table 5. Trade flows aggregated at the 2-digit level
Summary Results[a] (37 sectors)

	Positive	Negative	*Statistical Significance[b]* Positive	Not Sig.	Negative	*Average Coefficient*
Imports Equation[cd]:						
Interaction term	30	7	16	18	3	0.019
Distance	0	37	0	1	36	-1.23
Border	24	13	8	27	2	0.20
Common Lang.	37	0	36	1	0	0.76
PTA	21	16	9	24	4	0.12
Colonial	36	1	30	7	0	0.90
Common Colony	25	12	10	26	1	0.30
Fixed Cost Equation[c]:						
Distance	36	1	24	13	0	0.34
Border	31	6	17	20	0	0.82
Common Lang.	12	25	2	27	8	-0.18
PTA[e]	9	27	0	33	3	-1.97
Colonial[e]	4	32	0	35	1	-3.75
Common Colony	7	30	0	31	6	-0.92
Exporter GDP	2	35	0	7	30	-0.31
Importer GDP	14	23	3	26	8	-0.04
Average Predicted Censoring Point[e]:		$ 43,819				

[a] This table provides summary results for the estimation of the model using bilateral trade flows aggregated at the 2-digit level. The estimation is performed on 37 2-digit sectors.
[b] Significant at the 5% level.
[c] The dependent variable in the *Imports Equation* is the log of sectoral bilateral imports. The dependent variable in the *Fixed Cost Equation* is the log of the bilateral fixed costs of exporting. The *Fixed Cost Equation* determines the threshold for censoring in the *Imports Equation*. Both equations are estimated simultaneously by maximum likelihood, sector by sector.
[d] The Interaction term is the product of the log of exporter's quality and the log of importer's income per capita. The rest of the variables are defined as in Table 3.
[e] The estimated coefficient is $-\infty$ in 1 sector. This sector is not included in the reported results for this variable.
[f] The average predicted censoring point is the geometric average of the predicted value of the *Fixed Cost Equation* across all observations in all sectors.

Table 6. Trade flows aggregated into one sector[a]

	Coefficient	Standard Error
Imports Equation[bc]:		
Interaction term	-0.114	(0.014)**
Distance	-1.37	(0.04)**
Border	-0.32	(0.15)*
Common Lang.	1.00	(0.09)**
PTA	-0.26	(0.12)*
Colonial	1.00	(0.23)**
Common Colony	0.35	(0.17)*
Fixed Cost Equation[b]:		
Distance	0.22	(0.31)
Border	3.34	(1.27)**
Common Lang.	-0.22	(0.69)
PTA	-10.42	(74.29)
Colonial	-6.21	(323.83)
Common Colony	-1.99	(1.06)
Exporter GDP	-0.41	(0.27)
Importer GDP	-0.56	(0.21)**
Average Predicted Censoring Point[d]:	$ 5,293	

** Significant at the 1% level.
* Significant at the 5% level
[a] This table shows results for the estimation of the model using bilateral trade flows aggregated into one sector.
[b] The dependent variable in the *Imports Equation* is the log of bilateral imports. The dependent variable in the *Fixed Cost Equation* is the log of the bilateral fixed costs of exporting. The *Fixed Cost Equation* determines the threshold for censoring in the *Imports Equation*. Both equations are estimated simultaneously by maximum likelihood.
[c] The Interaction term is the product of the log of the exporter's Overall Quality Index and the log of the importer's income per capita. The rest of the variables are defined as in Table 3.
[d] The average predicted censoring point is the geometric average of the predicted value of the *Fixed Cost Equation* across all observations.

Table 7. Estimation using 3-digit quality indices
Summary Results[a] (112 sectors[e])

	Positive	Negative	Statistical Significance[b] Positive	Not Sig.	Negative	Average Coefficient
Imports Equation[cd]:						
Interaction term	94	18	57	48	7	0.033
Distance	0	112	0	0	112	-1.18
Border	89	23	23	86	3	0.23
Common Lang.	112	0	96	16	0	0.62
PTA	65	47	26	76	10	0.13
Colonial	107	5	81	31	0	0.88
Common Colony	84	28	28	81	3	0.37
Fixed Cost Equation[c]:						
Distance	104	8	68	44	0	0.32
Border[f]	97	14	32	79	0	0.58
Common Lang.	25	87	1	84	27	-0.28
PTA	37	75	2	91	19	-0.54
Colonial[g]	28	72	1	97	2	-2.60
Common Colony[f]	33	78	1	99	11	-0.61
Exporter GDP	2	110	0	35	77	-0.29
Importer GDP	43	69	16	75	21	-0.03
Average Predicted Censoring Point[h]:		$ 46,745				

[a] This table provides summary results for the estimation of the model using quality indices calculated at the 3-digit level instead of at the 2-digit level.
[b] Significant at the 5% level.
[c] The dependent variable in the *Imports Equation* is the log of sectoral bilateral imports. The dependent variable in the *Fixed Cost Equation* is the log of the bilateral fixed costs of exporting. The *Fixed Cost Equation* determines the threshold for censoring in the *Imports Equation*. Both equations are estimated simultaneously by maximum likelihood, sector by sector.
[d] The Interaction term is the product of the log of exporter's quality (at the 3-digit level) and the log of importer's income per capita. The rest of the variables are defined as in Table 3.
[e] Due to the loss of observations, it was not possible to estimate the model in one sector.
[f] The estimated coefficient is $-\infty$ in 1 sector. This sector is not included in the reported results for this variable.
[g] The estimated coefficient is $-\infty$ in 12 sectors. These sectors are not included in the reported results for this variable.
[h] The average predicted censoring point is the geometric average of the predicted value of the *Fixed Cost Equation* across all observations in all sectors.

Table 8. Estimation using 2-digit quality indices
Only observations with available 3-digit quality indices included
Summary results[a] (37 sectors)

			Statistical Significance[b]			*Average Coefficient*
	Positive	*Negative*	*Positive*	*Not Sig.*	*Negative*	
Imports Equation[cd]:						
Interaction term	29	8	18	15	4	0.019
Distance	0	37	0	0	37	-1.25
Border	25	12	8	27	2	0.19
Common Lang.	37	0	34	3	0	0.75
PTA	21	16	9	25	3	0.10
Colonial	37	0	30	7	0	0.89
Common Colony	25	12	10	27	0	0.27
Fixed Cost Equation[c]:						
Distance	35	2	24	13	0	0.34
Border	32	5	15	22	0	0.73
Common Lang.	11	26	2	28	7	-0.20
PTA	9	28	1	32	4	-1.66
Colonial[e]	7	28	0	35	0	-3.11
Common Colony	8	29	0	31	6	-1.02
Exporter GDP	1	36	0	5	32	-0.33
Importer GDP	13	24	3	25	9	-0.04
Average Predicted Censoring Point[f]:		$ 44,871				

[a] This table provides summary results for the estimation of the model using bilateral trade flows aggregated at the 2-digit level. The estimation is performed on 37 2-digit sectors. Only observations with available 3-digit quality indices are included.
[b] Significant at the 5% level.
[c] The dependent variable in the *Imports Equation* is the log of sectoral bilateral imports. The dependent variable in the *Fixed Cost Equation* is the log of the bilateral fixed costs of exporting. The *Fixed Cost Equation* determines the threshold for censoring in the *Imports Equation*. Both equations are estimated simultaneously by maximum likelihood, sector by sector.
[d] The Interaction term is the product of the log of exporter's quality and the log of importer's income per capita. The rest of the variables are defined as in Table 3.
[e] The estimated coefficient is $-\infty$ in 2 sectors. These sectors are not included in the reported results for this variable.
[f] The average predicted censoring point is the geometric average of the predicted value of the *Fixed Cost Equation* across all observations in all sectors.

Table 9. The aggregation bias: an artificial example[a]

	Importer								
	Machinery			*Apparel*			*Total*		
Exporter	US (U)	India (I)	Total Exports	US (U)	India (I)	Total Exports	US (U)	India (I)	Total Exports
Germany (G)	240	400	640	120	40	160	360	440	800
China (C)	20	50	70	400	200	600	420	250	670
Total Imports	206	450	710	520	240	760	780	690	1470
Ratio G/C	12	8		0.3	0.2		0.86	1.76	
Ratio of Ratios $(G/C)^U/(G/C)^I$	1.5			1.5			0.49		

[a] This table provides an artificial example to illustrate the aggregation problem. Entries in the first three rows are bilateral flows.

Table 10. Destination of exports by sectoral structure of exports and quality level
Percentage of exports to rich countries

Country	with Actual Quality: with Actual Sectoral Struct. (1)	with Actual Quality: with Sectoral Struct. of Rich (2)	with Actual Quality: Diff. (2) - (1)	with Quality of Rich: with Sectoral Struct. of Rich (4)	with Quality of Rich: Diff. (4) - (2)	Total Difference (4) - (1)
Switzerland	81.8%	85.3%	3.6	84.9%	-0.5	3.1
Japan	49.2%	49.1%	-0.1	49.0%	-0.1	-0.2
Denmark	85.6%	86.5%	0.9	86.7%	0.1	1.0
Germany	80.0%	80.3%	0.4	80.0%	-0.3	0.1
Austria	89.2%	88.2%	-0.9	88.1%	-0.1	-1.0
Singapore	47.7%	35.3%	-12.3	36.3%	0.9	-11.4
Belgium-Lux.	90.6%	87.6%	-3.0	87.4%	-0.2	-3.2
France	82.2%	81.8%	-0.4	81.4%	-0.3	-0.8
Sweden	82.2%	84.5%	2.3	84.1%	-0.4	1.8
Netherlands	87.9%	86.9%	-1.0	86.7%	-0.2	-1.2
Finland	79.1%	82.9%	3.8	83.0%	0.1	3.9
Hong Kong	45.5%	28.4%	-17.1	29.5%	1.1	-16.0
Australia	57.4%	57.6%	0.1	56.9%	-0.7	-0.6
Canada	63.7%	57.7%	-6.0	57.6%	-0.1	-6.1
Italy	77.8%	77.0%	-0.8	76.8%	-0.2	-1.0
United Kingdom	82.1%	81.2%	-0.9	80.9%	-0.3	-1.2
Israel	71.2%	64.0%	-7.1	64.1%	0.0	-7.1
Spain	77.0%	70.9%	-6.1	71.2%	0.3	-5.8
Average Rich	**73.9%**	**71.4%**	**-2.5**	**71.4%**	**0.0**	**-2.5**
Greece	85.2%	69.9%	-15.2	72.3%	2.4	-12.9
South Korea	61.9%	59.4%	-2.5	59.7%	0.4	-2.1
Taiwan	66.4%	63.2%	-3.2	65.3%	2.1	-1.1
Portugal	96.6%	93.2%	-3.4	93.6%	0.4	-3.0
Argentina	23.5%	17.6%	-5.9	18.7%	1.1	-4.8
Saudi Arabia	85.5%	69.7%	-15.8	74.2%	4.5	-11.3
Brazil	41.3%	37.3%	-4.0	38.1%	0.8	-3.2
Malaysia	80.6%	77.3%	-3.3	79.6%	2.3	-1.0
Chile	40.4%	12.5%	-27.8	13.2%	0.7	-27.1
Mexico	65.2%	61.7%	-3.6	62.3%	0.7	-2.9
South Africa	82.6%	77.9%	-4.7	79.3%	1.4	-3.3
Venezuela	8.8%	11.0%	2.2	11.6%	0.7	2.8
Poland	94.7%	91.7%	-2.9	92.4%	0.7	-2.3
Thailand	80.2%	72.8%	-7.4	75.0%	2.3	-5.1
Turkey	86.0%	69.8%	-16.3	72.8%	3.0	-13.3
Costa Rica	23.5%	13.6%	-9.8	14.2%	0.5	-9.3
Peru	61.1%	20.0%	-41.1	20.4%	0.4	-40.7
Colombia	27.6%	22.8%	-4.8	24.6%	1.8	-3.0
Avg. Mid-Income	**61.7%**	**52.3%**	**-9.4**	**53.7%**	**1.4**	**-8.0**
Tunisia	99.4%	95.9%	-3.5	96.2%	0.3	-3.2
Ecuador	44.6%	14.3%	-30.4	15.1%	0.8	-29.6
Bulgaria	82.8%	70.3%	-12.5	73.0%	2.7	-9.8
Dominican Rp	86.1%	68.1%	-18.0	69.2%	1.1	-16.9
Guatemala	10.0%	13.5%	3.5	14.5%	1.0	4.5
Romania	87.0%	71.1%	-16.0	73.8%	2.7	-13.3
Morocco	97.1%	90.0%	-7.1	92.2%	2.2	-4.9
Syrn Arab Rp	53.4%	20.8%	-32.6	22.7%	1.9	-30.7
Philippines	84.6%	75.5%	-9.0	77.1%	1.6	-7.4
Indonesia	76.0%	61.3%	-14.7	63.6%	2.3	-12.4
Egypt	77.2%	47.0%	-30.2	48.1%	1.1	-29.1
Sri Lanka	93.5%	75.1%	-18.4	78.5%	3.4	-15.0
China	85.2%	72.4%	-12.7	74.1%	1.7	-11.0
Pakistan	73.1%	60.6%	-12.6	63.1%	2.6	-10.0
India	76.1%	64.0%	-12.1	66.3%	2.3	-9.8
Bangladesh	90.6%	87.4%	-3.1	88.9%	1.5	-1.6
Vietnam	93.6%	74.4%	-19.2	81.1%	6.7	-12.5
Nigeria	95.0%	81.2%	-13.7	82.3%	1.1	-12.7
Average Poor	**78.1%**	**63.5%**	**-14.6**	**65.5%**	**2.1**	**-12.5**
Total Average	**71.2%**	**62.4%**	**-8.8**	**63.6%**	**1.2**	**-7.7**

Table A1. List of 3-digit SITC sectors included in the sample

Sector	*Description*	*Sector*	*Description*
34	Fish,fresh (live or dead),chilled or frozen	727	Food processing machines and parts
48	Cereal prepar. & preps. Of flour of fruits or veg.	728	Mach.& Equipment specialized for particular ind.
56	Vegetab.,roots & tubers,prepared/preserved,n.e.s.	736	Mach.tools for working metal or met.carb., Parts
73	Chocolate & other food preptns. Containing cocoa	741	Heating & cooling equipment and parts
98	Edible products and preparations n.e.s.	742	Pumps for liquids.liq.elevators and parts
111	Non alcoholic beverages,n.e.s.	743	Pumps & compressors,fans & blowers,centrifuges
248	Wood,simply worked,and railway sleepers of wood	744	Mechanical handling equip.and parts
431	Animal & vegetable oils and fats,processed & waxes	745	Other non-electrical mach.tools,apparatus & parts
533	Pigments,paints,varnishes & related materials	749	Non-electric parts and accessories of machines
541	Medicinal and pharmaceutical products	751	Office machines
551	Essential oils,perfume and flavour materials	752	Automatic data processing machines & units thereof
553	Perfumery,cosmetics and toilet preparations	761	Television receivers
554	Soap,cleansing and polishing preparations	762	Radio-broadcast receivers
591	Disinfectants,insecticides,fungicidesweed killers	764	Telecommunications equipment and parts
598	Miscellaneous chemical products,n.e.s.	771	Electric power machinery and parts thereof
611	Leather	772	Elect.app.such as switches,relays,fuses,pwgs etc.
612	Manufactures of leather/of composition leather nes	773	Equipment for distributing electricity
621	Materials of rubber(e.g.,pastes.plates,sheets,etc)	774	Electric apparatus for medical purposes,(radiolog)
625	Rubber tyres,tyre cases,etc.for wheels	775	Household type,elect.& Non-electrical equipment
628	Articles of rubber,n.e.s.	776	Thermionic,cold & photo-cathode valves,tubes,parts
635	Wood manufactures,n.e.s.	778	Electrical machinery and apparatus,n.e.s.
642	Paper and paperboard,cut to size or shape	781	Passenger motor cars,for transport of pass.& Good
651	Textile yarn	782	Motor vehicles for transport of goods/materials
652	Cotton fabrics,woven	783	Road motor vehicles,n.e.s.
653	Fabrics,woven,of man-made fibres	784	Parts & accessories of 722-,781--,782-,783-
654	Textil.fabrics,woven,oth.than cotton/man-made fibr	785	Motorcycles,motor scooters,invalid carriages
655	Knitted or crocheted fabrics	786	Trailers & other vehicles,not motorized
656	Tulle,lace,embroidery,ribbons,& other small wares	791	Railway vehicles & associated equipment
657	Special textile fabrics and related products	792	Aircraft & associated equipment and parts
658	Made-up articles,wholly/chiefly of text.materials	793	Ships,boats and floating structures
659	Floor coverings,etc.	812	Sanitary,plumbing,heating,lighting fixtures
661	Lime,cement,and fabricated construction materials	821	Furniture and parts thereof
662	Clay construct.materials & refractory constr.mate	831	Travel goods,handbags,brief-cases,purses,sheaths
663	Mineral manufactures,n.e.s	842	Outer garments,mens,of textile fabrics
665	Glassware	843	Outer garments,womens,of textile fabrics
666	Pottery	844	Under garments of textile fabrics
667	Pearls,precious& semi-prec.stones,unwork./worked	845	Outer garments and other articles,knitted
673	Iron and steel bars,rods,angles.shapes & sections	846	Under garments,knitted or crocheted
678	Tubes,pipes and fittings,of iron or steel	847	Clothing accessories of textile fabrics
679	Iron & steel castings,forgings & stampings;rough	848	Art.of apparel & clothing accessories,no textile
691	Structures& parts of struc.;iron,steel,aluminium	851	Footwear
692	Metal containers for storage and transport	871	Optical instruments and apparatus
694	Nails,screws,nuts,bolts etc.of iron.steel,copper	872	Medical instruments and appliances
695	Tools for use in hand or in machines	874	Measuring,checking,analysing instruments
696	Cutlery	881	Photographic apparatus and equipment,n.e.s.
697	Household equipment of base metal,n.e.s.	882	Photographic & cinematographic supplies
699	Manufactures of base metal,n.e.s.	884	Optical goods,n.e.s.
711	Steam & other vapour generating boilers & parts	885	Watches and clocks
713	Internal combustion piston engines& parts	892	Printed matter
714	Engines & motors,non-electric	893	Articles of materials described in division 58
716	Rotating electric plant and parts	894	Baby carriages,toys,games and sporting goods
721	Agricultural machinery and parts	895	Office and stationery supplies,n.e.s.
722	Tractors fitted or not with power take-offs, etc.	896	Art,collectors pieces & antiques
723	Civil engineering & contractors plant and parts	897	Jewellery,goldsmiths and other art. Of precious m.
724	Textile & leather machinery and parts	898	Musical instruments,parts and accessories
725	Paper & pulp mill mach.,mach for manuf.of paper	899	Other miscellaneous manufactured articles
726	Printing & bookbinding mach.and parts		

Table A2. Quality indices for 2-digit SITC sectors

	GDP p/cap.	3	4	5	7	9	11	24	43	53	54	55	59
1 Switzerland	43658		2.53	0.79	2.55	3.69	1.33	1.65		2.61	2.56	5.13	8.48
2 Japan	40955	1.78	3.75	1.73	0.97	5.73	3.44	0.13	4.54	3.40	2.86	5.03	4.11
3 Denmark	34608	0.00	0.61	0.27	2.15	12.16	0.36	2.73	0.37	1.13	1.99	0.65	4.63
4 Germany	29425		1.00	1.18	1.67	2.88	3.42	1.57	0.93	2.23	1.87	2.44	4.05
5 Austria	28705		0.51		2.29	0.46	0.78	0.00		1.68	3.85	1.47	4.14
6 Singapore	27992	1.58	1.49	0.32	1.26	1.31	0.27	2.46	0.24	0.25	0.09	0.80	2.22
7 Belgium-Lux.	27619	0.01	2.15	0.28	2.77	1.51	1.39	0.03	0.46	1.78	1.72	2.03	2.55
8 France	26404	0.50	1.73	1.64	2.40	1.92	1.26	2.40		2.41	1.37	3.02	5.26
9 Sweden	26192		0.79	0.02	1.09	1.42	2.33	1.07		1.36	4.28	2.45	5.92
10 Netherlands	25768	1.69	0.60	0.33	2.33	2.65	3.32	0.82	1.33	2.48	0.84	2.14	4.02
11 Finland	24652	0.00	0.98		0.58	0.11	0.01	1.81		2.52	2.13	0.45	1.74
12 Hong Kong	22619	0.32	1.79	0.40	1.02	1.94	0.95	0.14		0.17	1.03	1.00	1.99
13 Australia	20206	0.02	1.95	0.00	1.34	0.75	2.71	1.84		1.11	0.35	2.22	3.38
14 Canada	19535	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15 Italy	19019		1.65	1.70	2.77	3.67	1.57	3.27	0.12	0.93	1.15	2.29	2.68
16 United Kingdom	18890	0.00	1.81	0.29	1.46	1.39	2.47	2.38	0.41	1.89	4.14	2.10	2.44
17 Israel	15666	0.00	1.42	0.34	1.19	1.42	2.90			0.06	3.19	1.86	6.28
18 Spain	14273	1.16	0.76	3.00	1.81	1.10	1.30	1.96	3.73	0.51	1.83	1.76	1.10
19 Greece	11096	0.00	1.05	0.21	0.57	0.93	0.24	0.06		0.18	0.01	0.55	0.88
20 South Korea	10874	1.08	2.19	0.13		1.69	1.15			0.80		0.82	1.10
21 Taiwan	10601	1.27	1.87	0.38	0.51	1.60	0.30	1.89		0.91	0.01	1.06	1.40
22 Portugal	10545	1.31	1.07	0.31	2.68	1.11	1.31	1.08				0.14	0.00
23 Argentina	7429	0.37	0.55	0.33	0.51	2.10	0.76	1.70		0.03	0.02	1.47	0.48
24 Saudi Arabia	6735		0.28		2.94	0.01	0.30	2.25				0.78	0.07
25 Brazil	4418	0.80	0.38	0.13	0.88	0.49	0.77	1.45	0.17	0.13	1.26	1.03	0.49
26 Malaysia	4238	0.21	1.03	0.23	1.68	0.75	0.31	1.35	0.77			0.63	0.75
27 Chile	4176	1.50	0.68	0.40	1.07	1.37		1.98				0.29	
28 Mexico	3986	0.12	0.73	0.56	0.82	0.83	1.24	1.04		0.64	0.46	1.10	1.59
29 South Africa	3863	1.30	2.20	0.00	0.46	0.02		1.82		0.84	1.57	0.51	1.13
30 Venezuela	3537	0.22	0.78	0.00		0.32	0.31	0.04		0.21		0.47	0.08
31 Poland	3274	0.00	0.70	0.46	0.83	0.57	0.97	1.36				0.08	1.20
32 Thailand	2830	0.34	1.44	0.38		1.11	0.45	0.11	0.35	0.04	0.04	0.43	0.05
33 Turkey	2805		0.94	0.24	0.45	0.38	0.56	0.13				0.63	0.00
34 Costa Rica	2705	0.47	1.03	0.07	0.46	1.34		0.00		0.39	0.15	0.42	0.00
35 Peru	2507	0.09	0.69	0.18	0.06	0.64	0.20	0.90				0.30	0.03
36 Colombia	2399	0.83	0.42	0.34	0.62	0.43	0.43	0.63		0.13		0.22	1.40
37 Tunisia	2008		0.01									0.18	
38 Ecuador	1565	1.23	0.43	0.04	1.13	0.00	0.86	1.11		0.31		0.38	0.21
39 Bulgaria	1560			0.01		0.06						0.08	
40 Dominican Rp	1526	0.10	0.33	0.07	0.73	0.46	0.88	0.00		0.00	0.02	0.46	
41 Guatemala	1469	0.14	0.47	0.11		0.55		1.39			0.11	0.15	0.04
42 Romania	1448						0.21						
43 Morocco	1250	0.03	0.34	0.44								0.17	
44 Syrn Arab Rp	1173		0.63	0.10		0.51	0.11				1.30	0.06	
45 Philippines	1055	0.33	1.13	0.09	0.36	1.04	0.79	2.23	0.08			0.42	0.00
46 Indonesia	1042	1.57	0.78	0.29		0.85	0.16	1.07	0.06		2.04	0.15	0.03
47 Egypt	1034		0.80	0.09		0.30	0.39					0.46	
48 Sri Lanka	719		0.26	0.02		0.39	0.28	0.03				0.02	0.00
49 China	582	0.32	1.18	0.25	0.91	1.58	1.51	1.49		1.28	0.41	0.91	2.97
50 Pakistan	500	0.06	0.70	0.02		0.43	1.00	2.41				0.07	
51 India	392	0.24	0.90	0.32	0.56	3.08	1.15	0.03	0.18	0.00	0.47	1.43	1.37
52 Bangladesh	314	0.29										0.88	
53 Vietnam	277	0.17	0.30			0.00	0.03					0.01	
54 Nigeria	253		0.02	0.00		0.11		0.00				0.29	
Average	10785	0.56	1.04	0.41	1.29	1.40	1.06	1.20	0.92	1.01	1.38	1.04	1.93
Average Rich	25899	0.62	1.47	0.83	1.70	2.51	1.71	1.49	1.31	1.53	2.01	2.10	3.66
Average Poor	3227	0.53	0.80	0.20	0.91	0.78	0.62	1.02	0.27	0.39	0.56	0.49	0.64
Correl. w/GDP p/cap.		0.20	0.58	0.45	0.53	0.58	0.52	0.19	0.44	0.75	0.53	0.79	0.80
# of observations	54	40	51	47	38	50	45	44	16	33	32	53	42

Table A2. Quality indices for 2-digit SITC sectors (cont.)

	61	62	63	64	65	66	67	69	71	72	73	74	75
1 Switzerland	1.45	2.58	1.00	3.22	2.15	0.94	1.85	2.70	0.99	2.04	2.85	1.69	1.05
2 Japan	0.68	1.50	1.17	3.25	1.76	1.32	0.80	2.06	0.71	1.05	2.13	0.62	0.39
3 Denmark	0.13	0.33	0.91	2.95	0.87	2.72	1.05	1.89	1.24	1.17	0.16	1.53	1.15
4 Germany	1.34	1.46	4.69	4.15	1.56	1.53	1.16	1.83	1.49	1.48	1.92	0.99	1.12
5 Austria	2.85	1.57	0.21	5.35	1.47	0.98	0.94	1.91	0.94	1.50	0.67	2.97	1.63
6 Singapore	0.13	1.28	0.60	1.28	0.14	0.39	0.36	1.49	0.82	0.26	0.27	0.96	0.39
7 Belgium-Lux.	0.43	1.56	1.02	1.75	1.11	1.56	1.03	2.43	1.11	2.87	0.57	1.55	1.89
8 France	1.97	1.50	7.86	2.76	1.67	1.63	0.77	2.69	3.46	1.52	1.28	1.37	1.03
9 Sweden	2.98	1.80	3.69	2.45	1.06	1.10	0.69	2.28	2.19	1.75	1.14	1.45	0.96
10 Netherlands	0.49	1.58	1.93	3.00	1.65	0.96	0.79	1.55	2.58	1.05	1.30	1.56	1.69
11 Finland	0.03	1.40	1.13	0.92	0.93	0.94	0.21	1.52	1.40	0.91	0.43	1.59	0.64
12 Hong Kong	0.52	0.09	0.53	1.78	0.55	0.48	0.28	1.05	0.45	0.17	0.12	0.29	0.18
13 Australia	1.21	0.78	1.66	0.83	0.94	1.08	0.51	2.19	0.64	0.77	0.93	1.17	0.52
14 Canada	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15 Italy	1.43	1.11	2.87	3.47	1.87	1.06	0.87	1.49	0.63	1.06	1.66	0.56	0.48
16 United Kingdom	2.17	1.50	1.21	2.84	1.73	1.22	1.07	1.65	3.39	1.33	0.85	0.88	0.86
17 Israel	0.11	1.33	0.37	1.87	0.57	0.79	0.47	1.37	1.00	1.32	0.34	0.97	1.03
18 Spain	0.84	2.03	1.05	3.58	0.78	0.93	0.66	1.76	0.91	1.03	1.30	0.89	1.58
19 Greece	0.01	0.03	1.87		0.17	0.53	0.30	0.14	0.05	0.05	0.04	0.38	0.50
20 South Korea	1.03	0.77	0.92	1.46	0.74	0.80	0.72	1.09	0.43	0.87	0.79	0.61	0.19
21 Taiwan	1.14	0.34	0.85	2.14	0.46	0.71	1.08	0.71	0.30	0.12	0.24	0.19	0.19
22 Portugal	0.09	0.43	0.19	0.37	0.72	0.84	0.16	1.44	0.07	0.24	0.15	0.90	0.41
23 Argentina	0.81	0.85	0.55	0.35	0.29	0.39	0.19	0.92	0.81	0.45	0.01	0.58	5.17
24 Saudi Arabia		0.21		6.67	0.10	0.01		0.09		0.12		0.05	0.66
25 Brazil	0.67	0.88	0.35	0.19	0.60	0.55	0.48	0.80	0.68	0.76	0.39	0.95	0.64
26 Malaysia	0.08	0.52	0.83	1.29	0.19	0.79	0.11	1.10	0.11	0.10	0.01	0.23	0.16
27 Chile	0.03	0.50	0.38	0.41	0.33	0.10	0.00	0.40	0.12	0.32		0.15	0.75
28 Mexico	0.97	0.64	0.67	1.32	0.48	0.87	0.48	0.89	0.60	0.40	0.41	0.41	0.50
29 South Africa	5.26	1.16	0.80	1.08	0.51	0.41	0.20	1.17	1.00	0.52	0.05	0.60	1.33
30 Venezuela	0.03	0.66	0.61	0.47	0.18	0.20	0.07	0.34	0.28	0.34	0.08	0.80	0.51
31 Poland	0.01	0.59	0.22		0.18	0.31	0.24	0.58	0.32	0.89	0.25	0.44	0.18
32 Thailand	0.69	0.47	0.51	1.86	0.33	0.45	0.44	0.77	0.22	0.05	0.35	0.22	0.15
33 Turkey	0.08	0.71		0.87	0.54	0.53	0.07	0.55	0.62	0.38	0.07	0.51	0.57
34 Costa Rica	0.45	0.15	0.63	0.79	0.08	0.12	0.28	0.24	0.01	0.11		0.15	0.12
35 Peru		0.16	0.56	0.02	0.36	0.34	0.00	0.34	0.08		0.00	0.10	0.41
36 Colombia	1.08	0.65	1.76	0.76	0.23	0.29	0.06	0.54	0.17	0.06	0.01	0.05	0.47
37 Tunisia			0.12		0.00	0.31		0.02					0.06
38 Ecuador	0.10	0.48	0.14		0.10	0.06		0.11	0.12	0.11		0.44	0.64
39 Bulgaria	0.00	0.01			0.03	0.45		0.12	0.02	0.00	0.03	0.32	0.26
40 Dominican Rp	0.74	0.00	0.21	0.63	0.12	0.22	0.00	0.75	0.19	0.16		0.17	0.07
41 Guatemala	0.00	1.02	2.43		0.23	0.15		0.06	0.05	0.00		0.04	0.35
42 Romania	0.23	0.46	0.06	0.34	0.06	0.25	0.10	0.04	0.02	0.05	0.42	0.27	0.13
43 Morocco	0.00		2.84	0.94	0.25	0.35		0.25	0.05			0.00	0.07
44 Syrn Arab Rp					0.02	0.00		0.02				0.00	0.02
45 Philippines	0.04	0.29	0.82	1.66	0.27	0.58	0.13	0.57	0.04	0.01	0.06	0.78	0.11
46 Indonesia	3.12	0.25	0.43	0.41	0.32	0.47	0.19	0.51	0.29	0.00		0.29	0.20
47 Egypt		0.00	0.72	0.96	0.23	0.44		0.49		0.70		0.47	1.22
48 Sri Lanka	0.00	0.19	0.01	0.01	0.07	0.26		0.25			0.00	0.01	
49 China	0.48	0.29	0.62	1.57	0.35	0.38	0.18	0.58	0.27	0.08	0.12	0.16	0.09
50 Pakistan	0.79	0.00	1.16	0.70	0.19	0.07	0.27	0.33		0.13		0.03	0.13
51 India	0.98	1.14	0.75	0.72	0.37	0.60	0.15	0.59	0.82	0.12	0.17	0.32	0.22
52 Bangladesh	0.05		0.09	0.41	0.05	0.04		0.01					
53 Vietnam	0.00	0.00	0.22	0.00	0.00	0.05							
54 Nigeria	0.00		0.06		0.08	0.00			0.01				0.70
Average	0.79	0.78	1.11	1.63	0.58	0.62	0.49	0.95	0.71	0.64	0.58	0.65	0.68
Average Rich	1.10	1.36	1.83	2.58	1.21	1.15	0.81	1.83	1.39	1.24	1.05	1.22	0.98
Average Poor	0.61	0.45	0.70	1.01	0.26	0.36	0.25	0.49	0.28	0.25	0.17	0.33	0.52
Correl. w/GDP p/cap	0.22	0.70	0.38	0.58	0.83	0.77	0.78	0.87	0.59	0.75	0.73	0.75	0.29
# of observations	49	49	50	46	54	54	42	52	46	46	39	50	51

Table A2. Quality indices for 2-digit SITC sectors (cont.)

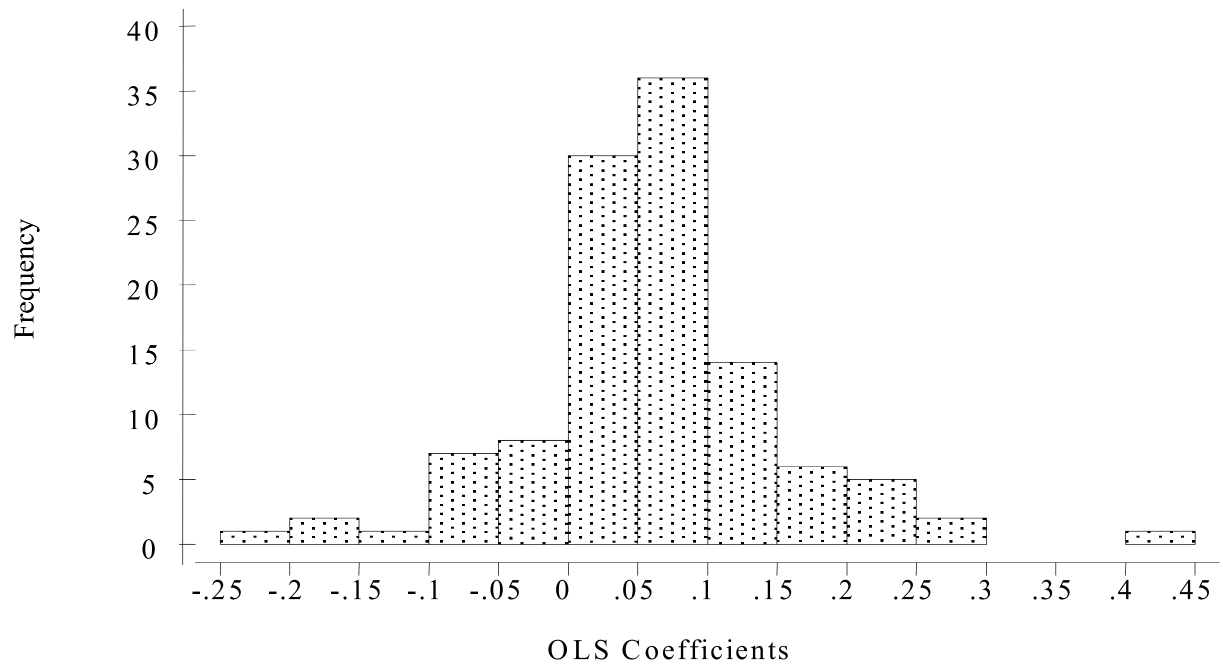
	76	77	78	79	81	82	83	84	85	87	88	89
1 Switzerland	0.55	0.92	2.38	0.13	0.65	1.70	1.62	2.27	1.09	1.11	1.22	1.53
2 Japan	0.43	0.52	0.31	1.63	1.71	1.01	1.14	1.83	0.69	0.45	0.58	1.87
3 Denmark	0.86	0.91	0.02	0.24	1.52	0.69	0.32	0.79	0.66	0.90	1.22	1.33
4 Germany	1.32	0.64	0.83	1.16	0.67	1.08	3.60	1.41	1.04	0.96	0.76	2.42
5 Austria	1.19	0.56	0.75	0.24	0.89	1.29	0.36	2.00	1.28	1.01	1.35	1.93
6 Singapore	0.40	0.30	0.01	2.48	0.26	0.30	0.96	0.46	0.33	0.54	0.32	2.06
7 Belgium-Lux.	0.81	0.62	0.89	1.34	1.56	0.97	1.60	1.67	2.45	1.23	0.78	1.42
8 France	0.74	1.22	0.19	1.27	0.73	1.16	5.95	2.14	1.98	1.19	0.77	2.72
9 Sweden	0.84	1.71	1.61	1.23	0.48	0.59	2.14	0.85	0.29	1.36	1.14	1.34
10 Netherlands	0.83	0.70	0.97	2.65	0.50	0.94	0.96	0.85	0.99	1.20	1.14	3.06
11 Finland	0.42	1.00	0.07	0.57	0.19	0.48	0.83	1.56	1.82	0.95	0.14	1.20
12 Hong Kong	0.16	0.22	0.00	0.20	0.12	0.29	0.50	0.58	0.46	0.22	0.20	0.71
13 Australia	0.75	1.34	1.53	1.91	0.81	1.69	1.74	1.05	0.78	1.49	0.88	1.68
14 Canada	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15 Italy	1.44	0.97	0.46	2.14	0.58	0.63	3.39	1.66	0.88	0.71	1.35	2.14
16 United Kingdom	1.34	0.65	1.26	1.77	0.90	1.12	1.22	1.40	0.95	0.66	0.66	1.62
17 Israel	1.22	1.08	0.01	1.86	0.94	0.47	0.39	0.50	0.56	0.67	0.66	0.95
18 Spain	0.41	0.56	0.24	0.38	0.67	0.75	2.39	1.33	0.67	0.45	0.62	1.43
19 Greece	0.00	0.82			0.47	0.31	0.28	0.69	0.40		0.08	0.43
20 South Korea	0.29	0.39	0.41	0.12	0.13	0.43	1.16	0.63	0.64	0.24	0.26	1.07
21 Taiwan	0.23	0.17	0.25	0.25	0.13	0.23	0.83	0.49	0.59	0.16	0.13	0.77
22 Portugal	0.13	0.26	0.09		0.80	0.62	1.63	0.97	0.75	0.65	0.04	0.76
23 Argentina	0.02	0.58	0.21	3.09	1.90	0.56	0.94	0.39	0.37	0.20	0.44	1.69
24 Saudi Arabia	0.07	0.01	0.00			0.35	0.65	0.10		0.01	0.00	0.16
25 Brazil	0.12	0.36	0.01	0.85	0.30	0.18	1.02	0.45	0.42	0.29	0.39	0.78
26 Malaysia	0.30	0.19	0.00	0.28	0.25	0.19	0.95	0.52	0.48	0.20	0.12	1.15
27 Chile	0.02	0.01	0.00		0.21	0.21	0.69	0.32	0.48	0.01	0.01	0.50
28 Mexico	0.45	0.41	0.20	0.16	0.19	0.32	1.23	0.39	0.43	0.24	0.41	0.83
29 South Africa	0.15	0.45	0.01	0.46	1.13	0.63	2.34	0.29	0.96	0.22	0.04	0.82
30 Venezuela	0.25	0.13	0.77	0.70	0.05	0.26	0.27	0.15	0.29	0.08	0.08	0.28
31 Poland	0.06	0.28	0.19	0.09	0.31	0.20	0.95	0.47	0.23	0.03	0.09	0.45
32 Thailand	0.15	0.14	0.24	0.05	0.16	0.23	1.41	0.48	0.46	0.15	0.12	0.94
33 Turkey	0.00	0.06	0.33		0.19	0.31	1.14	0.43	0.43	0.02	0.08	0.18
34 Costa Rica	0.00	0.22	0.00	0.43	0.07	0.28	0.48	0.37	0.53	0.02	0.08	0.17
35 Peru	0.00	0.01	0.00		0.00	0.25	0.30	0.25	0.14		0.04	0.22
36 Colombia	0.04	0.03	0.41		0.23	0.95	1.34	0.45	0.33	0.01	0.00	0.65
37 Tunisia	0.04	0.04	0.00				0.36	0.31	0.42	0.00	0.00	0.25
38 Ecuador	0.00	0.03			0.01	0.23	0.33	0.22	0.09		0.01	0.23
39 Bulgaria	0.07	0.10				0.04	0.00	0.22	0.19	0.00		0.23
40 Dominican Rp	0.09	0.18			0.27	0.44	1.12	0.35	0.60	0.03	0.00	0.66
41 Guatemala	0.00	0.23	0.00	0.17	0.00	0.23	0.29	0.34	0.08	0.01	0.02	0.30
42 Romania		0.02	0.28	0.04	0.49	0.04	0.10	0.22	0.37	0.02		0.16
43 Morocco	0.00	0.31	0.00		0.21	0.18	0.31	0.45	0.60	0.07	0.02	0.19
44 Syrn Arab Rp	0.02				0.02	0.02	0.02	0.08				0.14
45 Philippines	0.21	0.15	0.25		0.25	0.56	0.79	0.41	0.34	0.34	0.18	0.68
46 Indonesia	0.20	0.11	0.25		0.26	0.28	0.72	0.44	0.44	0.28	0.14	0.73
47 Egypt	0.01	0.18			0.83	0.35	0.26	0.21	0.24		0.00	0.25
48 Sri Lanka		0.00			0.04	0.14	0.36	0.37	0.28	0.05	0.00	0.26
49 China	0.15	0.15	0.32	0.04	0.12	0.22	0.50	0.42	0.39	0.14	0.12	0.66
50 Pakistan	0.02	0.03	0.23		0.23	0.35	0.33	0.25	0.24	0.00	0.01	0.24
51 India	0.06	0.31	0.01	0.22	0.31	0.55	0.49	0.42	0.33	0.22	0.40	0.84
52 Bangladesh	0.12	0.02				0.00	0.35	0.23	0.08			0.13
53 Vietnam		0.00				0.05	0.25	0.05	0.09			0.10
54 Nigeria	0.01		0.82				0.07	0.09	0.01			0.04
Average	0.35	0.41	0.40	0.88	0.49	0.51	1.01	0.67	0.59	0.43	0.38	0.90
Average Rich	0.82	0.83	0.70	1.23	0.79	0.90	1.67	1.30	1.00	0.89	0.82	1.69
Average Poor	0.10	0.19	0.20	0.46	0.32	0.30	0.67	0.36	0.37	0.13	0.11	0.50
Correl. w/GDP p/cap.	0.70	0.71	0.51	0.34	0.55	0.73	0.43	0.83	0.63	0.80	0.78	0.78
# of observations	51	52	45	33	48	52	54	54	52	46	48	54

Table A3. Specification derived from a discrete choice model
Summary Results[a] (113 sectors)

			Statistical Significance[b]			*Average Coefficient*
	Positive	*Negative*	*Positive*	*Not Sig.*	*Negative*	
Imports Equation[cd]:						
Price*GDPpc	84	29	49	55	9	0.027
Distance	1	112	0	4	109	-1.93
Border	63	50	3	107	3	0.04
Common Lang.	109	4	87	26	0	2.50
PTA	74	39	17	88	8	0.56
Colonial	78	35	4	109	0	0.69
Common Colony	99	14	38	75	0	1.50
Distance*GDPpc	104	9	67	44	2	0.08
Border*GDPpc	63	50	4	108	1	0.03
Com.Lang.*GDPpc	8	105	0	40	73	-0.21
PTA*GDPpc	45	68	10	90	13	-0.04
Colonial*GDPpc	65	48	1	112	0	0.02
Com.Colony*GDPpc	25	88	0	82	31	-0.16
Fixed Cost Equation[c]:						
Distance	105	8	62	51	0	0.28
Border	99	14	32	81	0	0.62
Common Lang.	31	82	1	93	19	-0.21
PTA	39	74	2	94	17	-0.38
Colonial[e]	18	87	1	96	8	-1.67
Common Colony	49	64	2	104	7	-0.18
Exporter GDP	3	110	0	31	82	-0.29
Importer GDP	48	65	18	75	20	-0.02
Average Predicted Censoring Point[f]:		$ 46,834				

[a] This table provides summary results for the estimation of the specification derived from the discrete choice model in Appendix A.
[b] Significant at the 5% level.
[c] The dependent variable in the *Imports Equation* is the log of sectoral bilateral imports. The dependent variable in the *Fixed Cost Equation* is the log of the bilateral fixed costs of exporting. The *Fixed Cost Equation* determines the threshold for censoring in the *Imports Equation*. Both equations are estimated simultaneously by maximum likelihood, sector by sector.
[d] The first interaction term is the product of importer's income per capita and exporter's export price. For the export price, the unit value (quality) indices are used. The second interaction term is the product of importer's income per capita and distance. The rest of the interaction terms are the product of importer's income per capita and the usual dummies. All continuous variables are in logs. The rest of the variables are defined as in Table 3.
[e] The estimated coefficient is $-\infty$ in 8 sectors. These sectors are not included in the reported results for this variable.
[f] The average predicted censoring point is the geometric average of the predicted value of the *Fixed Cost Equation* across all observations in all sectors.

Graph 1. Frequency Distribution of OLS Coefficients



Graph 2. Frequency Distribution of Baseline Coefficients