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Heterogeneous Quality Firms and Trade Costs

Matthias Helble
Toshihiro Okubo

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Abstract

There is increasing empirical evidence that vertical product differentiation is an important determinant of international trade. However, the economic literature so far has solely focused on the case in which quality trade stems from differences between countries. No studies investigate the role of quality trade between similar economies. This paper first develops a simple theoretical trade model that includes vertical product differentiation in a heterogeneous-firm framework. The model yields three main predictions for trade between similar economies. First, exported goods are of higher quality than goods sold on the domestic market. Second, larger economies have on average higher export qualities compared with smaller economies. Third, with increasing trade costs higher quality goods are exchanged. For all three effects, strong empirical support is found using detailed export trade data of the United States and 15 European Union countries.

This paper—a product of the Trade Team, Development Research Group—is part of a larger effort in the group to improve our knowledge on trade costs, trade facilitation, and economic development. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at helblem@who.int.

Heterogeneous Quality Firms and Trade Costs

Matthias Helble* and Toshihiro Okubo‡

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* Globalization, Trade and Health Team, Department of Ethics, Equity, Trade and Human Rights, World Health Organization, Geneva, Switzerland, Email: helblem@who.int

‡ Institute for Political and Economic Governance (IPEG), University of Manchester, Email: Toshihiro.Okubo@manchester.ac.uk

1. Introduction

Over the last decades, the issue of quality in international trade has only sporadically captured the attention of economists. However, in recent years, aspects of quality have increasingly come to the forefront of the research agenda. In a fast integrating world economy, the patterns of trade are not solely determined by endowment or productivity differences between countries. Additional dimensions, such as quality, need to be considered in order to be able to explain today's division of production between countries. One reason for this increased role of quality has been a trend among firms in developed as well as developing countries to achieve rising quality standards. The argument is that sustained success in international markets can only be reached if high productivity can be combined with high quality of products. The aim of this paper is to provide a better understanding of the role of quality in trade between countries of a similar level of economic development (similar factor endowments, productivity, and consumption preferences). In particular, we study the case of trade among the 15 countries forming the European Union prior to its recent enlargements (EU 15).

Going back in history, the first scholar in the field of economics who pointed out the possible importance of quality in trade was Linder (1961). He argued that consumers in rich countries spend relatively more on high quality goods than consumers in poor countries. Due to closeness to demand rich countries also enjoy a comparative advantage in producing high quality products. As a consequence, countries with similar per capita income levels trade more with one another.[1] Some years later, Alchian and Allen (1964) formulated the hypothesis that per unit trade costs lead to a shift in demand toward high-quality goods.[2] In other words, per unit trade costs raise the price of inexpensive goods relatively more compared to the price of high priced goods. As a corollary, goods of high quality (price) take a bigger share in exports. Since these seminal contributions, aspects of vertical product differentiation in international trade have attracted a limited, but growing attention among economists.[3] Today, the corresponding literature is still manageable and can roughly be divided into two groups: The first stream of literature looks at quality aspects in international trade from a supply side point of view, whereas the second one approaches the problem from the demand side.

[1] This hypothesis became known as the Linder Hypothesis. It contrasts sharply the Heckscher-Ohlin theory stating that the intensity of trade is higher for dissimilar countries.
[2] Their hypothesis is often referred to as "shipping the good apples out".
[3] We define vertical product differentiation as the behavior of firms to produce goods of different quality and price. Throughout the paper quality and vertical differentiation are used as synonyms.

The most prominent contributions of the first stream are Falvey (1981), Falvey and Kierzkowski (1987) as well as Flam and Helpman (1987).[4] Falvey (1981) constructs a model in which countries differ in their initial labor and capital endowments. Since the production of higher quality products requires the use of relatively more capital compared to labor, trade leads to a specialization in production. The country that has a relatively higher capital stock exports capital-intensive, higher quality goods and imports labor-intensive, lower quality products. In this Heckscher-Ohlin (HO) type set-up the factor endowment differences result in intra-industry trade of different vertical varieties. Falvey and Kierzkowski (1987) present a similar model of trade based on dissimilar factor endowments. However, they add a product which becomes traded according to technology differences along Ricardian lines. Flam and Helpman (1987) use also a Ricardian type approach to model quality trade. They assume that one country has a comparative advantage in high quality products and that under free trade this country exports high quality products and imports low quality goods. A recent paper by Feenstra and Romalis (2006) uses the HO framework with a continuum of industries. In their model, the industries in each country choose a price as well as quality level, depending on factor prices and trade costs.

The second strand of literature focuses on difference on the demand side between countries. In Stockey (1991) consumers in the rich country consume more of the same good than consumers in the poor country. Murphy and Shleifer (1997) construct a Ricardian model in which tastes differ between countries. High quality producing countries have a consumption preference for high quality goods and low quality producing countries for low quality goods. As a consequence of these consumption differences, countries might not even find it beneficial to start trade.

A growing number of empirical studies test these or similar models and show that quality aspects have indeed a major role to play in explaining international trade pattern. Schott (2004) studies very detailed US trade data and finds that countries tend to specialize within products and not as assumed so far across products. His study further indicates that the unit value of trade within one product is higher for high-wage countries. Schott (2004) concludes that the higher unit-value must come from additional features or quality that high-wage countries are able to add to their products. In their empirical investigation Hummels and Klenow (2005) reveal that richer countries export higher quality goods. Using import data from 76 countries at the six-digit level of the Harmonized System the authors also report that the quality margin

[4] Sutton (2007) develops a insightful model in which countries differ with respect to quality as well as productivity. He founds several interesting outcomes for different market equilibria.

is a function of the exporter size. Hallak (2006) focuses on the demand side and studies the relationship between per capita income and aggregate demand for quality. Analyzing bilateral trade flows among 60 countries, he finds that rich countries import relatively more from countries which produce high quality goods.

All theoretical and empirical studies presented above argue that differences in factor endowments, technology, or consumption preferences between countries constitute the main driving force behind trade of goods of different quality. Building on these differences between countries, the studies remain silent about the role of vertical product differentiation for trade between similar economies. The first question therefore to ask is to what extent quality-related aspects are crucial for trade between similar economies. We try to answer this question taking the case of trade between the EU 15 and analyze the trade pattern with respect to quality between this relatively homogeneous group of countries.

As commonly done in the literature on quality trade, we assume that unit values provide a reasonable measurement of vertical product differentiation.[5] Table 1 provides a summary of several key indicators on quality trade based on unit values of the highest disaggregated trade available.[6]

Table 1: ***Coefficient of Variation and Share of Quality Trade***

	(1)	(2)	(3)	(4)
	Coef.Var	±10 %	± 20 %	± 30 %
EU 15	70.18 %	85.66 %	72.90 %	61.29 %
Obs.	680,656	680,656	680,656	680,656

Notes: Coef. Var. is the abbreviation for the coefficient of variance expressed in percentage. EU 15 stands for all export flows between EU 15 countries. For the columns presenting the share of quality trade, the numbers in percentage report the share the lies outside the range of ± 10 %, ± 20 %, and ± 30 % respectively.

Column (1) in Table 1 reports the average value of the coefficient of variation of all available unit values per product for trade between the EU 15.[7] As explained above, the vast majority of trade models would predict that the coefficient of variation of unit values for each product

[5] See Greenaway (1995) for a detailed discussion on the use of unit values as a measure of quality.

[6] EUROSTAT offers detailed trade data on the 8 digit level (more than 10.000 different products) according to the Combined Nomenclature.

[7] The coefficient of variation is defined as the ratio between the standard deviation and the mean of the population. It yields a number without dimension that allows us to calculate the mean of the coefficient of variation over all product lines and exporting countries. We report the final result as percentage multiplying the coefficient of variation by 100.

traded between identical economies is small. Similar economies are supposed to have strong horizontal intra-industry trade links, but there is no room for vertical intra-industry trade. However, the coefficient of variations is of considerable magnitude for trade flows within the EU 15 and therefore gives us a first impression of the importance of quality trade between similar economies. However, it might be the case that some variations in unit values are the result of factors which are not directly linked to quality, such as price discrimination between markets. Since it is hard to control for these factors, we propose an additional approach to gauge the role of quality trade.

As commonly done in the literature that tries to measure the extent of vertical versus horizontal intra-industry trade, we fix a range in which the unit value is allowed to vary from its mean due to other factors than quality. We set this range at ±10%, ± 20%, and ± 30% which give us wedges of 20 %, 40 %, and 60 %. If the unit value of an export flow exceeds the range, we count it as quality trade. Our results again indicate that quality is an important determinant of trade between EU countries. Applying the 40 % wedge (column 3), one finds that over 70 % of trade between EU countries may be counted as quality trade. This share shrinks to about 60 % when using the 60 % wedge. In summary, all numbers point to the fact the quality is a crucial element of trade between similar economies, such as the EU 15.

Our first broad look at the data indicates that quality trade is an important feature of trade between economies of similar factor endowment, technology, or consumption preferences. Existing trade models do not provide any help in the understanding of these trade patterns. The main goals of this paper are therefore twofold. First, we want to develop a theoretical framework to explain the possible role of quality between countries that are identical or only differ in market size. Furthermore, we search for empirical evidence for the model's predictions analyzing in detail trade flows between the EU 15.[8] Overall, our paper tries to give a compelling answer why similar endowment, technology, supply and demand countries still engage in quality trade and how the trade flows are shaped.

Our model builds on the currently flourishing heterogeneous firms trade literature (Melitz, 2003; Helpman, Melitz and Yeaple, 2004; Melitz and Ottaviano, 2005, Bernard, Redding and Schott, 2004; Bernard, Eaton, Jensen and Schott, 2003; Falvey, Greenaway and Yu, 2004, Okubo, 2008). In this literature, firms are heterogeneous with respect to their productivity. Only highly productive firms are exporting their goods, whereas firms with low productivity

[8] Furthermore, the possible effect of trade costs is neglected in nearly all trade models with vertical product differentiation. One objective of this paper is to add to the literature by building a model that includes quality as well as trade costs.

do not even start to produce for the domestic market. All these models focus on productivity as the distinguishing feature among firms. However, recent research by Foster et al. (2006) shows that productivity (measured based on revenue) is not the only dimension along which firms differ. Other aspects, such as quality, which add to the profitability of firms, are equally important when trying to explain firms' survival.

In existing heterogeneous firms' trade models, high prices are charged by firms with low productivity, which are likely to exit the market first. However, this prediction only holds as long as firms produce goods which are horizontally differentiated. As soon as we introduce some kind of vertical product differentiation, these models lose their explanatory power. The simple reason is that in the vertical intra-industry trade literature (Greenaway, Hine and Milner, 1994 and 1995; Schott, 2004) higher prices indicate higher quality, whereas in heterogeneous firms trade models higher prices are typically charged by firms with low productivity (producers which only sell in the domestic market). The typical heterogeneous-firms trade framework thus does not give any guidance to think about quality aspects.

We provide a solution to this problem by proposing a heterogeneous firms model, in which firms do not differ in their productivity, but the quality they produce. In short, our model can be summarized as follows. We assume an economy in which varieties of different quality are produced at different marginal costs due to different factor intensities of skilled and unskilled labor. Firms that produce higher quality products face higher marginal costs due to skilled labor intensive variety and therefore ask higher prices from the consumer. Consumers in our model economy have a strong preference for high quality goods and are therefore willing to pay relative higher prices for these goods. As a result, profits of higher quality firms exceed profits of lower quality firms, and makes higher quality firms more likely to produce for the domestic as well as export market.[9]

The paper extends the existing trade literature in two important ways. First, it provides a general equilibrium trade model in which firms are heterogeneous with respect to the quality they produce. The model set-up allows us to derive several testable hypotheses, for example on the relation between economic size of countries and the quality composition of trade. Second, we test the hypothesis empirically and thereby provide new insights about the role of quality in international trade, in particular between similar economies. Since the majority of

[9] Baldwin and Harrigan (2007) independently developed a heterogeneous firms' trade model that features quality aspects. Their approach is simply to assume that quality is defining the profitability of firms, instead of productivity as in Melitz (2003).

empirical studies have focused on quality-related aspects of trade between dissimilar economies, the empirical part therefore provides another valuable extension to the literature.

Even though we confront our model with data from developed countries, namely trade between 15 EU countries, the mechanisms that we describe might also be at work for trade among developing countries. One of our key exogenous variables that decide on the export performance of the economy is trade costs. Given the fact that many developing countries still face considerable trade costs, the quality component of our model might help to better evaluate the export performance of developing countries.

A study closely related to our empirical investigation is the contribution of Hummels and Skiba (2004). Analyzing import flows of six countries from the rest of the world, the authors find strong evidence of per unit trade costs. They conclude that their results corroborate the Alchian-Allen effect of "shipping the good apples out". Whereas their study focuses on the trade costs, our primary concern is the role of quality in international trade.

The paper is structured as follows: Section 2 presents a model of a closed economy in which firms produce different qualities at different costs and in which consumers buy all qualities, but in different quantities. In section 3, the effects of trade between identical economies in the presence of trade costs are examined. Section 4 studies the trade patterns between different economies. Before concluding, we test our model empirically using detailed trade data from 15 EU countries.

2. Heterogeneous Quality Firms Trade Model

2.1 The Basic Model

We suppose a two-country economy, including the home country (Home) and the foreign country (Foreign, denoted *). The countries are identical in their production technology and freeness of trade. In each country a manufacturing sector (*M*) and an agricultural sector (*A*) are producing goods. Our model economy has three types of factor endowment: First, low-skilled labor, *L*, which is mobile between and employed by both sectors. Second, high-skilled labor, *H*, which is a production factor specific to the *M* sector. And finally, capital, *K*, which is also only used in the *M* sector and firm-specific (not transferable between firms). All three factors are immobile between countries.

For simplicity, we assume that each household holds a certain number of units of *K*, *L* and *H* respectively (*K**, *L** and *H** for Foreign). It earns an income with all three factors is therefore able to purchase products. Let us assume, without loss of generality, that the share of household (thus, capital, labor and skilled labor) is s>0.5 in the home country and 1-s <0.5 in the foreign country. In words, the home country is larger in market size and endowments.

The manufacturing sector produces goods of different quality under monopolistic competition à la Dixit and Stiglitz (1977) using unskilled and skilled labor (sector specific factor) as well as capital (firm specific factor). We assume away input-output linkages with other varieties within a sector on the supply side. The agricultural *A* sector is assumed to be a numéraire good sector that produces with constant returns to scale and under perfect competition (p=1). Agricultural goods are assumed to be traded without cost, whereas the manufactured goods face iceberg trade costs.

On the demand side, the tastes of representative consumers are quasi-linear:

$$U = \ln\left(\int_{j \in \Theta} \left(\gamma_j c_j\right)^{1-1/\sigma} dj \right)^{1/(1-1/\sigma)} + C_A; \qquad \sigma > 1,\ 0 < \gamma < 1$$

The utility is a composite of a variety of manufacturing goods, c_j, and agricultural goods C_A. The consumption of manufactured goods (M goods) is represented by a quality adjusted CES utility function across all varieties j. Θ represents the set of varieties produced, σ is the constant elasticity of substitution between any two varieties and γ_j (>0) stands for the quality of variety j. Importantly, this quasi-linear utility function implies that each household has a constant expenditure on M goods regardless of its income. Using the quasi-linear utility function we can exclude the income effect, and thus the total demand for M goods is dependent on the number of households rather than the total income of households. Hence, the demand size for M goods in our model is given as s>0.5 for the home country and vice versa.

Turning to the supply side, production in the *M* sector involves capital as well as low-skilled and high-skilled labor. Both factors enter the variable costs in a Cobb-Douglas functional form, whereas <u>one unit</u> of capital is required to cover the fixed cost. The marginal and fixed costs for a variety j can be expressed respectively as $MC_j = h^{1-\mu_j} w^{\mu_j}$ and $FC_j = k_j$, in which h denotes the wage of high-skilled labor, determined by high-skilled labor market clearance in each country, and k stands for the capital rewards. As shown below, μ_j is different across firms (varieties, j) and thus marginal costs and capital rewards (fixed costs) are different across varieties, i.e. k_j.[10] We further assume that μ is probabilistically distributed as specified below.

The low-skilled labor wage can be normalized to be one, i.e. $w = 1$, because the numéraire *A*-sector good is produced under perfect competition and traded without trade costs. Therefore, it must hold that low-skilled wages equal across countries and sectors, i.e. $p_A = p_A^* = w = w^* = 1$.

The price of variety *j* in the monopolistic competition sector is

$$p_j = \frac{1}{1-1/\sigma} h^{1-\mu_j} \tag{1}$$

where $h^{1-\mu_j}$ equals marginal costs. 1 - μ_j, the share of high-skilled labor in production, reflects quality. More high-skilled labor intensive varieties (smaller μ_j) are of higher quality with higher marginal costs and higher prices. At the same time, higher quality goods generate higher utility for consumers (higher γ in their utility function). In other words, μ_j is inversely related to quality: As μ_j goes to zero, the quality level, γ, increases. Or expressed differently, the level quality is just proportional to intensity of high-skilled labor in production. Firms are heterogeneous in the sense that the share of high-skilled labor in production is different across firms and they produce goods of heterogeneous quality. For simplicity, we assume $\mu_j = 1/\gamma_j$.

By assuming that the wage of high-skilled labor is higher than that of low-skilled labor, $h > 1 = w$, (due to the relatively scarcer endowments of skilled labor), that lower (higher) quality varieties (more skilled labor intensive varieties) have always lower (higher) prices:

$$\frac{\partial p_j}{\partial \mu_j} = -\frac{1}{1-1/\sigma} h^{1-\mu_j} \ln h < 0 .$$

Since our model involves quality consumption, consumers (demand side) decide not only about price, p_j, but also about quality, q_j. Expressed differently, consumers face "quality adjusted" prices. Using these quality adjusted prices, $q_j = p_j \mu_j$ à la Hallak (2006), the quality adjusted CES demand function for variety *j* can be expressed as

$$c_j = \frac{(q_j)^{-\sigma}}{\overline{m}} E$$

$$\overline{m}_i = q_j^{1-\sigma} + \phi \int_{j^* \in \theta} q_{j^*}^{1-\sigma} dj^*$$

where *E* is the expenditure spent for manufactured goods. (Note that for the endowments share of each country it holds *K/K*=L/L*=H/H**). $\overline{m}$ is the inversely weighted average of

[10] Likewise, foreign producers have $MC_j^* = h^{*1-\mu_j} w^{*\mu_j}$ and $FC_j^* = k_j^*$.

consumer prices and θ is a set of varieties. The first term in $\overline{m}$ denotes the prices of domestically produced goods. The second term shows the price of imported goods from the foreign market to the domestic market including their iceberg type of trade costs $t > 1$. $\phi = t^{1-\sigma}$ refers to it as the 'free-ness' of trade between countries. ϕ ranges from zero, when trade is perfectly un-free ($t = \infty$), to unity, when trade is perfectly free ($t = 1$). Using (1) q_j is the quality adjusted price of variety j given as

$$q_j \equiv p_j \mu_j = \frac{1}{1-1/\sigma} \mu_j h^{1-\mu_j} .$$

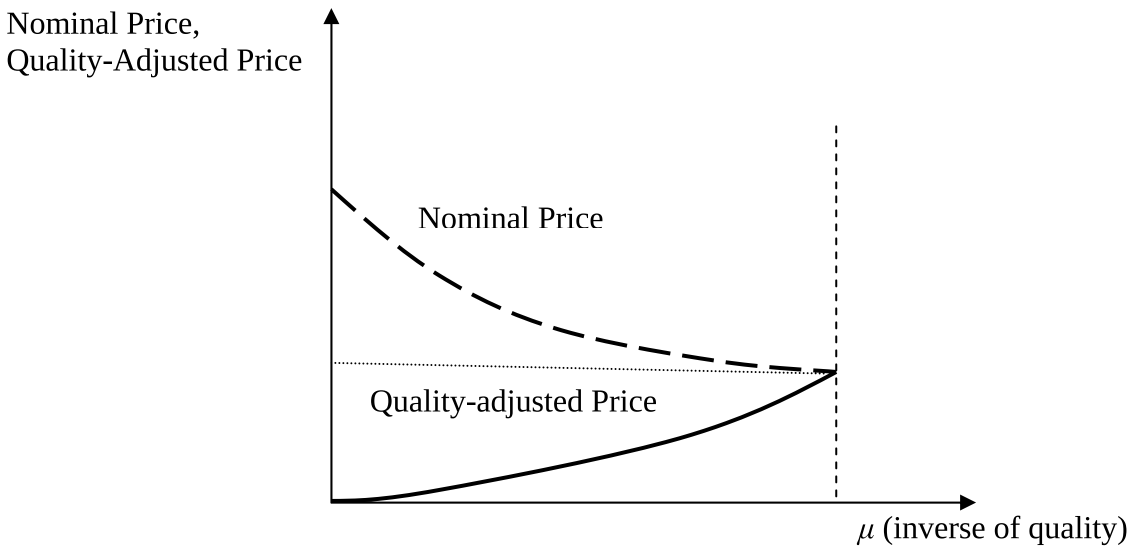
The quality adjusted prices differentiated by μ are

$$\frac{\partial q_j}{\partial \mu_j} = \frac{1}{1-1/\sigma} (-h^{1-\mu_j} \ln h + h^{1-\mu_j}) .$$

$\frac{\partial q_j}{\partial \mu_j} > 0$ holds as long as $1 < h < \exp$ is satisfied. More skilled capital intensive varieties, i.e. higher quality varieties, have lower quality adjusted prices, which triggers a stronger demand. In order to highlight how the quality adjusted demand differs from the usual price mechanism, our paper discusses the case of $\frac{\partial p_j}{\partial \mu_j} < 0$ and $\frac{\partial q_j}{\partial \mu_j} > 0$ with the necessary condition of $1 < h <$ exp. Higher quality products are sold at higher prices, p_j, but their quality adjusted prices, q_j, are relatively lower.[11] Figure 1 illustrates how higher quality firms charge higher nominal, but lower quality adjusted prices.

[11] The other case, in which the necessary condition is not binding, has $\frac{\partial q_j}{\partial \mu_j} < 0$. This case can be interpreted as the situation where nominal prices are strictly dominant over quality in consumption. This case is the same as the normal price mechanism without quality. However, this case is out of scope of our paper for several reasons. First, we cannot sufficiently highlight quality as a different dimension from the regular price mechanism. The quality adjusted price would work as a synonym of normal price. Second, this assumption would imply that high quality firms are more likely to make smaller profits and therefore face a higher risk to exit the market. The reason is that since quality adjusted prices behave as prices, higher quality (higher skilled labor intensive) varieties have lower demand and thus smaller pure profits with higher marginal costs. Our setting of beachhead costs would make high quality firms more likely to exit. However, this is a sharp contrast to many empirical studies.

Figure 1: ***Price versus Quality-Adjusted Price***



It follows that firms in our model have different marginal costs due to the different intensities of high-skilled labor in production. Higher quality requires higher proportion of high-skilled labor, involving higher marginal costs and higher prices. In summary, our model features heterogeneous firms that produce goods of different quality which are sold at different prices. Consumers in our model pay more attention to quality rather than prices and thus prefer to consume relatively more high quality varieties than low quality goods.

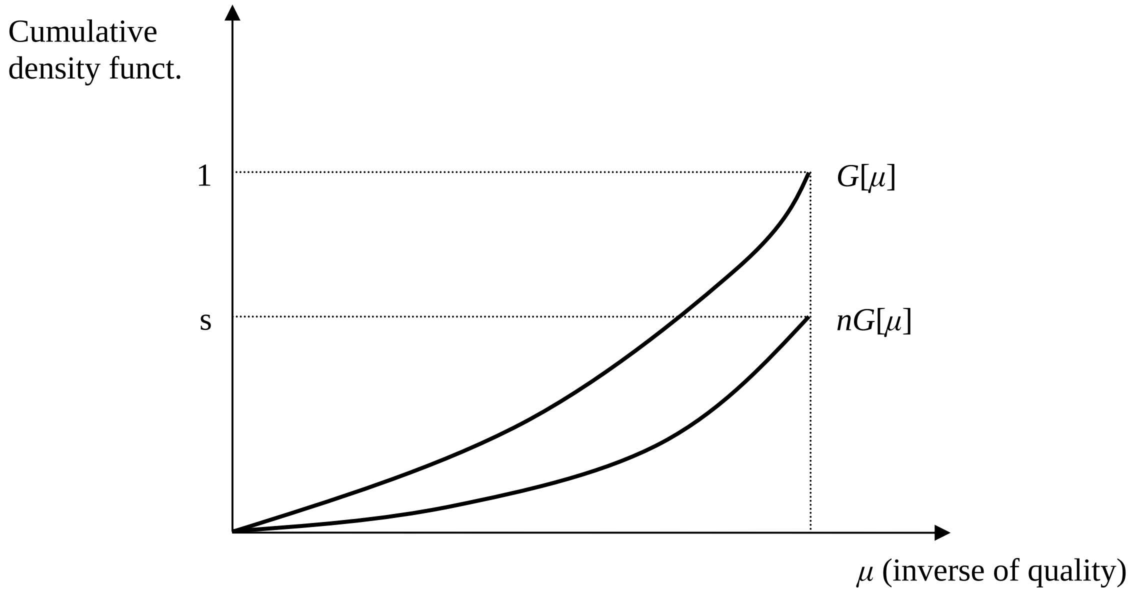
The inverse quality levels, $\mu_j \in (0,1)$, are distributed by a Pareto distribution in terms of j, a priori, without considering the R&D investment stage. The probability density function for μ's and its cumulative density function are respectively given as

$$g[\mu] = \rho\left(\frac{\mu}{\mu_0}\right)^{\rho-1} \quad \text{and}$$

$$G[\mu] = \left(\frac{\mu}{\mu_0}\right)^{\rho}$$

where $\rho > 1$ is a shape parameter and μ_0 is a scale parameter that can be normalized to be unity. Figure 2 shows the distribution of the cumulative density function (CDF) in the home country. n represents the mass of varieties in that country, $nG[\mu]=n\mu^{\rho}$. It follows that the number of high quality brands (small μ) is limited while the one of low quality and simple products (large μ) is large.[12]

Figure 2: ***Cumulative Density Function***



Unlike the standard heterogeneous firms trade models, we assume away the R&D investment stage before operation and we simply assume that μ is randomly distributed without any ex ante investment. The mass of varieties of firms in the home country and the foreign country are exogenously given as n and n^*, respectively, where $n + n^*=1$.

The capital endowments in both countries are given as $K = s$ and $K^* = 1 - s$, respectively. Since one unit of capital creates one firm, the mass of varieties corresponds to the market size, which is exogenously given as $n = s$ and $n^* = 1 - s$. The total number of home country firms is then defined as $n\int_0^1 \mu g[\mu] = n = s$, if all firms can operate.[13]

Furthermore, similar to the standard heterogeneous firms trade models, we introduce beachhead costs for domestic production and exporting so as to create different behaviors of different profit/quality firms. Different 'μ' and beachhead costs results in three types of firms

[12] ρ=1 would imply a uniform distribution with respect to μ. We exclude this possibility a priori.

[13] This number is the total number of firms including potential entrants. As shown below, some firms cannot operate due to relatively too high beachhead entry costs. Because capital is firm-specific, our model causes thus unemployment of capital. On the consumer side, households that own units of unemployed capital do not receive any rate of return. However, since each household not only holds capital, but also unskilled and skilled labor, they are able to generate income from these other two factors. Since we use a quasi-linear utility function, the different levels of capital return (and thus, different levels of household income) never matter for the demand size. The demand size for M goods is only dependent on the number of household, *s* and *1-s*, and not on their individual income size.

in both countries. Upon drawing their quality level, firms decide whether to be of *X* type (export firms), *D* type (domestic firms) or *N* type (non-producers). If the profits are only high enough to be present on the domestic market, firms will not export and therefore be called *D*-type firms. Then, if firms can pay the beachhead costs for exporting and get positive net pure profits (net of beachhead costs), firms will sell their goods on the domestic as well as foreign market and therefore are export firms, *X*-type firms.

The dynamics behind this division of firm into three groups stem from the assumption of domestic and export beachhead costs (overhead fixed costs). To sell locally, each firm has to pay domestic fixed costs, F_D. Likewise, each firm faces export fixed costs for exporting to the foreign country, F_X. Since pure profits are different across firms due to different (quality-adjusted) prices and demand, firms show a heterogeneous behavior. Firms which are unable to pay any type of beachhead costs are non-producers (*N*-type). They will not start operating and thus will neither generate profits nor capital rewards. The firms which earn enough to overcome domestic entry costs, but are not able to cover export fixed costs will be local producers (*D*-type). Finally, firms which can pay both types of beachhead costs will be exporter (*X*-type).

The net profits from selling of variety *j* to the domestic market are given in the home country by

$$\pi_D[\mu_j] = B\lfloor\mu_j\rfloor - F_D \tag{5}$$

where *B* denotes the profits from sales into the local market of the home country,

$$B\lfloor\mu_j\rfloor \equiv \frac{1}{\sigma}\frac{E^W}{N^W}\left(\frac{s}{\Delta}\right)\left(\mu h^{1-\mu_j}\right)^{1-\sigma}$$

Note that $\Delta \equiv n\int_0^{\mu D}\mu_j h^{(1-\mu_j)}dG[\mu] + n^*\phi\int_0^{\mu X}\mu_j h^{1-\mu_j}dG[\mu]$ and for the world (*W*) it holds $N^W = n + n^* = K^W = K + K^* = 1$ and $E^W = \sigma$, without loss of generality.[14] Since exporting requires the payment of additional beachhead costs, the net profits for domestic firms of exporting are given as

$$\pi_X\lfloor\mu_j\rfloor = \phi B^*\lfloor\mu_j\rfloor - F_X \tag{6}$$

where B^* denotes gross profits from the export market.[15]

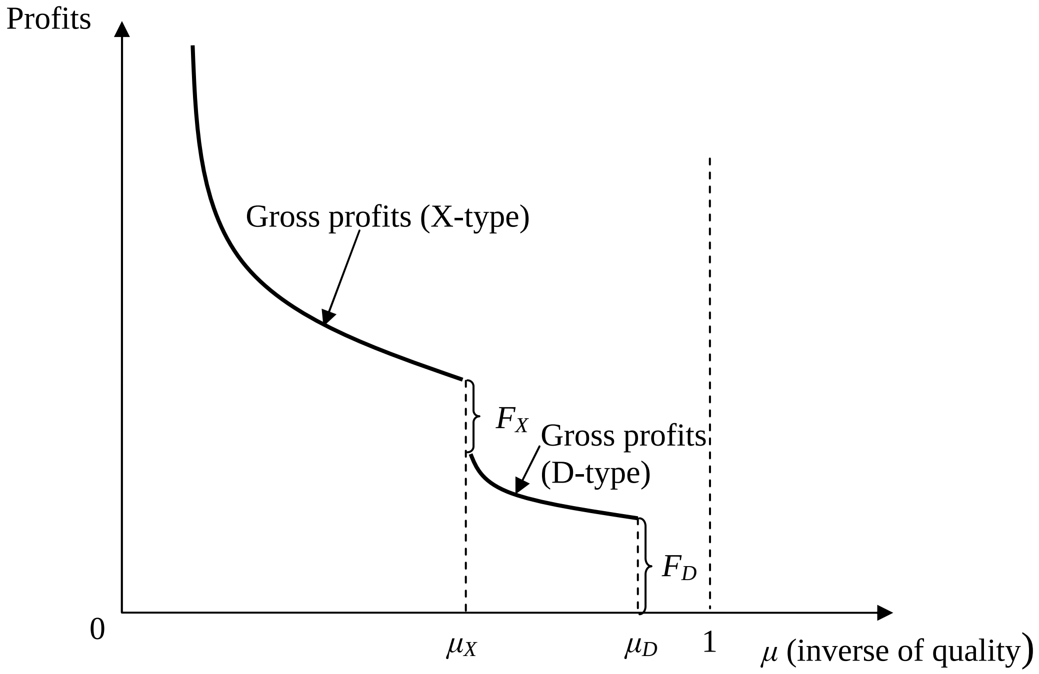
[14] The total number of households in the world is thus σ. Each household has 1/ σ units of capital.

[15] For the foreign country the following profit functions hold:, $\pi_D^*[\mu_j] = B^*(\mu_j) - F_D$ and $\pi_X^*[\mu_j] = \phi B(\mu_j) - F_X$.

$$B^*[\mu_j] \equiv \frac{1}{\sigma}\frac{E^W}{N^W}\phi\left(\frac{1-s}{\Delta^*}\right)\left(\mu h^{1-\mu_j}\right)^{1-\sigma}$$

Note that $\Delta^* \equiv n^* \int_0^{\mu D} \mu_j h^{*(1-\mu_j)} dG[\mu] + n\phi \int_0^{\mu X} \mu_j h^{1-\mu_j} dG[\mu]$.

Figure 3: ***Typology of Firms and Profit Functions***



2.2 Equilibrium

Using (5) and (6) the equilibrium involves four cutoff levels, μ_D, μ_D^*, μ_X and μ_X^*, with h and h^* determined by skilled labor market clearance. The cutoff level conditions are

$$\phi\frac{1-s}{\Delta^*}\left(\mu_X h^{1-\mu_X}\right)^{(1-\sigma)} = F_x \tag{11}$$

$$\phi\frac{s}{\Delta}\left(\mu_X^* h^{*1-\mu_X^*}\right)^{(1-\sigma)} = F_x \tag{12}$$

$$\frac{s}{\Delta}\left(\mu_D h^{1-\mu_D}\right)^{(1-\sigma)} = F_D \tag{13}$$

$$\frac{1-s}{\Delta^*}\left(\mu_D^* h^{*1-\mu_D^*}\right)^{(1-\sigma)} = F_D \tag{14}$$

The market clearances for skilled labor are

$$\left(\sigma-1\right)\left(\left(\frac{s}{\Delta}+\phi\frac{1-s}{\Delta^{*}}\right)s\int_{0}^{\mu_X}(1-\mu_j)\left(\mu_j h^{1-\mu_X}\right)^{(1-\sigma)}g[\mu_j]dj+\frac{s}{\Delta}s\int_{\mu_X}^{\mu_D}(1-\mu_j)\left(\mu_j h^{1-\mu_X}\right)^{(1-\sigma)}g[\mu_j]dj\right)-hH=0$$

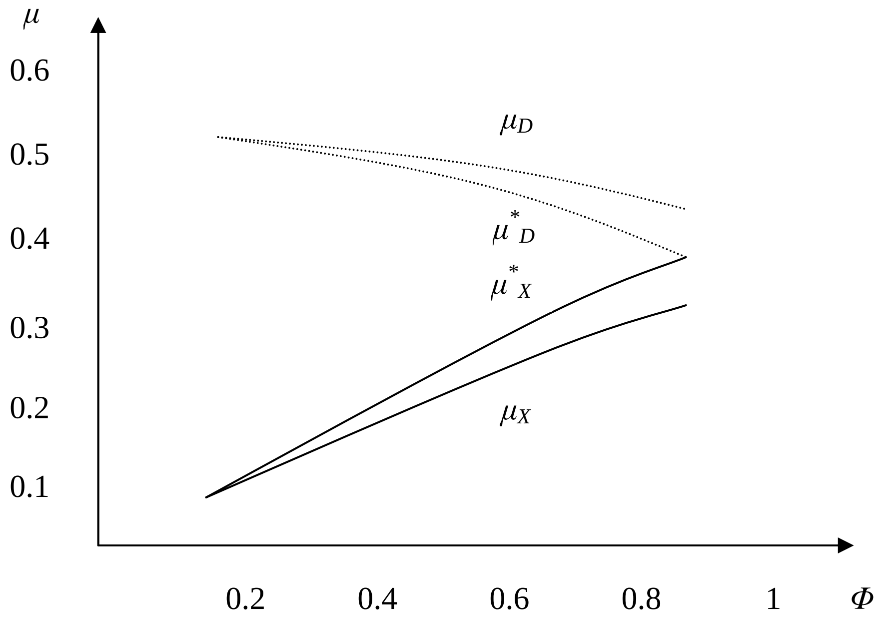
$$\left(\sigma-1\right)\left(\left(\phi\frac{s}{\Delta}+\frac{1-s}{\Delta^{*}}\right)(1-s)\int_{0}^{\mu_X^{*}}(1-\mu_j)\left(\mu_j h^{*1-\mu_X}\right)^{(1-\sigma)}g[\mu_j]dj+\frac{1-s}{\Delta^{*}}(1-s)\int_{\mu_X^{*}}^{\mu_D^{*}}(1-\mu_j)\left(\mu_j r_i^{*1-\mu_X}\right)^{(1-\sigma)}G[\mu_j]dj\right)-h^{*}H^{*}=0$$

[16]

For simplicity, without loss of generality we assume $F_X = F_D$, $H=s\,H^W$ and $H^*=(1\text{-}s)\,H^W$, where H^W is endogenously given endowment of skilled labor in the world.

Figures 4a and b plot the simulation results.[17] We always obtain $\mu_X < \mu_X^* < \mu_D^* < \mu_D$ (Figure 4-1) and $h > h^*$(Figure 4-2).[18]

Figure 4-1: ***Cut-off Levels,*** $\boldsymbol{\mu}$**.**

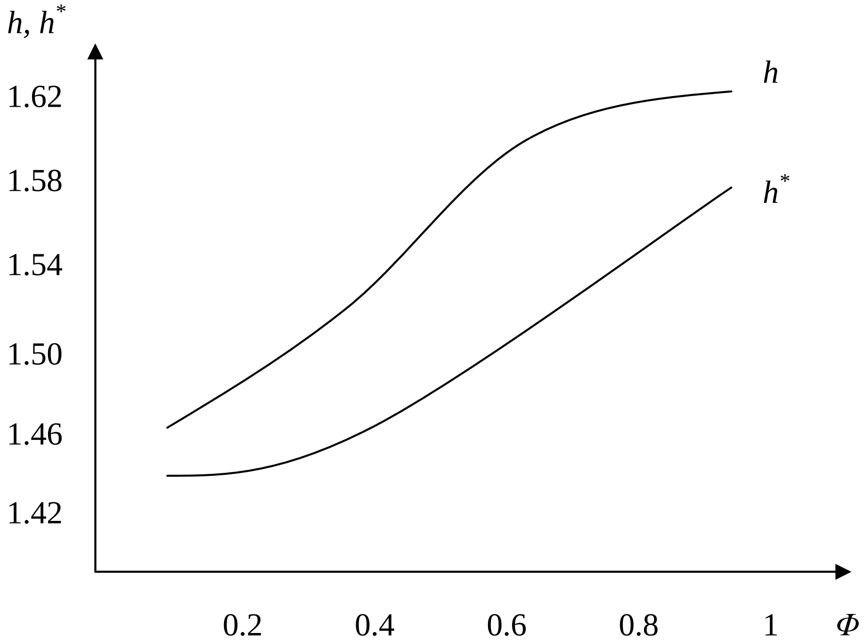


[16] Firm *j*'s demand for skilled labor is $(1-\mu_j)*TC_j$ (TC: total costs) due to the Cobb-Douglas cost function. The first term in each equation denotes the human capital demand.

[17] As in many heterogeneous-firm trade models, we cannot solve them analytically. The values of parameters for Figure 4 are as follows: σ=2, ρ=2, s=0.6, Fx=FD=2 and H^W=0.5.

[18] Note that to make things interesting and simple, we exclude the possibility of all firms being exporter in the small country, i.e. $\mu_X^* = \mu_D^*$, thus trade costs discussed in our paper are sufficiently high.

Figure 4-2: ***High-Skilled Wage Simulation Results***



As shown in Figure 5, the large country has more local producers and less exporters while the small country has more exporters and less local producers.

The prices are higher for better quality products compared to low quality products. However, quality adjusted prices are lower for high quality goods (under the necessary condition of $1 < h < exp$). When the consumers in our model face quality adjusted prices (q) rather than simple prices (p), their demand for higher quality goods is larger regardless of higher prices. For this reason, profits of high quality firms' must be higher, and it follows that higher quality goods are produced by *X*-type firms, while lower quality goods are sold by *D*-type firms.

The market size ratios, i.e. the expenditure shares, are s (>0.5) in the home country and (1 - s) in the foreign country. Due to the Home Market effect, the production share in the larger home country is more than proportional to the expenditure ratio (s > 0.5). This asymmetry increases the demand for high-skilled labor more strongly in the home country. As a consequence, the factor price for high-skilled labor raises more at home (h) than in the foreign country (h^*). Higher h (marginal costs) brings down profits of the firms in the home country, and loses their market share in the foreign country and reduce the number of Home's exporters. Mathematically, from (13) and (14) ((11) and (12)), the firms' profits in the local market (export market) at cutoff levels should be the same level between countries because we assume internationally identical beachhead costs of F_D (F_X). Together with $h>h^*$, this thus leads to lower (higher) export cutoff levels in the Home (Foreign) and less home exporters (more foreign exporters), i.e. $\mu_X < \mu_X^*$.

Figure 5-1: ***Home Market (large country)***

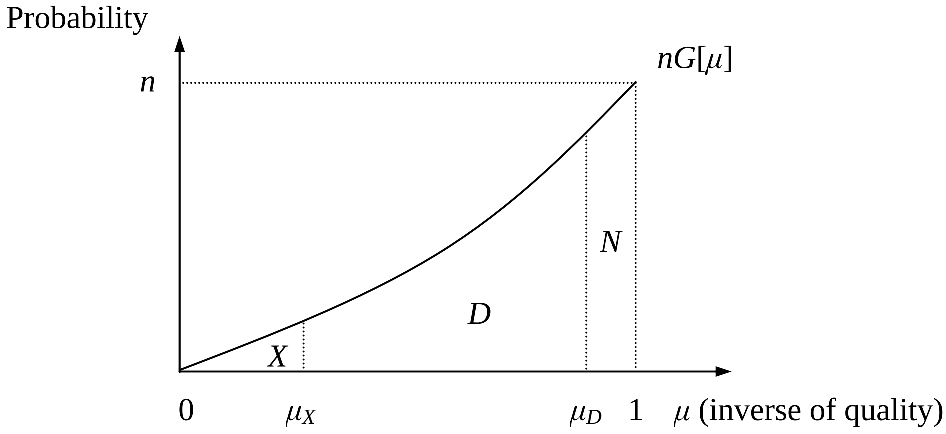
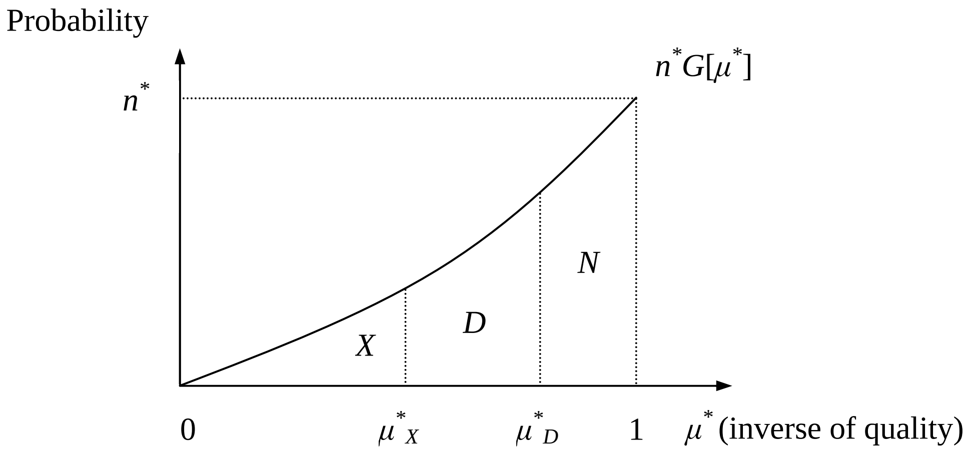


Figure 5-2: ***Foreign Market (small country)***



Furthermore, the presence of trade costs reduces the import penetration in the Home market, and the larger Home market allows for more domestic entrants, as long as *h* is sufficiently large in equilibrium so as to satisfy our assumption (1<h<e), i.e. $\mu_D^* < \mu_D$.[19] As a corollary, in Foreign relatively more firms are exporters due to a larger export market (Home).[20] Thus, in

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[19] If we allow for a large *h* and a small h^* with a substantially large gap of market size and small trade costs and a certain allocation of human capital, there is the possibility of $\mu_D^* > \mu_D$. However, this outcome occurs certainly in a special case and not crucial in discussion below. Our main focus is on the difference in export cutoffs between countries.

[20] Intuitively, higher *h* raises *q* and lowers $q^{1-\sigma}$ in the varieties produced in Home. This reduces Δ, but this decrease has a smaller impact on Δ^* due to trade costs and the impossibility of local varieties in Home through the presence of export beachhead costs. Hence, since Home has larger demand size and *h*>*h**, Δ / Δ^* <s/(1-s) holds. Using these relations, (13) and (14) give us $\mu_D^* < \mu_D$ due to

home the average nominal export prices (average nominal prices of X-types) are higher than the average (domestic) prices due to $\mu_X < \mu_D$ and $\frac{\partial p_j}{\partial \mu} < 0$ (vice versa for foreign country). From the outcome of $h > h^*$ and $\mu_X < \mu_X^*$, the price at the export cutoff in the Home country is higher than in Foreign, i.e. $p(\mu_X) > p(\mu_X^*)$ due to $\frac{\partial p_j}{\partial \mu} < 0$. The average export prices, $\overline{p}$ and $\overline{p}^*$, are higher in Home, i.e. $\overline{p} > \overline{p}^*$. We can summarize our results as follows:

Result 1: Higher quality firms are able to sell their products on the domestic as well as on the foreign market. Lower quality firms only produce for the domestic market, but are unable to export.

Result 2a: The average price of the exporting varieties is always higher than the average price for all produced goods.

Result 2b: The larger market has higher average export prices than the smaller market.

Note that Results 2a and 2b constitute a sharp contrast to the prediction of standard heterogeneous firms trade models, in which the export firms (high productivity firms) sell at low prices, while the low productivity firms need to sell at high prices. Thus, the average export prices in the standard model are always <u>lower</u> than the average price of all products produced and sold within a country. However, this standard models' result neglects quality aspects of international trade. Empirical evidence shows that higher unit values of exports indicate higher quality (Schott, 2004). Not only the productivity of firms, but also the quality they produce may determine whether a firm exports or not.[21]

$\frac{s/\Delta}{(1-s)/\Delta^*}\left(\frac{\mu_D}{\mu_D^*}\right)^{1-\sigma}\left(\frac{h^{1-\mu_D}}{h^{*(1-\mu_D^*)}}\right)^{(1-\sigma)} = 1$ and (11) and (12) give us $\mu_X < \mu_X^*$ due to $\frac{(1-s)/\Delta^*}{s/\Delta}\left(\frac{\mu_X}{\mu_X^*}\right)^{1-\sigma}\left(\frac{h^{1-\mu_X}}{h^{*(1-\mu_X^*)}}\right)^{(1-\sigma)} = 1$.

[21] See Baldwin (2005) about this shortcoming in the heterogeneous firms trade models and the inconsistency with the quality literature.

2.3 Comparative Statics - Market Size, Distance and Trade Costs

Studying the relationship between market size and export prices as well as between trade costs (distance) and export prices allows us to derive further testable hypotheses. Suppose that the domestic country has a relatively larger market compared to the foreign country. All pairs of lines for the home and foreign countries that are plotted in Figure 4 diverge as the market size becomes increasingly uneven. As the home market size is getting relatively large, the more than proportionally increased production demands more skilled labor in the home country than the increased market (demand) size, and vice versa for Foreign. This mechanism raises h relatively more than h^*. The higher marginal costs due to the rise of h reduces market competition in the domestic market and makes it for firms more difficult to enter the export market, i.e. we observe a fall of μ_X and a rise of μ_D. As a result, average export prices increase in the larger market, and vice versa.

Result 3: As the relative market size (a gap of market size) increases, average export prices increase in the larger market and decrease in the smaller market.

Turning to trade costs, in Figures 4 we plot the cutoffs in terms of trade costs (Figure 4-1) and skilled labor returns (Figure 4-2). The decline of trade costs (increased Φ) promotes competition and hence crowds out low quality local producers. In contrast, more firms are now able to export in our model. Since production shifts from local firms (non-exporters) to high quality firms, the high quality exporters demand more high-skilled labor which pushes up wages for high-skilled labor. Thus a trade costs reduction increases high-skilled labor factor prices in both countries.

Figure 4-2 tells us that the rise of high-skilled labor wages a home, h, is stronger than that of high-skilled labor wages in foreign, h^*, in case of a trade costs reduction. Higher human capital wages dampen gross profits more for the top range of quality exporters though a relatively stronger rise of their marginal costs. By contrast, the less high-skilled intensive firms (lower quality firms) are less concerned by this burden and therefore tend to become exporters. It follows that the rise of marginal costs increases μ_X and μ_X^* and decreases μ_D and μ_D^*.

Using the analogy of Results 2a and 2b that small market, Foreign, has higher μ_X^* and more exporters, the impact of trade cost reduction is larger in Foreign in total. Thus, as shown in

Figure 4-2, the increase in μ_X^* is more pronounced than that of μ_X, while the decrease in μ_D^* is stronger than that of μ_D^*. Thus, the average export prices increase in both countries, but the increase of the average price is relatively more pronounced in the foreign country. In other words, as countries are geographically farther away from each other, the gap of average export prices decreases more in the large country. The geographical distance should thus be negatively correlated with the gap of average export prices between countries.

Result 4a: As trading partners are located farther away (namely trade costs are higher), the quality of the exported goods increases (fall of μ_X and μ_X^*). The increase in export average prices is more pronounced in the large market. Thus, as geographical distance rises, export prices increase in both countries, and particularly the larger market experiences a substantial rise of the average prices.

Another interpretation for this outcome is possible in trade liberalization over time. The current trade liberalization reduces trade costs, i.e. the increased freeness of trade ϕ.

Result 4b: Trade cost reduction via trade liberalization results in a fall of the average quality of the exported goods. As trade costs decrease, the small market experiences a stronger decline of its average quality (exports and local sales) and hence a stronger fall in average prices.

2.4 Trade Costs and Distance in the Multi-Sector Framework

Until the last section, we studied a two-country model for simplicity's sake. Due to the assumption of the non-output-input linkages across sectors, identical distribution of firms' productivity and a quasi-linear utility function (to eliminate any income effect), our results can be reinterpreted in a multi-sector framework. We therefore reintroduce the multi-sector framework, for instance a continuum of sectors, $S \in (0,1)$. Since we assume a quasi-linear utility function and a symmetric firm distribution across sectors with neither comparative advantage nor different factor endowments, the basic outcomes can be applied in a multi-sector framework.

Since one sector is perfectly independent of all the others from the supply and demand side, introducing a multi-sector framework is innocuous to the model. Keeping this simplicity, we now introduce asymmetry in trade costs across sectors. We know that at the disaggregate product level, trade costs vary substantially across products due to certain product characteristics. Trade cost differences across products are likely to be much larger than within a certain product category.[22]

Owing to the simplicity of our basic model, the above-mentioned results can be re-interpreted. The product (sector) with high trade costs displays high average export prices; whereas the product (sector) with low trade costs allows more firms to enter export markets and thus has lower average export prices.

Result 5: In a multi-sector framework, products (sectors) with high trade costs have higher average export prices (qualities) compared to products with low trade costs. With increasing distance between trading partners, a higher share of products with low trade costs enter the export bundle.

3. Empirical Evidence

3.1 Data

In order to test our model empirically, data on the quality level of trade flows are needed. However, estimating the quality level of trade flows is not an easy task. The most commonly used measurement of quality is via unit values of trade flows (e.g. Hummels and Skiba, 2004). This measurement of quality performs better the higher the digit level at which trade data are recorded. International trade data is typically only available up to the six-digit level. Some countries collect data on higher digit levels which allow for a thorough analysis of quality issue. Schott (2004) uses this type of data to study the quality level of US imports. However, for the majority of countries only trade data at the six-digit level is recorded. The main data set used in this paper is at the eight-digit level and thus our measurement of quality might not be perfect, however, at the moment, we do not dispose of a more accurate method.

In order to test our first two results empirically, not only detailed international trade data are needed, but also data on intra-national trade flows. Data for our first sample come from the

[22] For example, Hummels and Skiba (2004) find substantial trade cost differences between different product categories.

U.S. Commodity Flow Survey and covers the year 2002. A detailed description of this data set follows in the next section.

To conduct empirical tests of the other results, our main sample covers detailed trade data of for EU 15 for the year 2005.[23] The total number of product in the Combined Nomenclature is more than 10,000 and the total number of observation is close to 700,000. Restricting our sample to EU trade allows us to analyze the role of quality for trade between countries that have similar factor endowments, technology as well as consumption preferences. It is true that there is some variation in these variables between the 15 countries in the sample. However, the variance does not exceed to a large extent the one that exists within a given EU country. Furthermore, the variance between EU countries is far smaller than within other country groups, like between Asian or South American countries. Finally, the main economies within this group, namely Germany, France, Italy, Spain, and the UK, which produce about 87 % of EU's GDP, share very similar factor endowments, technologies and consumption preferences. The main difference between the economies under consideration is the market size. We consider the GDP as an appropriate measure of market size (and thus the population size as a proxy). The GDPs vary from 29 billion euros in the case of Luxemburg to 224 billion in the case of Germany for the year 2005. As a proxy for market size, we also use the population size of EU countries.

For our estimations we necessarily need information about the trade costs between trading partners. As commonly done in the empirical trade literature, we assume that distance is an appropriate proxy of trade costs. For our estimation, two types of distance measures are applied: First, distance between trading partners is measured using the great circle formula. However, the great circle formula may suffer from the fact that it only takes into account the geographical location of the capital of a country. Neglecting the spatial distribution of economic activity becomes problematic, especially for shorter distances. In order to have a more appropriate measurement of distance, we also use a weighted distance measure. This measure takes into account the economic geography of a country/region by calculating the bilateral distances between the three cities with the largest population k in country i and l in country j in the trade pair and weighting them by the population share. Using this distance measure, we hope to capture in a more accurate way the economic geography of EU countries. Similar to Head and Mayer (2002) the following formula of distance between i and j is used:

[23] The countries are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Spain, Sweden, and United Kingdom.

$$d_{ij} = \sum_{k \in i} (pop_k / pop_i) \sum_{l \in j} (pop_l / pop_j) d_{kl}$$

In the following section the main predictions of our model are tested: First, we compare the quality of goods produced and sold domestically versus exported goods (Result 2). Second, market size effects are analyzed (Result 3). Third the influence of trade costs on the quality level of export flows is studied (Result 4). Fourth, we verify the claim that quality and the composition of trade are related (Result 5).

3.2 Domestic versus Foreign Sales

Testing our first hypotheses requires detailed data on domestically produced and sold products. Not only is the value of a product needed, but also its quantity. For European countries, these data are not available to our knowledge. However, in the USA the U.S. Census Bureau in partnership with the Bureau of Transportation Statistics of the U.S. Department of Transportation established for the year 2002 the Commodity Flow Survey (CFS) which contains detailed data on shipments by domestic establishments in manufacturing, wholesale, mining, and selected other industries. The data cover domestic shipments, available up to the four digit level of the Standard Classification of Transported Goods (SCTG), as well as exports, available up to the two digit level of SCTG. The data are recorded in values (millions US dollars) and quantities (thousands of tons).

In a first step, we compare the unit value of domestic and foreign shipments at the highest common level, the two digit level. Table 2 presents the comparison of both flows for all manufactured product groups within the SCTG classification. The last column reports the difference in percentage between the unit values of domestic and foreign shipments. The results indicate that the average unit value (U.V.) of domestically transported goods is substantially lower than the average unit value of exported goods. The only exception is the product group 36 SCTG (Motorized and other vehicles, including parts) which has the approximately the same unit value for internal shipments and exports.

It has to be noted that these shipment data do not satisfy completely our needs. Products, which are shipped domestically, are not only those that are manufactured within the US, but also abroad. This problem becomes especially worrisome for product groups in which the US is a net importer. Comparing domestic and foreign shipments therefore has to be taken with some caution. Furthermore, the two digit level does not seem to be most appropriate to draw conclusions about the quality level of products.

The domestic shipment data on the four digit level (SCTG) can be exploited to make a more detailed comparison with international trade flows. Several four digit SCTG product groups in manufacturing goods have an exact counterpart in the HS 1996 classification. However, not all of the HS 1996 product groups that correspond to the HS 1996 classification are recorded in tons as trade quantity. Furthermore, for the reason explained above, the US needs to be by far a net exporter in order to obtain valuable results.

Table 2: ***Unit Value Comparison of Domestic and Foreign Shipments***

		Domest. Shipm.		Foreign Shipm.		**U.V.**
SCTG	Commodity description	Value	Av. U.V.	Value	Av. U.V.	**Diff. %**
33	Articles of base metal	234,571	2.01	12,093	3.03	**+50.53**
34	Machinery	484,152	7.64	56,562	11.59	**+51.72**
35	Electronic & other elec. Equip. & comp. & office equip.	890,803	17.96	149,163	38.93	**+116.70**
36	Motorized & other vehicles (including parts)	748,550	5.62	68,768	5.58	**-0.78**
37	Transportation equipment, n.e.c.	155,013	8.45	28,238	51.06	**+504.54**
38	Precision instruments & apparatus	225,070	12.26	39,314	104.84	**+754.83**
39	Furniture, mattresses & mattr. Supp., lamps, light. fittings	139,727	4.29	2,736	5.69	**+32.49**
40	Miscellaneous manufactured products	387,426	4.89	24,009	8.88	**+81.60**
41	Waste and scrap	37,896	0.17	5,170	0.46	**+165.58**

Notes: Value stands for the total value of the shipment in current U.S. dollars. U.V. denotes the average unit value of the shipment in each SCTG commodity group. Diff. % expresses the difference in percentage between domestic and foreign shipments

All these criteria are only fulfilled by two headings, namely HS 8301 (Padlocks, locks, claps with locks, and keys) and HS 8803 (Parts of aircraft, spacecraft, etc.). For the year 2002, in case of HS 8301, the US exported goods worth 337 million US dollars and imported only half of this amount; and for HS 8803 the exports amounted to 8,584 million US dollars compared to imports of only 197 million US dollars.

Since we are interested in quality trade between similar economies, we have extracted the US export data for both product groups towards the 15 EU countries, plus Canada and Japan, from the UN COMTRADE Database. Table 3 lists in the first two columns of each product group the unit values of exports and the difference in percentage compared to the unit values of domestic shipments. The average unit values of domestic shipments for HS 8301 are 6.71 (US dollars per ton) and for HS 8803 180.72 (US dollars per ton) according to SCTG data.

Table 3: ***Unit Value Comparison of Domestic Shipments and Exports in the case of USA***

	Padlocks, locks, claps with locks, and keys (HS 8301)				Parts of aircraft, spacecraft, etc. (HS 8803)		
Importer	U.V.	Diff. %	GDP %	Importer	U.V.	Diff. %	GDP %
Denmark	47.96	+680.97	1.64	Netherlands	495.60	+173.66	4.01
Austria	44.67	+627.48	1.99	Ireland	464.48	+156.48	1.15
Sweden	34.50	+461.80	2.32	Finland	434.90	+140.15	1.27
Spain	30.74	+400.54	6.57	Sweden	377.93	+108.69	2.32
U.K.	23.36	+280.48	15.00	Denmark	364.48	+101.26	1.64
Greece	23.20	+277.83	1.28	France	347.02	+91.62	13.97
Japan	22.99	+274.48	38.05	Germany	313.92	+73.34	19.38
Belgium	22.00	+258.23	2.36	Japan	285.72	+57.77	38.05
Italy	21.94	+257.38	11.37	Canada	253.88	+40.19	6.96
Netherlands	21.56	+251.15	4.01	Austria	253.07	+39.74	1.99
Finland	20.80	+238.68	1.27	Italy	233.88	+29.15	11.37
Portugal	20.48	+233.53	1.16	Portugal	219.62	+21.27	1.16
Canada	17.21	+180.27	6.96	Belgium	214.03	+18.19	2.36
Germany	15.75	+156.50	19.38	Spain	195.70	+8.06	6.57
France	14.62	+138.17	13.97	Greece	179.21	-1.04	1.28
Ireland	13.25	+115.75	1.15	U. K.	163.70	-9.61	15.00
Luxemburg	no imports	-	0.21	Luxemburg	136.33	-24.72	0.21

Notes: U.V. denotes the average unit value of the shipment in each SCTG commodity group. Diff. % stands for the difference in percentage between the domestic and the export trade flow. GDP % calculates the size of the importing country compared to the U.S. economy in percentage terms. The countries' GDPs are all measured in current U.S. dollars.

The numbers in Table 3 demonstrate that all exports unit values of HS 8301 products are substantially higher than the unit values of domestically shipped HS 8301 products. In case of HS 8803 the vast majority of importing countries have also higher unit values, with Greece, the UK, as well as Luxemburg as exceptions. Overall, the results seem to corroborate our first hypothesis. There seem to be empirical evidence that the average price of domestically produced and sold products is lower than the average price of exported goods.

The results have been sorted by the percentage for which the unit value of exports exceeds the unit value of the domestically shipped goods. One observes that for the heading HS 8301 all export unit values exceed the domestic counterpart by up to 681 %. A less stark picture emerges by analyzing the case of HS 8803. Except for three cases, all export unit values are substantially higher than the domestic unit value.

Since our model makes strong predictions about the impact of market size, Table 3 also includes the GDP ratio (in percentage) between the USA and the importing country (GDP is measured in current US dollars). It is interesting to see that there seems to be a tendency that exports towards small countries have higher unit values than export flows towards large economies. Empirical evidence of a positive relationship between the GDP ratio (the difference between the GDP of the exporting and importing country) and the quality level would support the model's prediction. In section 4.4, this hypothesis is tested more thoroughly.

3.3 Trade Costs and the Quality Level

Our model of section 2 claims that with increasing trade costs the quality level of trade flows rises (Result 3). Only producers of high quality goods find it still profitable to export when trade costs increase. The result of this effect is the same as described by Alchian and Allen (1964) as "shipping the good apples out". Hummels and Skiba (2004) prove the Alchian-Allen effect for import flows of six countries (Argentina, Brazil, Chile, Paraguay, Uruguay, and the United States).

Even though the prediction of our model corresponds to the Alchian-Allen effect, the mechanism is slightly different. Alchian and Allen (1964) claim that per unit trade costs constitute the prevalent type of trade cost, and as a consequence, the price difference between low and high quality goods becomes increasingly blurred with rising trade costs. Consumers at the final destination then start preferring higher quality goods since they become more and more inexpensive compared to lower quality goods. In contrast, the model in this paper assumes that consumer demand is biased towards high quality goods, which allows high quality producers to penetrate more easily export markets.

Whereas the mechanism in both approaches is different, the outcome is similar. The type of beachhead costs that we assume in our model, have the same effect as the assumption of per unit trade costs underlying the reasoning of Alchian and Allen (1964). Our model might be seen as an appealing answer to the question how per unit and iceberg type trade costs may interplay in quality trade. In the following, we show that the Alchian-Allen effect can be observed for trade flows between similar countries.

The mechanism of "shipping the goods apples out," translates into the prediction that the unit value rises with increasing trade costs.[24] As common in empirical work, we approximate trade costs by the distance between trading partners. Again, distance is only a rough measurement of trade costs. However, the success of the gravity model to predict trade flows suggests that distance is an appropriate approximation of trade costs.

[24] One may recall that traditional trade models assume that the unit value is not related to distance.

At this point, it is important to note again the difference of our model predictions to the ones of heterogeneous-firms trade models à la Melitz (2003). The typical heterogeneous firms trade models, i.e. Melitz (2003), Helpman, Melitz and Yeaple (2004), Falvey, Greenaway, and Yu (2004), Helpman, Melitz and Rubinstein (2004), Redding and Schott (2005) and Okubo (2008), predict a negative correlation between average export prices and trade costs. The reason is that the most efficient firms, which are also the exporting firms, sell their goods at the lowest price (see Baldwin, 2005, for details). In contrast, our model states that average export prices are positively correlated with trade costs. Only firms that produce high quality goods are able to overcome high trade costs. Even though both model types seem to yield contradicting predictions, we are able to reconcile them. Our model adds an important dimension to the standard Melitz (2003) model. We claim that only considering the productivity of firms is not enough. Vertical product differentiation has an important role to play in shaping international trade. Our model therefore complements the heterogeneous-firms trade theory and delivers new testable hypotheses.

Results 3 and 4 predict a positive relationship between the quality level of exports and trade costs. When approximating quality by unit value and trade costs with distance, we would expect to find in the data a positive relationship between both. In order to test empirically for this positive relationship, the following functional form can be specified:

$$\log(p_{ijk}) = \alpha + \beta \log(dist_{ij}) + \chi adj_{ij} + \delta lang_{ij} + \phi cur_{ij} + \nu_k prod_k + \omega_i ex_i + \iota_j im_j + \varepsilon_{ij} \qquad (13)$$

In this equation p_{ijk} denotes the unit value exported from country *i* to country *j* of product group *k*. Bilateral trade costs are captured by the distance ($dist_{ij}$) between country *i* and country *j*. In order to improve our estimation of trade costs, we also include the variable adjacency. The variable *adj* becomes unity if two countries are adjacent and zero otherwise. Since the 15 EU countries form a common market, no tariff data needs to be included. Non-tariff barriers (NTBs) probably still play a role in European trade, however, they are difficult to measure. Two NTBs which are readily available are common language and a shared currency, namely the euro. We include them as *lang* and *cur* in our gravity equation.

All parameters need to be estimated together with product fixed effects, $v_k prod_k$. The main reason for using product fixed effect is that the absolute values of unit values vary substantially across products. A subheading like, for example, bolts has a very different unit value compared to the subheading for medical instruments. Another reason is that the quantities reported are not identical for all products. All in all, one of 12 different quantity measures can be applied.[25] Since country specific effects might also influence the result, we further use fixed effects for importing and exporting countries (ω_i and ι_j). Finally, ε_{ij} denotes a Gaussian white noise error term. [26]

Table 4: *Quality and Trade Costs Effects in Intra-EU Trade*

	(1)	(2)	(3)	(4)	(5)
G.C. Dist.	0.112***		0.080***		0.075***
	(0.017)		(0.019)		(0.021)
Wei. Dist.		0.136***		0.103***	
		(0.020)		(0.033)	
Adjacency			-0.063***	-0.045	-0.069***
			(0.020)	(0.030)	(0.022)
Com. Lang.					-0.008
					(0.032)
Com. Curr.					0.029
					(0.026)
Obs.	857747	857747	857747	857747	857747
R^2	0.540	0.540	0.540	0.540	0.540

Notes: All regressions are run with importing and exporting country fixed effects as well as product fixed effects, but for which the coefficients are not reported; G.C. Dist. and Wei. Dist. stand for log of the great-circle distance and the log of weighted distance, respectively; ***,**,* denotes significance at the 1 %, 5 %, and 10 % level, respectively; robust standard errors, which are in parentheses, are corrected for clustering by country pair.

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Column (1) of Table 4 documents the regression results when all 857747 trade flows in all goods between EU 15. The regression yields a highly significant and positive distance coefficient which means that the unit value of exported products increases with trade costs.[27] This result holds true whether we approximate trade costs with weighted distance or use the unweighted distance measure.

[25] Area in square meters, electrical energy in thousands of kilowatt-hours, length in meters, number of items, number of pairs, volume in liters, weight in kilograms, thousands of items, number of packages, dozens of items, volume in cubic meters, weight in carats.

[26] Another way to estimate the effect of trade costs on distance is to work with deviations from the mean, like in Hummels and Skiba (2004). If the Alchian-Allen effect holds, then the distance deviation from the mean of each product group should be positive. It would indicate that quality and trade costs are positively correlated. The primary concern of Hummels and Skiba (2004) is to show how freight costs and prices are related. They find that the elasticity of freight rates with respect to price is less then unity which means that when prices double the trade costs less than double. They conclude that the iceberg assumption of shipping costs is therefore not correct. Furthermore, their results indicate that the unit values of trade flows increase with freight costs by 80-141 percent. These findings clearly confirm the Alchian-Allen effect. Hummels and Skiba (2004) also include tariffs in their estimation. Since in intra-European trade no tariffs apply, they cannot be included in our estimation.

[27] The R-squared reported do not correspond to ordinary OLS R^2, since we estimate a fixed-effect model.

In columns (3) to (5) we include additional variables to control for geographical particularities as well as NTBs. It is interesting to see that the distance coefficients shrink in all regressions. All additional variables have a negative sign, except for common currency, but only adjacency is statically significant when the great-circle distance is used. The negative coefficient of adjacency confirms the model's predictions that lower trade costs due to adjacent countries leads to lower quality which becomes traded, resulting in lower average prices. As we see in column (4), the weighted distance seems to take care of the influence of adjacency, and therefore we mainly include weighted distance as a measure of trade costs in the later regressions. Summarizing all regression results so far, we find strong support of an Allen-Alchian effect and hence Results 4 and 5.[28]

Table 5: ***Product Groups (HS Classification Codes)***

HS	Product Group Description	HS	Product Group Description
01-05	Animal & Animal Products	50-63	Textiles
06-15	Vegetable Products	64-67	Footwear/Headgear
16-24	Foodstuffs	68-71	Stone/Glass
25-27	Mineral Products	72-83	Metals
28-38	Chemicals & Allied Industries	84-85	Machinery/Electrical
39-40	Plastics/Rubbers	86-89	Transportation
41-43	Raw Hides, Skins, Leathers, & Furs	90-97	Miscellaneous
44-49	Wood & Wood Products	98-99	Service

In Table 6 we present the result when applying the basic equation (regressing unit values on weighted distance) for 15 commodity groups of the Combined Nomenclature (Table 5).[29] The distance coefficient of all product groups has a positive sign, except for textiles as well as footwear/headgear. The negative and significant results are difficult to explain.[30] The link between trade costs and quality seems to be strong for all industry with a polypolistic structure. Furthermore, we observe that for industry which produce output that is relatively costly to trade, such as mineral products which include cement, tend to have a higher distance coefficient.

[28] In contrast to Hummels and Skiba (2004), we focus on trade between similar economies. We confirm their results and offer a theoretical explanation. The increase in the unit value could be due to the quality effect described in our model.
[29] The Combined Nomenclature follows the classification of the Harmonized System, but offers 8-digit subcategories.
[30] As we will see later, when taking into account zero trade flows the signs changes into positive.

The small coefficient and significant distance coefficient for the product groups 86 to 89 probably stems from the fact that several of these products are dominantly provided by a small number of suppliers. For example in the case of the automobile industry, we know that European car firms made repeatedly use of price discrimination when selling into the European market.

Table 6: ***Quality and Trade Cost Effect by Product Group***

	(1)	(2)	(3)	(4)	(5)
HS Chapters	01 - 05	06 - 15	16 - 24	25 - 27	28 - 38
Wei. Dist.	0.106***	0.166***	0.157***	0.366***	0.246***
	(0.023)	(0.029)	(0.034)	(0.038)	(0.036)
Observations	39432	43246	54892	13484	89891
R-squared	0.384	0.461	0.360	0.472	0.530

	(6)	(7)	(8)	(9)	(10)
HS Chapters	39 - 40	41 - 43	44 - 49	50 - 63	64 - 67
Wei. Dist.	0.267***	0.185***	0.246***	-0.101**	-0.454***
	(0.020)	(0.052)	(0.030)	(0.051)	(0.145)
Observations	42535	11166	38586	120374	14464
R-squared	0.375	0.345	0.512	0.351	0.420

	(11)	(12)	(13)	(14)	(15)
HS Chapters	68 - 71	72 - 83	84 - 85	86 - 89	90 - 97
Wei. Dist.	0.255***	0.238***	0.147***	0.045	0.071**
	(0.025)	(0.023)	(0.028)	(0.035)	(0.035)
Observations	29915	95229	170448	21902	70889
R-squared	0.621	0.519	0.325	0.340	0.388

Notes: All regressions are run with importing and exporting country fixed effects as well as product fixed effects, but for which the coefficients are not reported; Wei. Dist. stands for the log of weighted distance; ***,**,* denotes significance at the 1 %, 5 %, and 10 % level, respectively; robust standard errors, which are in parentheses, are corrected for clustering by country pair.

One might argue that the results only hold for product groups with relatively low unit values. The argument is that for products with higher unit values the transport costs decline. In order to test this hypothesis we first calculate the average unit value in logarithm of each product group and sort the whole sample accordingly. We then form ten sub-samples at 10 percent steps and run the basic regression again. The results are depicted in Table 7. Our result of a positive relationship between unit value and trade costs holds true for nearly all groups. Only the last tenth, containing products with extremely high unit values, yields the contrary result. For these products distance seems to even enhance trade. We further notice that, overall, the distance coefficient is not declining with a higher average unit values. We conclude that the dynamics described in our model seem to play an important role for shaping trade flows in nearly all product groups, irrespective of their average unit value.

Table 7: Quality and Trade Cost Effect by Tenth Parts (Average Unit Value of Product Group)

Tenth Parts	(1)	(2)	(3)	(4)	(5)
Wei. Dist.	0.236***	0.179***	0.175***	0.177***	0.192***
	(0.024)	(0.022)	(0.019)	(0.020)	(0.019)
Observations	85779	85849	85595	86023	343246
R-squared	0.224	0.079	0.053	0.040	0.361

	(6)	(7)	(8)	(9)	(10)
Wei. Dist.	0.198***	0.176***	0.204***	0.194***	-0.279***
	(0.021)	(0.025)	(0.030)	(0.018)	(0.083)
Observations	85694	85999	85735	686315	85709
R-squared	0.034	0.028	0.025	0.468	0.157

Notes: All regressions are run with importing and exporting country fixed effects as well as product fixed effects, but for which the coefficients are not reported; Wei. Dist. stands for the log of weighted distance; ***,**,* denotes significance at the 1 %, 5 %, and 10 % level, respectively; robust standard errors, which are in parentheses, are corrected for clustering by country pair.

3.4 Market Size Effect

Our model predicts that market size is positively correlated with the average price of exports (Result 3). To test this result empirically, a measure of market size needs be included in the econometric specification of (13). Excluding the bilateral variables adjacency, language and currency, we obtain the following equation:

$$\log(p_{ijk}) = \alpha + \beta \log(dist_{ij}) + \gamma \log(ms_i / ms_j) + \nu_k prod_k + \omega_i ex_i + \iota_j im_j + \varepsilon_{ij} \qquad (14)$$

In equation (14) ms_i and ms_j stand for the market size of the exporting (i) and importing (j) country, respectively. The other variables are identical to equation (13).

A country's GDP might constitute the most appropriate variable to measure its market size. The population size also holds information on the size of an economy. The predictions of our model are tested using the ratios between the exporting and importing country.[31] Table 8 reports the estimation results for the market size effect. Column (1) and (3) of Table 8 include the GDP ratio and column (2) and (4) the population ratio in the regression.

[31] Other studies (e.g. Hallak, 2006) use the difference of per capita income as a variable to explain quality trade. The underlying thinking of these models is that different consumption preferences shape the quality content of trade flows (Linder Hypothesis). However, in our model the economies are assumed to be identical in consumption and per-capita income differences are neglected.

All estimated coefficients are highly statistically significant revealing that market size is positively correlated with quality. Applying the weighted or great-circle distance does not change substantively the result. We can conclude that there seems to be evidence that the market size differences affect the quality composition of trade via the competition effect described above.

Table 8: ***Quality and Market Size Effect***

	(1)	(2)	(3)	(4)
Wei. Dist.	0.136***	0.136***		
	(0.020)	(0.020)		
Geo. Dist.			0.112***	0.112***
			(0.017)	(0.017)
GDP Ratio	0.137***		0.142***	
	(0.011)		(0.010)	
Pop Ratio		0.118***		0.122***
		(0.009)		(0.009)
Observations	857747	857747	857747	857747
R-squared	0.540	0.540	0.540	0.540

Notes: All regressions are run with importing and exporting country fixed effects as well as product fixed effects, but for which the coefficients are not reported; G.C. Dist. and Wei. Dist. stand for the log of great-circle distance and the log of weighted distance, respectively; GDP Ratio and Pop Ratio denote the ratio (in logs) of GDP and of population between the importing and exporting country; ***,**,* denotes significance at the 1 %, 5 %, and 10 % level, respectively; robust standard errors, which are in parentheses, are corrected for clustering by country pair.

Table 9: ***Trade Costs and Market Size Effect by Country***

	(AT)	(BE)	(DE)	(DK)	(ES)	(FI)	(FR)	(GB)
Wei. Dist.	0.176**	0.036	0.004	0.173***	0.127	0.118**	0.078**	0.145**
	(0.081)	(0.029)	(0.055)	(0.048)	(0.098)	(0.054)	(0.035)	(0.050)
GDP Ratio	0.079**	0.153***	0.127***	0.069***	0.074***	0.007	0.129***	0.092***
	(0.027)	(0.029)	(0.021)	(0.023)	(0.020)	(0.025)	(0.013)	(0.025)
Observations	46631	78659	109120	49025	64943	26917	89671	82048
R-squared	0.622	0.620	0.646	0.610	0.593	0.628	0.610	0.603

	(GR)	(IE)	(IT)	(LU)	(NL)	(PT)	(SE)
Wei. Dist.	0.211	0.253*	0.210**	0.024	0.017	-0.136	-0.017
	(0.163)	(0.135)	(0.093)	(0.112)	(0.035)	(0.103)	(0.100)
GDP Ratio	-0.070	-0.032	0.073**	0.034	0.124***	0.087**	0.062
	(0.060)	(0.053)	(0.030)	(0.082)	(0.026)	(0.035)	(0.037)
Observations	17026	25897	81961	20453	85855	29827	49714
R-squared	0.607	0.622	0.616	0.680	0.619	0.598	0.612

Notes: All regressions are run with importing and exporting country fixed effects as well as product fixed effects, for which the coefficients are not reported; Wei. Dist. and GDP Ratio stand for the log of weighted distance and the ratio (in logs) of GDP between the importing and exporting country, respectively; ***,**,* denotes significance at the 1 %, 5 %, and 10 % level, respectively; robust standard errors, which are in parentheses, are corrected for clustering by country pair.

In Table 9 we present the regression results for all 15 EU countries individually. One observes that the distance and GDP coefficients vary from country to country. In most cases, both coefficients are positive and often statistically significant. Where they are negative, they are not statistically significant. It seems to be a tendency that for countries that are located in the core of the EU, such as Belgium, Germany, France, or the Netherlands, the GDP coefficients are higher. When studying the distance coefficients, one observes that for the core EU countries the distance coefficient is often small and not statistically significant.

3.5 Robustness Check: Measurement Errors and Composition Effect

We have already used different distance measures and different samples to check the validity of our results. One major concern, that might bias the estimation, are measurement errors. The trade flows analyzed in this study cover trade in more than ten thousand goods between European countries. If trade took place between all economies in each and every good, the total number of possible observations would be over two million. However, less than a half of all possible trade relations are actually observed.

The observations of zero trade flows can be combined very well with our model. Result 4 claims that with increasing trade costs the export cutoff levels μ_x and μ^*_x decrease. This implies that when trade partners are distant, the number of export firms is small and the average export price is high. When countries are very distant from each other, trade between them becomes close to zero. In the data, trade flows for distant countries might not be observed and appear as zero-trade flows. Since in our case, we indeed have a substantial number of zero-trade flows, this measurement error might bias the estimation since in the estimation of the average export price only the trade flows towards closer destinations are taken into account.

A possible way to include zero-trade flows in the estimation is to use the Heckman estimation technique. In a first step, we choose as variables in the selection model the same variables as in the outcome equation, namely distance and GDP ratio. The Heckman's two-stage estimation is then just identified and can be specified as follows:

Selection equation:

$$z_{ijk} = \upsilon + \varphi \log(dist_{ij}) + \varpi \log(ms_i / ms_j) + \xi_k prod_k + \psi_i ex_i + \varsigma_j im_j + \varepsilon_{ij} \tag{15}$$

Flow equation:

$$\log(p_{ijk}) = \alpha + \beta \log(dist_{ij}) + \gamma \log(ms_i / ms_j) + \nu_k prod_k + \omega_i ex_i + \iota_j im_j + \varepsilon_{ij} \tag{16}$$

Where z_{ijk} is 1, if a trade flow in product k between countries i and j is observed, and 0 otherwise. We run the two-step Heckman model for the 15 sectors described above, with some minor changes.[32]

Table 10: ***Heckman Estimation for Quality Trade***

Chapters	01-05		06-15		16-23		25-27	
	(1) Flow	(2) Select	(3) Flow	(4) Select	(5) Flow	(6) Select	(7) Flow	(8) Select
Wei. Dist.	0.117***	-1.148***	0.133***	-0.947***	0.168***	-1.070***	0.443***	-1.282***
	(0.018)	(0.077)	(0.023)	(0.074)	(0.020)	(0.086)	(0.039)	(0.066)
GDP Ratio	0.119***	-0.285***	0.185***	-0.264***	0.144***	-0.230***	0.086***	0.638***
	(0.009)	(0.046)	(0.011)	(0.038)	(0.010)	(0.049)	(0.019)	(0.021)
Obs.	168630	168630	140490	140490	169470	169470	51660	51660

Chapters	28-38		39-40		41-43		44-49	
	(9) Flow	(10) Select	(11) Flow	(12) Select	(13) Flow	(14) Select	(15) Flow	(16) Select
Wei. Dist.	0.205***	-0.698***	0.191***	-0.814***	0.090**	-0.616***	0.215***	-0.928***
	(0.026)	(0.049)	(0.016)	(0.052)	(0.040)	(0.044)	(0.023)	(0.050)
GDP Ratio	0.129***	-0.330***	0.120***	0.534***	0.120***	0.410***	0.213***	0.507***
	(0.012)	(0.021)	(0.009)	(0.012)	(0.027)	(0.017)	(0.012)	(0.019)
Obs.	267120	267120	77280	77280	32340	32340	86940	86940

Chapters	50-63		64-67		68-71		72-83	
	(17)Flow	(18)Select	(19)Flow	(20)Select	(21)Flow	(22)Select	(23)Flow	(24)Select
Wei. Dist.	0.115***	-0.749***	0.092*	-0.760***	0.289***	-1.200***	0.196***	-1.194***
	(0.025)	(0.053)	(0.048)	(0.085)	(0.027)	(0.074)	(0.020)	(0.071)
GDP Ratio	0.176***	-0.355***	-0.122***	0.463***	0.156***	-0.326***	0.111***	0.691***
	(0.016)	(0.022)	(0.042)	(0.031)	(0.011)	(0.032)	(0.010)	(0.023)
Obs.	258510	258510	23310	23310	66780	66780	214410	214410

Chapters	84		85		86, 88, 89		90-97	
	(25)Flow	(26)Select	(27)Flow	(28)Select	(29)Flow	(30)Select	(31)Flow	(32)Select
Wei. Dist.	0.143***	-0.726***	0.234***	-0.985***	0.038	-0.752***	0.182***	-1.055***
	(0.017)	(0.048)	(0.026)	(0.078)	(0.051)	(0.061)	(0.025)	(0.077)
GDP Ratio	0.102***	0.538***	0.078***	0.705***	0.070**	0.509***	0.120***	0.825***
	(0.005)	(0.012)	(0.009)	(0.023)	(0.032)	(0.026)	(0.011)	(0.029)
Obs.	186270	186270	137130	137130	23310	23310	137970	137970

Notes: All regressions are run with importing and exporting country fixed effects as well as product fixed effects, for which the coefficients are not reported; Wei. Dist. and GDP Ratio stand for the log of weighted distance and the ratio (in logs) of GDP between the importing and exporting country, respectively; ***,**,* denotes significance at the 1 %, 5 %, and 10 % level, respectively; robust standard errors, which are in parentheses, are corrected for clustering by country pair.

The Heckman estimation results which are reported in Table 10 confirm the earlier regressions results. For all selection equations (all even column numbers) the distance coefficient is strongly negative, corroborating the conjecture that trade relations are less likely

[32] We had to drop the chapter 24 as well as 87 in order to be able to find solutions. Furthermore, we run separate estimations for the chapters 84 (nuclear reactors, boilers, machinery & mech. appliances; parts) and 85 (electrical machinery, equipment, and parts as well as telecomm. equipment, sound recorders, and television recorders).

to be observed as trade costs increase. The GDP ratio in the selection equations is in most cases positive. The reason is that since our model claims that larger economies export higher quality goods and in relatively small amounts, some trade relations may not appear in the data and hence the expected sign should be positive.

The second step estimations results (flow equations) again corroborate the key predictions of our model. The coefficients of distance and GDP ratio are positive and statistically significant with only two exceptions. In the product group “footwear/headgear” the GDP ratio coefficient is negative, and in the product group “transportation” (86, 88, and 89) the distance coefficient is insignificant. Overall, the magnitude of the distance and GDP ratio coefficients varies, but it is similar to the one observed above. Future studies might try to investigate why the magnitude of both coefficients varies from one sector to another.

For our last robustness check we improve our Heckman set-up by over-identifying the selection equation. We therefore need to find a variable that is has an impact on whether or not trade relations are observed, but which is unrelated to the quality traded. We think that information about the cost of starting a business might fulfill this requirement. Costs to start a business can be thought of proportional to (business) cultural differences. Our model expresses this as trade costs and predicts that lower trade costs between two countries (i.e. similar business culture and market circumstances) allow more firms to export in both countries, assuming the market size between economies constant, and thus lower cost of starting business raises the probability of having observations. And hence we expect a negative sign in the selection equation.

The data base of Doing Business provides useful information about the cost of starting a business (World Bank, 2007). We have gathered the data on the number of procedures to register a firm and the official cost of each procedure (as percentage of GNI per capita) for all 15 EU countries. We are thus able to run a Heckman estimation with the following econometric specification:

Selection equation:

$$z_{ijk} = \upsilon + \varphi \log(dist_{ij}) + \varpi \log(ms_i / ms_j) + o \log(db_i + db_j) + \xi_k prod_k + \psi_i ex_i + \varsigma_j im_j + \varepsilon_{ij} \quad (17)$$

Flow equation:

$$\log(p_{ijk}) = \alpha + \beta \log(dist_{ij}) + \gamma \log(ms_i / ms_j) + \nu_k prod_k + \omega_i ex_i + \iota_j im_j + \varepsilon_{ij} \quad (18)$$

We run the Heckman estimations focusing only on one chapter, namely 85. Chapter 85 records trade in electrical machinery, equipment, and parts as well as telecommunications equipment, sound recorders, and television recorders. It is thus a chapter that holds highly differentiated products, in a horizontal as well as vertical sense. The estimation results are reported in Table 11. A very similar picture emerges as in the estimations above. Facing high costs of starting a business, in terms of procedures and cost, indeed reduces the probability of trade links between countries in goods of product group 85. Trade costs and market size are again positively correlated with the unit values. The coefficients of both variables in columns (1) and (3) are nearly identical to the ones observed in Table 10, (27).

Table 11: ***Heckman Estimation for Quality Trade (Chapter 85)***

	(1) Flow	(2) Select	(3) Flow	(4) Select
Wei. Dist.	0.235***	-0.952***	0.234***	-0.948***
	(0.026)	(0.077)	(0.026)	(0.076)
GDP Ratio	0.078***	-0.490***	0.078***	-0.456***
	(0.009)	(0.046)	(0.009)	(0.041)
Procedures		-1.000***		
		(0.347)		
Cost				-0.143***
				(0.039)
Observations	137130	137130	137130	137130

Notes: All regressions are run with importing and exporting country fixed effects as well as product fixed effects, for which the coefficients are not reported; Wei. Dist. and GDP Ratio stand for the log of weighted distance and the ratio (in logs) of GDP between the importing and exporting country, respectively; Procedures and Cost present the log of the sum of both variables between the exporting and importing country; ***,**,* denotes significance at the 1 %, 5 %, and 10 % level, respectively; robust standard errors, which are in parentheses, are corrected for clustering by country pair.

4. Summary and Conclusion

This paper constitutes a first attempt to fully model quality in a heterogeneous quality firms' framework. In our model high quality firms enjoy a relatively stronger demand for their products, as a result, high quality products are more likely to be exported and to be traded over greater distances.

Our model also features a market size effect. The export cut-off level in the smaller market is always higher which means that more firms are able to enter the export market. The reason is that the bigger market is an attractive export destination. A fact that also precludes firms in the bigger market from exporting and that makes them focusing on the domestic market instead. As corollary it is true that the domestic cut-off level is higher in the domestic market compared to the smaller foreign market.

Even though our model is similar to Melitz (2003) the predictions it yields are different. Most importantly, not the goods that are produced by the most productive firm (low prices) are traded furthest, but the highest quality goods. Furthermore, the cut-off levels are not identical across countries as in other heterogeneous-firm trade models, but depend on the market size. Our model therefore adds important new dimensions to the standard heterogeneous firms' model. At the same time it contributes to the literature of trade models which include quality aspects.

We find strong empirical evidence for the predictions delivered by the model. The first key result is that the unit price is increasing with trade costs. To the extent to which high unit values mirror high quality, higher quality goods are indeed exported further. The second main finding is that there is empirical evidence for the market size effect as described in this paper. Overall, our model with heterogeneous quality firms seems to fit the data better than the standard heterogeneous firms' trade model.

The key results of our paper have strong implications for developed as well as developing countries. Our model gives strong emphasis to the finding that, apart from trade costs and market access, the quality dimension is key for the export performance of countries. Especially in developing countries, where trade costs can be still considerably high, looking at quality aspects is an important policy consideration. One interesting extension of our model would be to include the case of trade between dissimilar economies.[33] This would imply an extension of the empirical analysis to a wider range of countries, which might then yield new development-relevant results.

Our model is certainly only one of many possibilities to include quality in a heterogeneous firms' framework. It might also be worth studying how to add additional dimensions to the model. For example, including dynamics of product innovation might yield further interesting hypotheses. Another shortcoming of our model is that it neglects price competition between firms. A promising approach might be to combine our model with the type of price competition model that Melitz and Ottaviano (2005) propose.

[33] One possible source of detailed trade data is the data set on Japanese trade used by Okubo (2007).

Concerning the empirical part of this paper, the availability of micro data that includes quality aspects would help test the model predictions more thoroughly. For the moment, we have to rely on unit values and have to stretch their use as far as it can go. Future research efforts that aim at collecting and analyzing firm level trade data with quality aspects would certainly be a worthwhile undertaking. As this paper shows, quality has a major role to play in shaping international trade.

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6. Data Appendix

Exporting countries included in the sample:

- Austria (AT)
- Belgium (BE)
- Denmark (DK)
- Finland (FI)
- France (FR)
- Germany (DE)
- Greece (GR)
- Ireland (IE)
- Italy (IT)
- Luxemburg (LU)
- Netherlands (NL)
- Portugal (PT)
- Spain (ES)
- Sweden (SE)
- United Kingdom (GB)

Definition and data source of each variable used in the estimations:

p_{ijk} denotes the logarithm of the unit value (value per quantity) of the trade flow from country i to country j of subheading k (eight digit Combined Nomenclature). The unit value can only be constructed for those products for which quantities are reported. The value is reported in current euros and is the FOB price. The unit value can therefore be interpreted as the average export price within each subheading *k* at the border of the exporting country. The data has been downloaded from the EUROSTAT database. The data has been downloaded in June 2007 from the website: http://epp.eurostat.ec.europa.eu.

$dist_{ij}$ measures the logarithm of distance (unit: km) between country *i* and country *j*. The distance is measured using the great-circle formula (denoted G.C. Dist. in the tables) or by taking into account the demographic distribution within each country of the trading pair (denoted Wei. Dist. in the tables). The data on the geographical position of cities is taken from the encyclopedia Encarta.

$prod_k$ stands for the fixed effect dummies of each subheading (eight digit CN). If a subheading is *k*, the dummy is one; otherwise, the dummy takes the value of zero.

ex_i and im_j are the fixed effect dummies for the exporting and importing countries. If the exporting country is *i*, then *ex* is 1 and zero otherwise. The same holds for the importing countries. The data is freely available.

ms_i, ms_j represent the market size of the exporting country *i* and importing country *j*. The market size has been calculated in two ways: First, the market size is measured by the logarithm of GDP. The GDP data come from EUROSTAT and are recorded in current euros. The second measure of market size is the logarithm of the population size. The data on population size come also EUROSTAT. Both samples have been downloaded in June 2007 from the following website: http://epp.eurostat.ec.europa.eu. The data is freely available.

db_i, db_j stand for the doing business data on the number of procedures to register a firm or the official cost of each procedure as percentage of per-capita gross national income. The doing business data measure the cost in launching a commercial or industrial firm with up to 50 employees and start-up capital of 10 times the economy's per-capita gross national income (World Bank, 2007).