HETEROGENEOUS QUALITY FIRMS AND TRADE COSTS

Matthias Helble and Toshihiro Okubo

Abstract

There is increasing empirical evidence that vertical product differentiation is an important determinant of international trade. Whereas all empirical studies focus on the quality of products traded differs between dissimilar economies, we yet lack of empirical studies that investigate the role of quality trade between identical economies. This paper first develops a simple theoretical model that includes vertical product differentiation in a heterogeneous firms' framework. The model yields three main predictions for trade between similar economies: First, exported goods have a higher quality than goods sold on the domestic market. Second, larger economies have on average higher export qualities compared to 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 US and fifteen EU countries.

JEL Classifications: F12, F14
Keywords: heterogeneous firms, trade costs, quality, vertical product differentiation.

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1. INTRODUCTION

Aspects of vertical product differentiation in international trade attract a growing attention among economists.¹ The first economist 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. This is the Linder Hypothesis which contrasts sharply the Heckscher-Ohlin theory stating that the intensity of trade is higher for dissimilar countries.

In the late 1980s several economists began to formalize the relationship between trade and quality in general equilibrium models. The most prominent contributions are Falvey and Kierzkowski (1987), Flam and Helpman (1987), Grossman and Helpman (1991), as well as Murphy and Shleifer (1997). All these models share the feature that trade in quality stems from differences in factor endowments, productivity or demand preferences. For example, as a result of the consumption differences between rich and poor countries richer countries typically produce and export higher-quality products, the so-called quality margin (Murphy and Shleifer, 1997).

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 is a function of the

¹ 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.
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 so far argue that differences in factor endowments, technology, or consumption preferences between countries constitute the main driving force behind trade of goods of different quality. As a consequence, the models bear little evidence for quality trade between similar economies. The main goal of this paper is therefore to analyze in detail the different aspects of quality trade between countries that are identical or only differ in market size. We provide a theoretical framework to explain the possible role of quality and also provide empirical evidence.

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). In this literature, trade liberalization has a different impact on firms with heterogeneous productivity via a selection effect and a profit-shifting effect. However, when it comes to think of linkages to quality, these models completely lose their explanatory power.

The vertical intra-industry trade literature by Greenaway, Hine and Milner (1994 and 1995) and Schott (2004) suggests that higher prices indicate higher quality. In contrast, in heterogeneous-firms trade models, high prices are charged by firms with low productivity, which are likely to exit the market first. The typical heterogeneous-firms trade framework thus does not help thinking about quality aspects and therefore needs to be modified.

The key assumption in our model is that firms face different marginal costs. This heterogeneity does not determine their productivity like in Melitz (2003), but the quality they produce. In short, our model can be described as follows. We assume an economy in which varieties of different quality are produced at different marginal costs. Firms that produce

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.
higher quality products also face higher marginal costs and therefore ask higher prices from the consumer. Firms’ heterogeneity in our model means that firms produce goods of different quality level.

The paper extends the existing trade literature in two important ways. First, it provides a general equilibrium trade model in which firms that 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.

The paper is structured as follows: First, we show several facts about quality trade and give a brief literature review. 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 fifteen EU countries.

2. RELATED LITERATURE AND SOME STYLIZED FACTS

2.1 RELATED LITERATURE ON QUALITY AND TRADE

The international trade literature that focuses on quality trade can 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.

The most prominent contributions of the first stream are Falvey (1981), Falvey and Kierzkowski (1987) as well as Flam and Helpman (1987). 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 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.

The second strand of literature focuses on difference on the demand side between countries. Linder (1961) argues that consumer in rich countries spend relatively larger amounts of their income on high quality goods compared to consumer in poor 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.

The common feature of all models of both types is that they assume differences in factor endowment, technology, or consumption between countries. This difference becomes key in explaining quality aspects in international trade. However, we have seen in the section above that quality trade not only comes into play for trade between dissimilar countries. 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. In contrast, our model gives a compelling answer why similar endowment, technology, supply and demand countries still engage in quality trade and how the trade flows are shaped.

Furthermore, the dynamics of our model come from, among others, firm heterogeneity, beachhead costs and trade costs in monopolistic competition model. Empirically we know
that both elements are crucial in our understanding of international trade. Many of the both mentioned trade models neglect these aspects.

Finally, as mentioned in the introduction there has been a surge in empirical studies on quality aspects in international trade. These studies confirm the predictions of the theoretical models and find that quality is an important determinant of international trade. Since these empirical studies are designed to test the existing theoretical models, they use data that reflect trade flows between countries that have different factor endowments, technologies or preferences. However, the focus of this paper is to analyze the role that quality plays for trade between identical economies. The empirical part therefore provides another valuable extension to the literature on quality trade.

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.

2.2 SOME STYLIZED FACTS

As we have observed in the previous section empirical studies so far have focused on quality aspects of trade between dissimilar economies. The purpose of this section is to show that quality is also an important determinant for trade between similar countries.

In order to establish several facts on quality trade between similar economies, we analyze export data for manufactured goods of fifteen EU countries (all EU member countries before the 2004 enlargement) towards 173 countries in the world (including the fifteen EU countries). The years covered are 1995 to 2004. In the empirical part of our study, we use the same data sets, but with a more detailed econometric analysis.

The first question to ask is how important quality trade is between developed countries with similar factor endowments, productivity, and consumption preferences. As common in the
literature on quality trade, we assume that unit values provide a reasonable measurement of vertical product differentiation (see Greenaway, 1995, for a detailed discussion on the use of unit values).

The first indicator of quality trade is the coefficient of variation of unit values per product. The vast majority of trade models would predict that the coefficient of variation of unit values for each product 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.

Table 1: Coefficient of Variation and Share of Quality Trade

<table>
<thead>
<tr>
<th></th>
<th>(1) Coef.Var</th>
<th>(2) Unweighted</th>
<th>(3) Weighted</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Unweighted</td>
<td></td>
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<tr>
<td></td>
<td>±10%</td>
<td>±20%</td>
<td>±30%</td>
</tr>
<tr>
<td>EU 15</td>
<td>65.29%</td>
<td>75.14%</td>
<td>60.49%</td>
</tr>
<tr>
<td>Obs.</td>
<td>155174</td>
<td>155174</td>
<td>155174</td>
</tr>
<tr>
<td>EU 15 +</td>
<td>79.42%</td>
<td>91.18%</td>
<td>78.40%</td>
</tr>
<tr>
<td>Obs.</td>
<td>186244</td>
<td>186244</td>
<td>186244</td>
</tr>
<tr>
<td>EU-Dev.</td>
<td>123.10%</td>
<td>85.23%</td>
<td>76.07%</td>
</tr>
<tr>
<td>Obs.</td>
<td>566485</td>
<td>566485</td>
<td>566485</td>
</tr>
</tbody>
</table>

Notes: Coef. Var. is the abbreviation for the coefficient of variance expressed in percentage. EU 15 stands for all exports flows between EU 15 countries. EU 15 + denotes exports of EU 15 countries towards all other EU 15 countries plus Canada, Japan, and the USA. EU Dev includes all exports from EU 15 countries towards developing countries. For the columns presenting the share of quality trade, the numbers in percentage report the share that lies outside the range of ±10%, ±20%, ±30% respectively.

Column (1) in Table 1 reports the average value of the coefficient of variation for exports of fifteen EU countries towards three destinations: First, for trade flows towards the other EU countries. Second, for trade flows towards EU countries plus USA, Japan, and Canada. And finally, for export flows that went to from EU countries towards 129 developing countries.

3 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
The coefficient of variations is of considerable magnitude for trade flows within the EU. It increases substantially when exports from EU countries towards developing countries are studied.

Overall, the results indicate that the coefficient of variation is substantial for trade between developed countries and it even becomes higher for trade between developed and developing countries. The coefficient of variation gives us a first impression of the importance of quality trade between similar economies. However, it might be that some variation 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 another methodology 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 (e.g. Greenaway et al., 1995), 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. For example, in product HS 820110 (spades and shovels) Austria exports to 11 EU countries and the average unit value per ton is 2.070 Euro. Five observations of unit values lie outside the ±20% wedge and are therefore assumed to constitute quality trade. This counting exercise allows us to calculate the percentage of products that seem to be traded for quality reasons. The numbers in columns (2), (3) and (4) of Table 1 report the results.

The results again indicate that quality is an important determinant of trade between developed countries as well as for exports from developed to developing countries. Applying the 40% wedge (column 3), one finds that around 60% of trade between EU countries may be counted as quality trade. This share shrinks to about 50% when using the 60% wedge. As one might have expected, the results are even starker when we consider export flows the leave the EU. In columns (5) to (7) the same approach as before has been applied, but now the unit values are weighted by the volume of the trade flows, in order to give bigger trade flows more variation over all product lines and exporting countries. We report the final result as percentage multiplying the coefficient of variation by 100.
weight when calculating the mean. We observe a slight increase in the results for the first sample. In summary, all numbers point to the fact the quality is a crucial element of trade. In the following section, we develop a simple model that constitutes a first attempt to better understand the role of quality for trade between similar countries.

3. HETEROGENEOUS QUALITY FIRMS TRADE MODEL

3.1 THE BASIC MODEL

We suppose a two-country economy, including the home country and the foreign country (denoted *). The countries are identical in consumers' tastes, factor endowments, production technology and freeness of trade. In each country a continuum of manufacturing sectors, \( S \in (0,1) \), and a numeraire good sector are producing goods. Each manufacturing sector produces goods under monopolistic competition à la Dixit and Stiglitz (1977) and face iceberg trade costs. We assume away the input-output linkage with other manufacturing sectors as well as with other varieties within a sector on the supply side. The only factor of production available to all sectors is labor. Except monopolistic-competition manufacturing sectors, one sector (agriculture) is assumed to be a numeraire good sector that produces with constant returns to scale and under perfect competition \((p=1)\). The numeraire good is assumed to be traded without cost.

The tastes of representative consumers are quasi-linear:

\[
U = \int_0^1 \mu_s \ln C_s ds + C_A
\]

where \( C_s \) and \( C_A \) are respectively the consumption of manufacturing sector \( S \) and of agriculture \( A \) and \( \mu_s \) is subject to a uniform distribution in terms of \( S \) and \( C_s \) is a composite of the varieties in one sector in manufacturing to equalize the expenditure share across manufacturing sectors. \( C_s \) is given by the following CES function across varieties under monopolistic competition,
\[
C_s = \left( \int_{i\in \Theta} e^{1-\sigma di} dt \right), \quad \sigma > 1
\]

\(\sigma\) is the constant elasticity of substitution between any two varieties in the \(S\)-sector. \(\mu\) is the share of expenditure of the product and \(\Theta\) represents a set of varieties produced. Total expenditure in the world is assumed to be unity, \(E^w = 1\). For simplicity, we assume that the expenditure allocated to each sector is the same, that is, uniformly distributed \(\mu_s\).

\[1 = \int_0^1 \mu_s ds \Rightarrow \mu_s = 1\]

\(\mu_s\) can be normalized to unity. Thus, all monopolistic competition sectors are symmetric and not correlated with each other on the demand side.

As in the standard Dixit-Stiglitz model, the labor wage is normalized to be one, because the numeraire good (\(p=1\)) is produced under perfect competition and traded without trade costs. Therefore, it must hold that wages equal in all countries and sectors, i.e. \(p = w = 1\). The prices of varieties, \(j\), in a monopolistic competition sector \(S\) are

\[p_j = \frac{1}{1-1/\sigma a_j} \]

where \(1/a_j\) equals marginal costs, i.e. the unit labor requirement for variety \(j\). \(a_j\) denotes the inverse of quality; as \(a_j\) goes to zero the quality level increases. Note that high quality varieties have higher prices because the production requires higher marginal costs, \(1/a_j\). \(^4\)

The standard CES demand function for variety \(j\) is

\[c_j = \frac{(p_j)^{-\sigma}}{\bar{m}} E \]

\[\bar{m} = \int_{i\in \Theta} p_i^{1-\sigma} di + \int_{h\in \phi} p_h^{1-\sigma} dh\]

\(^4\) Our model supports the idea that consumers perceive the price of a good as a reliable signal of quality. In contrast, larger advertising efforts are not interpreted as a signal of higher quality. Caves and Greene (1996) provide empirical evidence that price indeed signals quality in contrast to advertising, which is found not to serve as a quality signal. Milgrom and Roberts (1986) show that only in the case of incomplete information of
where \( p_j \) is the price of variety \( j \) and \( \bar{m} \) is the inversely weighted average of consumer prices and \( \theta \) is a set of varieties. The first term 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. \( \phi \) ranges from zero, when trade is perfectly un-free \((t = \infty)\), to unity, when trade is perfectly free \((t = 1)\).

In contrast to the standard Dixit-Stiglitz monopolistic competition model, the unit labor requirements are different across varieties \((j)\), following the heterogeneous-firms trade literature. However, unlike the standard heterogeneous-firms trade models (Melitz, 2003), firms do not differentiate their products horizontally, but vertically so as to express product quality rather than productivity. For simplicity, the quality that results from vertical differentiation is not explicitly modeled in the utility function, unlike other studies on quality issues (e.g. Flam and Helpman, 1987). Instead, we assume that quality is perfectly reflected in its own price. The different qualities are positively correlated with their prices, i.e. higher quality goods are sold by higher prices. Higher quality goods are then also consumed in smaller quantities compared to low quality goods owing to higher prices.

For simplicity and without loss of generality, we can focus only on one sector, \( S \), within numerous monopolistic competition sectors due to symmetry and independence across sectors. Firms in the \( S \)-sector produce varieties of goods with different quality as well as with different marginal costs. We assume that firms that produces the highest quality goods, \( a_j = 0 \), where "\( a \)" measures the inverse of unit labor requirement, face the highest (infinitive) marginal costs, \( 1/a = \infty \). Whereas producers of the lowest quality, \( a_j = 1 \), enjoy the lowest marginal costs, \( 1/a = 1 \).

In summary, each firm has different marginal costs which are increasing with quality. The inverse quality levels, i.e. the inverse of labor requirements and the inverse of marginal costs,
$a \in (0,1)$, are distributed by a Pareto distribution. The probability density function for ‘$a$’s and its cumulative density function are respectively given as

$$g[a] = \rho \left( \frac{a}{a_0} \right)^{\rho - 1}$$

and

$$G[a] = \left( \frac{a}{a_0} \right)^\rho.$$

where $\rho > 1$ is a shape parameter and $a_0$ is a scale parameter that can be normalized to be unity. Figure 1 shows the distribution of the cumulative density function (CDF) in the home country. $n$ represents the mass of varieties in that country, $nG[a]=na^\rho$. It follows that the number of high quality brands (small $a$) is limited while the one of low quality and simple products (large $a$) is large.\(^5\)

Figure 1: Cumulative Density of Firm Distribution and Cutoff Shifts


Unlike the standard heterogeneous firms trade models, we assume away the process of free entry and R&D investment before operation and instead we simply assume that $a$ is randomly distributed without any entry payments and that the production location is equally allocated across nations. The mass of varieties of firms in the home country and the foreign country denotes $n$ and $n^*$, respectively, where $n+n^*=1$. For simplicity’s sake, we assume $n=n^*=0.5$ in

\(^5\) $\rho=1$ would imply a uniform distribution with respect to $a$. We exclude this possibility a priori.
order to have similar markets. This implies that each potential entrant draws ‘a’ subject to the Pareto distribution without any payments and then is allocated equally across the two locations - either in the home or the foreign country. In other words, firms are distributed equally between countries and thus the probability density function of firm distribution is identical.

Our model differs in another way from the standard monopolistic competition trade models. Similar to Melitz (2003) we assume two kinds of beachhead costs (overhead fixed costs). The one is to enter the domestic market and the other to enter the foreign market. We call them domestic marketing costs and export marketing costs, respectively. However, in contrast to Melitz (2003) firms in our model do not face identical beachhead cost, but different beachhead costs depending on the quality level they produce. In other words, we specify the beachhead costs as firm-productivity dependent, in which selling the lower quality products implies facing higher beachhead costs. For instance, this relationship reflects marketing costs, such as advertisement and marketing, to persuade consumers to switch from high quality goods to its own lower quality goods. Higher quality goods producers are required less advertisement costs (beachhead costs). Note that this activity requires the employment of labor.

First, we characterize export marketing costs. If firms of variety \( j \) in the home country decide to export to the foreign country, i.e. export firms (\( X \) type), they face additional sunk costs of the following type:

\[
F_x(a_j) \equiv f_x(n + n^*)a_j^\rho = f_xa_j^\rho
\]  

(2)

where \( f_x \) is assumed to a be a positive constant and identical across countries and \( n^* \) denotes the mass of foreign varieties in the foreign market and \( n \) denotes the mass of varieties of rival import products from the domestic market. Firms that are not able to pay the costs due to

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6 In Melitz (2003) the mass of varieties, \( n \), is determined by the condition of expected zero profits from R&D investment stage. By contrast, our model assumes away the innovation process and entry process for simplicity’s sake. Thus, we assume the same mass of varieties, \( n=n^*=0.5 \), in order to be able to make predictions about the possible impact of market size asymmetries.
small sales cannot be exporters. The total number of rival firms in the foreign market that has a higher quality than $a_j$ can be expressed as $(n^* + n)a_j^\rho$.

Next, we characterize the domestic marketing costs. Depending on the quality they produce, firms, which would like to sell in the domestic market, are assumed to undergo the following beachhead costs. The costs are defined as

$$ F_D(a_j) = f_d(na_j^\rho + n^*a_X^\rho) \text{ if } a_j > a_X^* $$

(3)

$$ F_D(a_j) = f_d(na_j^\rho + n^*a_j^\rho) \text{ if } a_j < a_X $$

(4)

where $f_d$ is a constant fraction and the terms in the brackets stands for the total number of rival firms, which has a higher quality sold in the local market than $a_j$. $na_j^\rho$ denotes the number of the domestic brands higher than $a_j$. $n^*a_X^\rho$ constitutes the total number of the imported brands, where $a_X$ denotes the export cutoff level in the foreign country (the varieties from the home country to $a_X$ are imports from the foreign country), which will be shown below. The firms that can pay $F_D$ but not $F_X$ are domestic firms, and called $D$-type firms. Note that $n=0.5$, as mentioned above. In other words, producers of lower quality goods have higher fixed costs to enter the market and to sell their products in the local market compared to producers of higher quality goods.

Note that the beachhead costs in both $F_X$ and $F_D$ are proportional to a cumulative density from 0 to $a_j$. This means that the costs for lower quality producers increase cumulatively.\(^8\) In other words, the beachhead costs for variety $j$ are proportional to the number of brands that produce a higher quality than $a_j$. Or stated differently, lower quality firms have more difficulties in penetrating the domestic and especially the export market. On the other hand, the highest quality producers do not need to pay domestic and export marketing costs.

\(^7\) These are true for the foreign country: $F_X'(a_j) = f_j(a_j^\rho)$, $F_X'(a_j) = f_d(na_j^\rho + n^*a_X^\rho) \text{ if } a_j > a_X$ and $F_D'(a_j) = f_d(na_j^\rho + n^*a_j^\rho) \text{ if } a_j < a_X$.

\(^8\) This assumption is supported by the literature in industrial organization. For example, Schmalensee (1978) shows in a model that advertising level may indeed be negatively correlated with quality.
One interpretation of this assumption is that it reflects the increasing costs for sales promotion and advertisement of low quality producers. Lower quality producers have to pay more sales promotion costs for their own products and plus some additional costs to persuade consumers to switch from the higher quality brand to their own products. Logically, the highest brand does not need to pay any sales promotion costs due to the wide and positive reputation of high quality, but instead it is producing with high marginal costs; while the lower brand needs more sales promotion costs to persuade people to switch their consumption from high quality brands to lower quality brands with rather bad reputation.

Another possible explanation might be transaction or delivery costs. Hummels and Skiba (2004) find clear evidence of per unit trade costs, which translates into the prediction that low quality producers face relatively per-firm extra transaction costs in their transportation and delivery than high quality producers. Thus, shipping low quality goods to the domestic or foreign markets therefore comes at a relatively higher price.

Different ‘a’ and two kinds of beachhead costs results in three types of firms 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-producer). In each country we can distinguish between three types of firms: First, firms that do not produce at all since beachhead costs exceed the possible pure profits of production. We denote these firms $N$-type firms. Second, firms that are able to sell goods on the domestic market, but they are unable to export. The profits are only high enough to be present on the domestic market, therefore these firms are called $D$-type firms. Finally, when firms can pay the beachhead costs for exporting and get positive net pure profits (deduced beachhead costs), firms that produce both for the domestic and foreign market are $X$-type firms. We will precisely show them below.

The net profits for domestic firms of variety $j$ in the home country are given by

$$\pi_D[a_j] = B_D(a_j) - F_D(a_j)$$

(5)

where $B_D$ denotes pure profits in domestic market,
\[ B_D[a_j] = B[a_j] = \frac{1}{\sigma} E^W \left( \frac{s}{\Delta} \right) \left( \frac{1}{a_j} \right)^{1-\sigma} \]

Note that \( \Delta = n_0 \int_0^{\sigma_j} a^{-\sigma-1} dG[a | a_D] + n \int_0^{\sigma_j} a^{-\sigma-1} dG[a | a_D] \)

Similarly, the net profits of the firms in the foreign country that export to the home country are given as

\[ \pi_x[a_j] = B_D(a_j) + B_x(a_j) - F_D(a_j) - F_X(a_j) \tag{6} \]

where \( B_x \) denotes pure profits from foreign market.\(^9\)

\[ B_x[a_j] = \phi B_x[a_j] = \frac{1}{\sigma} E^W \phi \left( \frac{1-s}{\Delta} \right) \left( \frac{1}{a_j} \right)^{1-\sigma} \]

Note that \( \Delta^* = n_0 \int_0^{\sigma_j} a^{-\sigma-1} dG[a | a_D] + n \int_0^{\sigma_j} a^{-\sigma-1} dG[a | a_D] \) and \( a_D \) is the cutoff level between \( N \) and \( D \) types.

Now, we make the assumption that the only difference between the two economies is the demand size, \( s \).\(^{10}\) The home country is assumed to have a relative big market whereas and the foreign country (denoted with *) has a small market size. The market size ratios, i.e. the expenditure shares, are \( s (>0.5) \) in the home country and \((1-s) \) in the foreign country.\(^{11}\)

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\(^9\) These are true for the foreign country,

\[ \pi_D^*[a_j] = B_D^*(a_j) - F_D^*(a_j) \text{ where } B_D^*[a_j] = \frac{1}{\sigma} E^W \left( \frac{1-s}{\Delta} \right) \left( \frac{1}{a_j} \right)^{1-\sigma} \] and

\[ \pi_X^*[a_j] = B_D^*(a_j) + B_X^*(a_j) - F_D^*(a_j) - F_X^*(a_j) \text{ where } B_X^*[a_j] = \phi B[a_j] = \frac{1}{\sigma} E^W \phi \left( \frac{s}{\Delta} \right) \left( \frac{1}{a_j} \right)^{1-\sigma} \] .

\(^{10}\) Since we use a quasi-linear utility function, we can cut income effect. Thus, the relative demand size is always equal to population ratio. In our model, \( s \) can also reflect population size.

\(^{11}\) We assume that \( s \) is not a very large number. We exclude the case of extremely asymmetric economies. This is consistent with the actual European countries case shown in our empirical section.
Before considering trade between the two countries, we first study the autarky equilibrium, i.e. $\phi = 0$. Note that $\Delta = 0.5\lambda a_D^{\rho-1}$ and $\Delta^* = 0.5\lambda a_D^{\rho-1}$ in autarky, where $\lambda = \frac{\rho}{\sigma - 1 + \rho}$. Since the pure profit, (4), is zero at $a=a_D$, the cutoff level condition between $D$ and $N$ types, $a_D$, can be given as

$$\pi_D[a_D] = B_D(a_D) - F_D(a_D) = 0$$

(7)

in the home country. Similarly, the condition in the foreign country can be written as

$$\pi_D^*[a^*_D] = B^*_D(a^*_D) - F^*_D(a^*_D) = 0.$$  

(8)

Using these two cutoff level conditions (equation (7) and (8)), we can derive a relationship, $\frac{s}{1-s} = \frac{a_D^{\rho^*}}{a_D^{\rho}} > 1$. This means that the expenditure share (relative market size) is proportional to the firm share. But, contrary to the standard Dixit-Stiglitz model, firms are heterogeneous and thus the cutoff levels are different between countries. Due to $s>0.5$ and $\rho>1$, we can get one cutoff level relation, $a_D > a_D^{\rho^*}$. Intuitively, a market with a larger demand generates more low quality producers. In our model, since the mass of varieties and firm distribution are identical, the cutoff level in the larger market has a large cutoff level and thus has more low quality producers. The average quality produced in the country with the larger demand is lower. For this relation, we can derive $B(a) > B^*(a)$ for any $a$. The per-firm pure profits in the large market are larger than in the small one.

---

12 Under autarky, the firm share is just proportional to the relative demand, i.e. $s = \frac{na_D^{\rho^*}}{n a_D^{\rho}} = \frac{a_D^{\rho^*}}{a_D^{\rho}}$, where $na_D^{\rho^*}$ is the number of firms in the home country and $n=n^* = 0.5$.

13 $s = \frac{a_D^{\rho^*}}{a_D^{\rho}} > \frac{a_D^{\sigma^*} \rho^*}{a_D^{\sigma^*} \rho} = \frac{\Delta}{\Delta^*} \Delta$ due to $\rho > \sigma - 1$, which is from the condition $\sigma - 1 - \rho < 0$. From the definition of $B$ and $B^*$, this results in $B > B^*$. 
In this section we consider trade and derive the equilibrium in an open economy case. We start with the autarky equilibrium outcome and then think about a gradual decrease of trade costs.\(^{14}\) If \(\phi\) is gradually moving away from zero, trade costs decrease, but are still at a substantial level. When a country thus moves from autarky to trade due to a decrease in trade costs, \(B\) decreases due to increased \(\Delta\), but \(B^*\) also raises thanks to a decreased \(\Delta^*\), given constant \(s>0.5\). However, \(B>B^*\) is always satisfied.\(^{15}\)

Before solving equations (4) and (5) at the cutoff levels, we first give some intuition for the operating profits and marketing costs given in (4) and (5) using a simple graph. Focusing on the home country, Figure 2 plots \(B_D, B_X, F_D,\) and \(F_X\) in terms of \(a\). (These are identical to the foreign country from (5).) All of them have positive slopes from origin. For the highest quality producers, \(a=0\), \(Bs\) are zero due to infinitive marginal costs \((1/a=\infty)\) and \(Fs\) are zero because no higher quality brands exists which would make marketing costs necessary.

\(^{14}\) This approach also helps to highlight trade costs, which is one of the most important factors in the paper.

\(^{15}\) \(B=B^*\) cannot hold as long as \(s>0.5\). If \(B=B^*\) holds, then \(a_X=a^*_X\) can be derived from (5)=0 at the cutoff \(a_X\). Thus, \(B=B^*\) and \(a_X=a^*_X\) results in \(a_D\) and \(a^*_D\) from (4)=0 at \(a_D\). However, this means \(\Delta^*=\Delta\) and thus \(B>B^*\) due to \(s>0.5\). This is contradiction to \(B=B^*\). Hence, \(B\) cannot equal to \(B^*\) for any \(s>0.5\).
The loci of all Bs and Fs intersect at the origin. The gap between \(B_D\) and \(F_D\) corresponds to net pure profits from domestic sales and the gap between \(B_X\) and \(F_X\) represents net profits for export sales. The net pure profits are quadratic forms in terms of \(a\). The highest quality firms \((a=0)\) have \(B_D=F_D\) and \(B_X=F_X\) and thus zero pure profits, while intermediate quality firms have positive pure profits.

The condition for every firm below \(a_X\) being an exporter rather than a local firm is \(\sigma - 1 - \rho < 0\).\(^{16}\) If this condition is not satisfied, then the locus of \(B_X (B_D)\) is always below the locus of \(F_X (F_D)\) for any positive ‘a’s and thus there does not exist any operating firm, i.e. not of \(X\) type neither \(D\) type.

The intersection of \(B_D\) and \(F_D\) is denoted by \(a_D\), while that of \(B_X\) and \(F_X\) by \(a_X\). The intersections represent the cutoff levels for \(X\)-type and \(D\)-type firms. Below \(a_X\), higher quality \(X\)-type producers make positive net profits. Their operating profits are small due to high marginal costs, but they also benefit from low fixed costs. Between \(a_X\) and \(a_D\), producers are not able to export and therefore only sell their goods on the domestic market. Below \(a_D\), no firm starts producing or selling (\(N\)-type).\(^{17}\)

It follows from our model set-up that those firms that produce for the domestic and the foreign market, produce the goods of higher quality. \(D\)-type firms produce an inferior quality, whereas \(N\)-type firms face sunk costs that are too high to start the production of even lower quality goods. These specifications and outcomes are identical to the foreign country concerning \(B^*_D, F^*_D, B^*_X\) and \(F^*_X\).

In order to find the trade equilibrium, we need to define the two cutoff levels for both countries. Using equations (5) and (6), the four cutoff levels, \(a_D, a^*_D, a_X, a^*_X\) are given by following four conditions.

\[
\frac{s}{\Delta} a_D^{\sigma -1} - f_d (a_D^p n + a^*_X n^*) = 0
\]

\(^{16}\) Note that our feasible parameter values for \(\sigma\) and \(\rho\) are \(\sigma -1 + \rho >0\) (regularity condition, as mentioned below).

\(^{17}\) Note that the sufficient condition for \(a_X < a_D\) is \(\frac{f_D \phi}{f_X} < 1\) (see Appendix A).
\[
\frac{1-s}{\Delta} a_D^{\sigma-1} - f_d(a_D^{\sigma} n^* + a_X^s n) = 0 \quad (10)
\]

\[
\phi \frac{1-s}{\Delta} a_X^{\sigma-1} - f_x(a_X^{s} n^*) = 0 \quad (11)
\]

\[
\phi \frac{S}{\Delta} a_X^{s \sigma-1} - f_x(a_X^{\rho} n^*) = 0 \quad (12)
\]

where \( \Delta \) and \( \Delta^* \) in equilibrium can be written as

\[
\Delta = n \int_0^{\rho^*} a^{\sigma-1} dG[a | a_D] + n^* \int_0^{\sigma^*} a^{\sigma-1} dG[a | a_D]
\]

\[
\Delta^* = n^* \int_0^{\rho^*} a^{\sigma-1} dG[a | a_D] + n \phi \int_0^{\sigma^*} a^{\sigma-1} dG[a | a_D]
\]

The first two cutoff conditions (9) and (10) are the ones for the domestic market in both countries. If the beachhead costs for domestic sales exceed their operating profits, they are non-producers (\( N \)-type). If the beachhead costs are lower than the profits in domestic market, they decide to produce. Further, if the third and fourth conditions, (11) and (12) are satisfied, firms are able to enter the export market and then become \( X \)-type firms. If the export beachhead costs to enter the foreign market are higher than the profits from exporting, the firms remain domestic producers (\( D \)-type). \( \Delta \) and \( \Delta^* \) can be solved as:

\[
\Delta = \frac{\rho}{\sigma + \rho - 1} \frac{n a_D^{\sigma+\rho-1} + n^* \phi a_X^{\sigma+\rho-1}}{a_D^\rho} \quad \text{and} \quad \Delta^* = \frac{\rho}{\sigma + \rho - 1} \frac{n^* a_X^{\sigma+\rho-1} + n \phi a_X^{\sigma+\rho-1}}{a_D^\rho}
\]

(The regularity condition is \( \sigma - 1 + \rho > 0 \), which ensures the convergence of integrals in \( \Delta \) and \( \Delta^* \)).

As long as we assume asymmetric market (population) size, \( s > 0.5 \), neither the \( a_X \)s nor the \( a_D \)s are equal across countries. We obtain this result by solving the system of equations with a numerical simulation technique. Figure 3 illustrates the possible cutoffs shifts for both
countries. The model implies that the larger economy has a $a_X$ closer to 0 compared to the $a^*_X$ of the smaller foreign economy; whereas the domestic cutoff level ($a_D$) is located closer to 1 than the $a^*_D$ of the foreign country with a smaller economy.

In summary, the firm that produces the highest quality $a = 0$ has zero sunk costs for its sales in the domestic and foreign market. However, its marginal costs and its price go to infinity and therefore its net profits are zero due to zero demand. The net-profit rises as ‘$a$’ rises and then fall. The net profit from exporting goes to zero at $a_X$ and the one from domestic sales goes to zero at $a_D$. The lowest quality firm ($a = 1$), has the lowest marginal costs, namely 1, but also faces the highest beachhead costs of all firms, which drives its net profits into losses.\textsuperscript{18}

With this model set-up, we are now able to derive several predictions:

\textbf{Result 1:} Higher quality firms are able to sell their products on the domestic as well as on the foreign market due to smaller beachhead costs. Intermediate quality firms only produce for the domestic market, but are unable to export due to high fixed costs of exporting. The high beachhead costs of lowest quality firms preclude them from entering any market.

From the Pareto distribution, the average price of exports, $\overline{P}_E$, and the average price of all produced varieties, $\overline{P}$, can be derived as

$$\overline{P} = \frac{1}{1 - \frac{1}{\sigma} \frac{\rho}{1 + \rho} a_D} \quad \text{and} \quad \overline{P}_E = \frac{1}{1 - \frac{1}{\sigma} \frac{\rho}{1 + \rho} a_X}. \quad \text{\textsuperscript{19}}$$

Due to $a_X < a_D$, $\overline{P}_E > \overline{P}$ always holds. We can summarize this results as follows:

\begin{itemize}
  \item When $f_D$ is above a certain level to exceed profits, there exists $N$ type. But our interest as seen in empirical estimation is mainly export and $X$ type firms. Thus, our paper does not need to explicitly specify the condition for existing $N$ type of firms. Even in the case that there are no $N$ type firms, it does not affect our main results.
  \item The average value of $a$ from 0 to $a_X$ in the Pareto distribution, $g[a]$, can be expressed as $(\rho((\rho+1))a_X$.
\end{itemize}
Result 2: The average price of the exporting varieties is always higher than the average price for all produced goods.

Note that Result 2 constitutes a sharp contrast to the prediction of standard heterogeneous firms trade models. In this type of models, 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 are always lower than the average price of all products produced and sold within a country. However, this result neglects quality aspects of international trade. Empirical evidence shows that higher unit values of exports indicate higher quality. Not only the productivity of firms, but also the quality they produce may determine whether a firm exports or not. (See Baldwin (2005) about this shortcoming in the heterogeneous firms trade models and the inconsistency with the quality literature.)

3.4 Market Size and Cutoff Levels Difference

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. Since wage rates and the mass of varieties \( n \) and \( n^* \) are identical for both countries and given as 0.5, but since \( s \) is larger than 0.5, different market sizes of both countries lead to different cutoffs.

The four cutoff levels cannot be derived by numerical simulation (equation (9) to (12)) Figures 3 and 4 illustrate the results. The numerical simulation with the appropriate parameter values yields the key relationships, such as \( a_X < a_X^* \) and \( B > B^* \). The result implies a higher average export price in the larger market. Since the cutoff levels \( a_D \) and \( a_D^* \) can neither be solved analytically in the open economy case, the numerical simulation, utilizing the cutoff conditions from (9) to (12), delivers \( a_D > a_D^* \), which is consistent with the cutoff relation under autarky.

\(^{20}\) For supporting the simulation result, Appendix B provides an analytical solution for this result, using a specific case.
The larger market has a lower $a_X$ and a higher $a_D$, which means less exporters but more local producers. Note again that our model assumes the same mass of varieties in both countries in order to be able to make predictions about the impact of market size asymmetries. However, the relatively bigger market translates into a bigger domestic demand which triggers the entry of more domestic firms (more $D$-type in the domestic country) and attracts the exports of foreign producers (more $X$-type in the foreign country). At the same time, the foreign smaller market is not very profitable which reduces exports from the domestic country (less $X$-type in the home country).

3.5 Comparative Statics
Having derived the key conditions of our model, we are able to do some comparative statics which provide further intuitions and a better understanding of our model. In a two-country set-up, we analyze the impact of a change in the two central variables of our model, market size and trade costs, on the cutoff levels, $a_D, a^*_D, a_X$ and $a^*_X$ and thus export prices.

As a first step, we are interested in knowing the effects of an increase in the market asymmetry between countries. We therefore solve our model by a numerical simulation using different market shares. The results for the domestic and foreign cutoff levels, $a_D, a^*_D, a_X$ and $a^*_X$ are illustrated in Figure 5. The basic mechanism is the following: As described above, the mass of varieties is assumed to be identical between countries, $n=n^*=0.5$. However, the different market size leads to a different market competition and therefore different cutoff levels across countries. At the end, it is the relative market size that determines the number of active firms and their market share in each country.

When the size of the home market increases relatively to foreign, more and more domestic firms, which so far have not found it profitable to produce, decide to enter the domestic market; $a_D$ therefore increases. On the foreign market in contrast, competition between domestic firms becomes tighter and lower quality firms begin to stop their production and drop out of the market; $a^*_D$ falls. In summary, as the market asymmetry between countries increases, the domestic cutoff levels diverge more and more.

Figure 5: Market Size and Cutoff Levels
The market size of a country has not only an impact on the domestic cut-off conditions, but also on the foreign ones. A relatively higher market share in home country triggers more imports and reduces exports compared to the smaller foreign market. As we can see in Figure 5, as the domestic market increases, \( a_X \) decreases since selling in the domestic market becomes more attractive compared to exporting to the smaller foreign market with the burden of export beachhead costs and trade costs. In contrast, as the foreign country becomes relatively smaller, \( a^*_X \) increases which means that more and more \( D \) type firms become \( X \) type firms. An increasing number of export firms in the foreign country would now like to reap the benefits of the large export market. Note that the export cutoff levels are proportional to the export prices.

**Result 3:** The country with the larger market size has a lower export cutoff level and therefore the exports have a higher average price compared to the exports of the smaller economy.

Stated differently, being the larger economy implies also having a bigger domestic demand, which in turn makes the market of the smaller economy a less attractive export destination. The exports from the large to the small economy must therefore be biased towards high quality goods.

The second key variable of our model are trade costs, i.e. freeness of trade \( \phi \). As \( \phi \) goes to zero, trade costs increase and become prohibitive for \( \phi = 0 \). As shown above, trade costs impact the level of quality traded. Figure 6 presents the simulation results for the domestic and foreign cutoff levels, \( a_D, a^*_D, a_X \) and \( a^*_X \), when different trade costs are applied. (The domestic market is assumed to be the larger market, \( s = 0.6 \).)
A fall in trade costs heightens the import competition and therefore crowds out lower quality producers in both countries. Since home is the larger market, the pressure to exit the market is particularly strong in the smaller foreign market. At the same time, more and more firms in both countries are given the chance to enter the export market. \( a_X \) and \( a^*_X \) therefore increases which translates into a fall in the average price level (quality) in both countries. Since the foreign market is smaller and foreign firms are more attracted to export sales, the increase in \( a^*_X \) is stronger than the increase in \( a_X \).

Figure 6: Freeness of Trade and Cutoff Levels

Trade costs and distance change the cutoff levels. Lower trade costs increase \( a_X \), but decrease \( a_D \). This is the result of a selection effect, akin to Melitz (2003). Lower trade costs make the market more competitive. The highest-quality local producers (\( D \) type) enter the export market, but the lowest-quality local firms (also \( D \) type) are forced to exit. This movement decreases the average export price. Or put differently, lower trade costs (due to geographical distance and trade liberalization) decrease the threshold for exporters, but increase the threshold for firms to enter the domestic market. The reason is that trade liberalization leads to higher market competition. In sum, the increase in \( a_X \), caused either by increased \( \phi \) or by decreased \( s \), decreases the average export price.
Result 4: A decrease in trade costs between two given countries increases the cutoff levels $a_X$ and decreases the cutoff level $a_D$. As more and more $D$-type firms are able to enter the export market, the average quality (price) of exports must fall.

Furthermore, trade costs can be interpreted as geographical distance. Thus, we can state:

Result 5: As trading partners are located farther away geographically, the quality of the exported goods increases and therefore the export prices are ceteris paribus higher on average.

Intuitively, the components of the commodities in the trade with distant partners are supposed to be high-priced and high quality goods. Trade with neighboring countries covers a wider range of quality levels. Not only high quality goods, but also simple goods are traded.

3.6 TRADE COSTS 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 and identical distribution of firms' productivity, our results can be reinterpreted in a multi-sector framework. We therefore reintroduce the multi-sector framework, $S \in (0,1)$, which has been dropped at the beginning. 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.\(^{21}\) Owing to the simplicity of our basic model, the above-

\(^{21}\) For example, Hummels and Skiba (2004) find substantial trade cost differences between different product categories.
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 6: 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.**

4. **EMPIRICAL EVIDENCE**

4.1 **DATA**

In order to test our model empirically, data on the quality level of trade flows is 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 is 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 also at the six-digit level and thus our measurement of quality is far from 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 is needed, but also data on intra-national trade flows. Data for our first sample comes from the 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 export data of manufactured goods for fifteen EU countries (all members of the European Union prior to
enlargement) for the year 2004. We define manufactured goods as all products ranging from subheading 811300 to 961800 (HS 1992). The total number of subheadings in this range is 1360. The products include intermediate as well as finished manufactured goods of all kind, varying from relative simple goods like for example ‘spades and shovels’ (HS 820110) to high technology products such as ‘aircraft propellers, rotors and parts thereof’ (HS 880310). We have chosen these subheadings since they offer a considerable variety of goods and since the sectors included in this group are the less distorted by special provisions, such as the Common Agriculture Policy for the agricultural sector. In the focus of the empirical analysis in this section are the trade flows in manufactured goods among the fifteen EU countries. However, we also study the export flows that were directed to other developed countries (USA, Canada, and Japan) as well as to another 155 countries worldwide.

Restricting the main 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 fifteen 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 32 billion US Dollars in the case of Luxemburg to 274 billion in the case of Germany for the year 2004. 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

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22 The countries are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Spain, Sweden, and United Kingdom.
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 can become 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 biggest cities 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 is used:

\[ d_{ij} = \sum_{k=1}^{n} \left( \frac{pop_k}{pop_i} \right) \sum_{l=1}^{n} \left( \frac{pop_l}{pop_j} \right) d_{kl} \]

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, the influence of trade costs on the quality level of export flows is studied (Result 4 and 5). Third, market size effects are analyzed (Result 4). Fourth, we verify the claim that quality and the composition of trade are related (Result 6).

4.2 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, this data is 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 covers 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 is 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 this shipment data does 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.

Table 2: Unit Value Comparison of Domestic and Foreign Shipments

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

30
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.

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 goods for 176 million US Dollars; and for HS 8803 the exports amounted to 8,584 million US Dollars compared to imports of 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 fifteen 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

<table>
<thead>
<tr>
<th>Importer</th>
<th>U.V.</th>
<th>Diff. %</th>
<th>GDP %</th>
<th>Importer</th>
<th>U.V.</th>
<th>Diff. %</th>
<th>GDP %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>47.96</td>
<td>+680.97</td>
<td>1.64</td>
<td>Netherlands</td>
<td>495.60</td>
<td>+173.66</td>
<td>4.01</td>
</tr>
<tr>
<td>Austria</td>
<td>44.67</td>
<td>+627.48</td>
<td>1.99</td>
<td>Ireland</td>
<td>464.48</td>
<td>+156.48</td>
<td>1.15</td>
</tr>
<tr>
<td>Sweden</td>
<td>34.50</td>
<td>+461.80</td>
<td>2.32</td>
<td>Finland</td>
<td>434.90</td>
<td>+140.15</td>
<td>1.27</td>
</tr>
<tr>
<td>Spain</td>
<td>30.74</td>
<td>+400.54</td>
<td>6.57</td>
<td>Sweden</td>
<td>377.93</td>
<td>+108.69</td>
<td>2.32</td>
</tr>
<tr>
<td>U.K.</td>
<td>23.36</td>
<td>+280.48</td>
<td>15.00</td>
<td>Denmark</td>
<td>364.48</td>
<td>+101.26</td>
<td>1.64</td>
</tr>
<tr>
<td>Greece</td>
<td>23.20</td>
<td>+277.83</td>
<td>1.28</td>
<td>France</td>
<td>347.02</td>
<td>+91.62</td>
<td>13.97</td>
</tr>
</tbody>
</table>
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.
Our model of section 3 claims that with increasing trade costs the quality level of trade flows rises (Result 5). 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 high quality producers face lower beachhead costs, which allow them 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.\textsuperscript{23} 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.
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), and Helpman, Melitz and Rubinstein (2004), Redding and Schott (2005), 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.

Result 4 and 5 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:

\[
\log(p_{ijk}) = \alpha + \beta \log(dist_{ij}) + \delta_k prod_{k} + \eta_i ex_i + \iota_j im_j + \mu_{ij}
\]

(13)

In this equation \(p_{ijk}\) denotes the unit value exported from country \(i\) to country \(j\) of product group \(k\); \(dist_{ij}\) measures the distance between country \(i\) and country \(j\). The parameters \(\alpha_k\) and \(\beta\) are to be estimated together with product fixed effects, \(\gamma_{prod_k}\). 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 twelve different quantity measures can be

\[\text{34}\]

\[\text{23}\] One may recall that traditional trade models assume that the unit value is not related to distance.
applied.\textsuperscript{24} Since country specific effect might also influence the result, we further use fixed effects for importing and exporting countries ($\eta_i$ and $\iota_j$). $\mu_{ij}$ denotes a Gaussian white noise error term.\textsuperscript{25}

Column (1) of Table 4 documents the regression results when all 641624 export flows in manufactured goods from 15 EU countries towards 173 countries in the world (including the 15 EU countries) in the year 2004 are taken into account. The regression yields a highly significant and positive distance coefficient (great-circle formula) which means that the unit value of exported products increases with trade costs. In column (2) the sample is restricted to trade flows from the EU 15 to the other 15 EU countries as well as Canada, Japan, and the US. The magnitude of the distance coefficient changes only slightly. When only intra EU trade is considered (column (3)), the coefficient becomes slightly smaller. Whereas in column (3) we use the simple great-circle distance, in column (4) the population weighted distance is applied. For the last specification in column (4) the distance coefficients become bigger and again highly statistically significant.\textsuperscript{26}

Table 4: Quality Trade IN Manufactured Goods

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.C. Dist.</td>
<td><em><strong>0.213</strong></em></td>
<td>***0.149</td>
<td><em><strong>0.153</strong></em></td>
<td><em><strong>0.156</strong></em></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.003)</td>
<td>(0.004)</td>
<td>(0.008)</td>
<td></td>
</tr>
<tr>
<td>Wei. Dist.</td>
<td></td>
<td></td>
<td></td>
<td><em><strong>0.187</strong></em></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.009)</td>
<td></td>
</tr>
<tr>
<td>Trade Flows</td>
<td>EU15-World</td>
<td>EU15-World</td>
<td>EU15-EU15+</td>
<td>EU15-EU15</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{24} 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.

\textsuperscript{25} 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.
In Table 5 we present the regression results for all 15 EU countries individually. One observes that the distance coefficients vary substantially from country to country, ranging from 0.454 in the case of Finland to 0.010 in the case of Sweden. All coefficients are positive and statistically significant, except of the case of Germany, Greece, Italy, Sweden, and the UK. It seems to be a tendency that smaller economies have higher distance coefficients with a higher statistical significance compared to larger economies. Furthermore, it appears that for countries that are located at the periphery of the EU the distance coefficients are higher.

Table 5: Quality Trade by Country In Manufactured Goods

<table>
<thead>
<tr>
<th></th>
<th>AUS</th>
<th>BEL</th>
<th>DEN</th>
<th>FIN</th>
<th>FRA</th>
<th>GER</th>
<th>GRE</th>
<th>IRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wei.Dist.</td>
<td>***0.075</td>
<td>***0.132</td>
<td>***0.168</td>
<td>***0.365</td>
<td>***0.138</td>
<td>-0.006</td>
<td>0.077</td>
<td>***0.166</td>
</tr>
<tr>
<td></td>
<td>(0.020)</td>
<td>(0.001)</td>
<td>(0.015)</td>
<td>(0.026)</td>
<td>(0.013)</td>
<td>(0.008)</td>
<td>(0.108)</td>
<td>(0.028)</td>
</tr>
<tr>
<td>Obs.</td>
<td>10203</td>
<td>11882</td>
<td>9140</td>
<td>6876</td>
<td>14798</td>
<td>16150</td>
<td>3025</td>
<td>3831</td>
</tr>
<tr>
<td>Products</td>
<td>1123</td>
<td>1195</td>
<td>1080</td>
<td>1024</td>
<td>1267</td>
<td>1253</td>
<td>838</td>
<td>944</td>
</tr>
<tr>
<td>R²</td>
<td>0.744</td>
<td>0.690</td>
<td>0.763</td>
<td>0.722</td>
<td>0.776</td>
<td>0.845</td>
<td>0.493</td>
<td>0.772</td>
</tr>
</tbody>
</table>

<table>
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<th>ESP</th>
<th>SWE</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dist</td>
<td>***0.059</td>
<td>***0.101</td>
<td>***0.038</td>
<td>***0.408</td>
<td>***0.286</td>
<td>0.012</td>
<td>***0.047</td>
</tr>
<tr>
<td></td>
<td>(0.015)</td>
<td>(0.018)</td>
<td>(0.011)</td>
<td>(0.039)</td>
<td>(0.023)</td>
<td>(0.011)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>Obs.</td>
<td>14794</td>
<td>4217</td>
<td>12886</td>
<td>4255</td>
<td>11424</td>
<td>9911</td>
<td>14979</td>
</tr>
<tr>
<td>Products</td>
<td>1271</td>
<td>955</td>
<td>1192</td>
<td>946</td>
<td>1239</td>
<td>1032</td>
<td>1302</td>
</tr>
<tr>
<td>R²</td>
<td>0.770</td>
<td>0.823</td>
<td>0.871</td>
<td>0.664</td>
<td>0.643</td>
<td>0.792</td>
<td>0.893</td>
</tr>
</tbody>
</table>

Summarizing the regression results, we find strong support of an Allen-Alchian effect. In contrast to Hummels and Skiba (2004), we limit our sample to manufactured goods and focus on trade between similar economies. We confirm their results and offer an theoretical explanation. The increase in the unit value could be due to the quality effect described in our
model. With beachhead costs negatively related to quality, the further the products are traded, the higher becomes the average quality of the exported goods.

4.4 **Market Size Effect**

Our model yields the prediction that market size is positively correlated with the average price of exports (Result 5). To test this result empirically, a measure of market size needs to be included in the econometric specification from above (13), which then takes the following form:

\[
\log(p_{ij}) = \alpha + \beta \log(dist_{ij}) + \gamma \log(ms_i / ms_j) + \delta_i \text{prod}_i + \eta_i \text{ex}_i + \iota_j \text{im}_j + \mu_j (14)
\]

In equation (14) \(ms_i\) and \(ms_j\) stand for the market size of the exporting (i) and importing (j) country, respectively. All 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.27 Table 6 and 2-7 report the estimation results for the market size effect.

Column (1) and (3) of Table 6 include the GDP ratio and column (2) and (4) the population ratio in the regression. All estimated coefficients are highly statistically significant revealing that market size is positively correlated with quality. 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 6: *Market Size Effect For Intra-EU Trade*

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
</table>

27 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.
Table 7: Market Size Effect by Country

<table>
<thead>
<tr>
<th></th>
<th>AUS</th>
<th>BEL</th>
<th>DEN</th>
<th>FIN</th>
<th>FRA</th>
<th>GER</th>
<th>GRE</th>
<th>IRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wei. Dist.</td>
<td>***0.074</td>
<td>***0.071</td>
<td>***0.168</td>
<td>***0.391</td>
<td>***0.135</td>
<td>0.002</td>
<td>0.076</td>
<td>***0.126</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.011)</td>
<td>(0.015)</td>
<td>(0.025)</td>
<td>(0.013)</td>
<td>(0.008)</td>
<td>(0.117)</td>
<td>(0.030)</td>
</tr>
<tr>
<td>GDP Ratio</td>
<td>0.001</td>
<td>***0.098</td>
<td>***0.025</td>
<td>***0.049</td>
<td>0.005</td>
<td>***0.026</td>
<td>0.001</td>
<td>***0.050</td>
</tr>
<tr>
<td></td>
<td>(0.006)</td>
<td>(0.008)</td>
<td>(0.007)</td>
<td>(0.010)</td>
<td>(0.005)</td>
<td>(0.004)</td>
<td>(0.033)</td>
<td>(0.014)</td>
</tr>
<tr>
<td>Obs.</td>
<td>10203</td>
<td>11882</td>
<td>9140</td>
<td>6876</td>
<td>14798</td>
<td>16150</td>
<td>3025</td>
<td>3831</td>
</tr>
<tr>
<td>Products</td>
<td>1212</td>
<td>1291</td>
<td>1149</td>
<td>1050</td>
<td>1336</td>
<td>1312</td>
<td>865</td>
<td>1006</td>
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<tr>
<td>$R^2$</td>
<td>0.744</td>
<td>0.694</td>
<td>0.764</td>
<td>0.723</td>
<td>0.776</td>
<td>0.846</td>
<td>0.493</td>
<td>0.773</td>
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</table>

<table>
<thead>
<tr>
<th></th>
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<th>LUX</th>
<th>NET</th>
<th>POR</th>
<th>ESP</th>
<th>SWE</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wei. Dist.</td>
<td>0.028</td>
<td>***0.099</td>
<td>***0.033</td>
<td>***0.405</td>
<td>***0.265</td>
<td>-0.006</td>
<td>***0.047</td>
</tr>
<tr>
<td></td>
<td>(0.017)</td>
<td>(0.018)</td>
<td>(0.011)</td>
<td>(0.042)</td>
<td>(0.023)</td>
<td>(0.011)</td>
<td>(0.015)</td>
</tr>
<tr>
<td>GDP Ratio</td>
<td>***0.027</td>
<td>0.011</td>
<td>***0.050</td>
<td>0.003</td>
<td>***0.030</td>
<td>***0.051</td>
<td>***0.023</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.011)</td>
<td>(0.007)</td>
<td>(0.019)</td>
<td>(0.008)</td>
<td>(0.005)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Obs.</td>
<td>14794</td>
<td>4217</td>
<td>12886</td>
<td>4255</td>
<td>11424</td>
<td>9911</td>
<td>14979</td>
</tr>
<tr>
<td>Products</td>
<td>1328</td>
<td>984</td>
<td>1277</td>
<td>1005</td>
<td>1295</td>
<td>1233</td>
<td>1310</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.770</td>
<td>0.823</td>
<td>0.872</td>
<td>0.664</td>
<td>0.794</td>
<td>0.794</td>
<td>0.893</td>
</tr>
</tbody>
</table>

Notes: All regression are run with product fixed effects, but for which the coefficients are not reported; Wei. Dist. stands for the weighted distance; ***,**,* denotes significance at the 1 %, 5 %, and 10 % level, respectively; robust standard errors in parentheses.

Table 7 reports the main specification with GDP ratios for each country in the sample. Looking at each country separately, we observe that Belgium, France, and Greece report...
insignificant market size effects. All other countries have significant and positive results, except for Luxembourg and Sweden recording a negative coefficient.

4.5 ROBUSTNESS CHECK: MEASUREMENT ERRORS AND COMPOSITION EFFECT

We have already used different distance measures and different sample sizes to check the validity of our results. One major concern that might bias the estimation are measurement errors. Our sample covers trade in 1358 manufactured goods between 15 EU countries. The total number of possible observations is therefore: 1358x15x14 = 285180. However, only about a half of all possible trade relations is actually observed, 148371.

Result 5 claims that with increasing trade costs the export cutoff levels $a_X$ and $a^*_X$ 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 our estimation, 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 technique can then be specified as:

Selection equation: $z_{ijk} = \phi + \phi log(dist_{ij}) + \theta_k prod_k + \rho_i ex_i + \zeta_j im_j + \epsilon_{ij}$

Flow equation: $log(p_{ijk}) = \alpha + \beta log(dist_{ij}) + \delta_k prod_k + \eta_i ex_i + \tau_j im_j + \mu_{ij}$

Where $z_{ijk}$ is 1, if a trade flow in product $k$ between countries $i$ and $j$ is observed, and 0 otherwise.
Running a two-step Heckman model for the specifications (13) and (14) we obtain the results reported in Table 8. The Heckman estimations confirm the results found earlier. For all selection equations (columns (1), (3), and (5)) the distance coefficient is strongly negative corroborating the conjecture that trade relations are less likely to be observed as trade costs increase. The negative coefficient of the GDP ratio in column (3) is also in line with the model’s predictions. 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. The positive coefficient of the population ratio in column (5) is difficult to interpret. The second step estimation results corroborate the results found earlier. All coefficients of interest are positive and strongly statistically significant. The magnitude of all coefficients is very similar to the one observed above.

Table 8: Heckman Estimation for Quality Trade

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wei. Dist.</td>
<td>***-0.479</td>
<td>***0.172</td>
<td>***-0.479</td>
<td>***0.172</td>
<td>***-0.479</td>
<td>***0.172</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.005)</td>
<td>(0.007)</td>
<td>(0.005)</td>
<td>(0.007)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>GDP Ratio</td>
<td>***-0.319</td>
<td>***0.055</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POP Ratio</td>
<td>***0.385</td>
<td>***0.048</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
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<tr>
<td>Obs.</td>
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<td>285180</td>
<td>285180</td>
<td>285180</td>
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<tr>
<td>Censored obs.</td>
<td>141096</td>
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<td>141096</td>
<td>141096</td>
<td>141096</td>
<td>141096</td>
</tr>
<tr>
<td>Uncensored obs.</td>
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<td>144084</td>
<td>144084</td>
<td>144084</td>
<td>144084</td>
<td>144084</td>
</tr>
<tr>
<td>Equation</td>
<td>Selection</td>
<td>Flow</td>
<td>Selection</td>
<td>Flow</td>
<td>Selection</td>
<td>Flow</td>
</tr>
</tbody>
</table>

Notes: FE stands for fixed effects regressions; *** denotes significance at the 1 % level; robust standard errors in parentheses.

Another way to check to validity of our results is to see whether the model predictions are also evidenced in a multi-sector framework (Result 7). Trade costs may not only shape the quality content of trade within products groups, but also across product groups. This means that product groups which face high trade costs (or have low average quality) are supposedly to be more present in those exports flows that are trade over small distances. When trade costs increase, more and more product groups (or sectors as defined in our model) that face lower trade costs (or have a higher average quality) should enter the export flow. We call this
effect composition effect, since it describes the hypothesis that the export mix changes with distance.

In order to test this hypothesis, we need to generate two additional variables. First, we calculate the average unit value of exports of each product group over all trading partners for each country. The average unit value gives us some insights about the relative vertical price position of each product group. Second, we take the mean distance over which each product group is traded, also for each country. Since not all products are traded with all countries or trade is not recorded, the distance can vary between product groups. For our estimation, we then apply the following econometric specification:

\[ p_{ki} = \alpha + \beta \text{dist}_{ki} + \eta_i \text{ex}_i + \iota_j \text{im}_j + \mu_{ki} \]

We simply regress the logarithm of the average unit value for each exporting country, \( p_{ki} \), on the logarithm of the mean distance, \( \text{dist}_{ki} \). As above, exporter and import fixed effects, \( \eta_i \) and \( \iota_j \), are used. Why does this specification make sense?

Table 9: Composition Effect in Quality Trade

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
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<tr>
<td>Weigh. Dist.</td>
<td>***0.544</td>
<td>***0.544</td>
<td>***0.544</td>
</tr>
<tr>
<td></td>
<td>(0.071)</td>
<td>(0.071)</td>
<td>(0.071)</td>
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<tr>
<td>GDP Ratio</td>
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<td></td>
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<td></td>
<td>(0.020)</td>
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<tr>
<td>POP Ratio</td>
<td>0.004</td>
<td></td>
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<tr>
<td></td>
<td>(0.018)</td>
<td></td>
<td></td>
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<td>Obs.</td>
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<td>16661</td>
<td>16661</td>
</tr>
<tr>
<td>Product</td>
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<td>1358</td>
<td>1358</td>
</tr>
<tr>
<td>R²</td>
<td>0.110</td>
<td>0.110</td>
<td>0.110</td>
</tr>
</tbody>
</table>

1. Notes

: FE stands for fixed effects regressions; *** denotes significance at the 1 % level; robust standard errors in parentheses.

If only the quality effect (Alchian-Allen effect) comes into play, then the mean distance cannot explain the value of the average unit value. In other words, the good apples and the
good automobiles are then shipped out towards all destinations. However, if the mean distance explains the value of the average unit value, a composition effect kicks in, which would mean that the product groups that face high trade costs are exported towards closer destinations than product groups with low trade costs. The estimation results are presented in Table 9.

5. SUMMARY AND CONCLUSION

This paper constitutes a first attempt to model quality in a heterogeneous quality firms’ framework. In our model high quality firms face high marginal costs of production, but low beachhead costs to enter the domestic and the foreign market. 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 are traded furthest, but the goods of the highest quality. Furthermore, the cut-off levels are not identical across countries as in Melitz (2003), 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.

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.

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.

6. BIBLIOGRAPHY


7. **APPENDICES**

7.1 **THE CONDITION FOR CUTOFF LEVELS**

The condition for export firms to exist, i.e. all ‘$a$’s such that $a < a_X < 1$ are X-type firms, can be written as

$$\frac{\phi}{\sigma} \frac{1-s}{\Delta} a^{\sigma-1} - f_X n^* a^\rho > 0; \ a < a_X$$

which means firms ‘a’ make positive profits from export market. Using equation (12),

$$\frac{\phi}{\sigma} \frac{1-s}{\Delta} a^{\sigma-1}_X - f_X n^* a^\rho_X = 0;$$

the above condition can be reduced to $a^{\sigma-1}_X < a^{\sigma-1}$. Thus, we can derive the condition, $\sigma - 1 - \rho < 0$ to satisfy $a < a_X < 1$.

One more condition is necessary to ensure $a_X < a_D$, in which there exists D type in the home country. Combining the equations (6) and (8), we get
Because the home country is large and has a competitive market, \( s > 0.5 \), \( s/\Delta > (1-s)/\Delta^* \), which is \( B>B^* \). We assume away the extreme cases like \( a^*_X > a^*_D \), and thus

\[
\frac{a^*_X}{a^*_D} < 1.
\]

The parenthesis is less than 2. Therefore, the sufficient condition for \( a_X < a_D \) under the above condition, \( \sigma - 1 - \rho < 0 \), can be written as \( \frac{f_D \phi}{f_X} < 1 \). Likewise, a necessary condition for the foreign country, \( a^*_X < a^*_D \), can be derived using (10) and (12) as the same.

7.2 PROOF OF THE CUTOFF LEVELS

At the heart of our model is the export cutoff level, \( a_X < a^*_X \). This relationship leads to the important result of the higher average export price in the large market. However, this result cannot help depending on numerical simulations, because of the impossibility of solving analytically. Here, in order to check the robustness of our result, we show an analytical proof for the result of \( a_X < a^*_X \) by using a specific case. Following the way of the discussion in the main text, we start from autarky, \( \phi=0 \). Since the cutoff conditions can induce a relationship,

\[
\frac{s}{1-s} = \frac{a^*_D}{a^*_D} > 1,
\]

as shown in section 3.2, \( a_D > a^*_D \) always holds. Equivalently, we get

\[
\frac{B}{B^*} = \frac{s/\Delta}{(1-s)/\Delta^*} = \left( \frac{a_D}{a^*_D} \right)^{1-\sigma+\rho} > 1 \text{ in autarky.}
\]

Next, as seen in the main text, we begin to open trade, i.e. \( \phi>0 \). As trade costs decrease, \( a_X \) and \( a^*_X \) increases from zero. To examine the impact of a trade cost reduction on the cutoff levels, we first consider the case of sufficiently high (finite) trade costs (\( \phi \) is close to zero but positive for simplicity) so as to keep \( B>B^* \). Thus, \( a_X \) and \( a^*_X \) are regarded as approximately zeros and \( \Delta s \) are thought of approximately the same as the ones in autarky.
From the export cutoff conditions, (11) and (12), we get

\[
\frac{B^*}{B} = \frac{(1-s)/\Delta^*}{s/\Delta} = \frac{1-s}{s} \left( \frac{a_D}{a_D^*} \right)^{\sigma^{-1}} = \left( \frac{a_X^*}{a_X} \right)^{1-\sigma+\rho} < 1
\]

\( (a_D \text{ and } a_D^* \text{ are assumed to be the same levels as in autarchy, i.e. } a_D > a_D^*) \). Thus, \( a_X^* > a_X \) can be derived.

Now, the robustness of this outcome is checked by considering reducing trade costs more. As seen in export cutoff level conditions (11) and (12), the crucial point is that as long as \( B > B^* \) is satisfied, \( a_X^* > a_X \) always holds.

However, we have to notice that as seen in the definition of \( \Delta s \), as trade costs reduce, \( \Delta \) and \( \Delta^* \) increases. Furthermore, the increase of \( \Delta \) is larger than that of \( \Delta^* \) due to \( a_X^* > a_X \). This means that the decreased \( B \) is larger than decreased \( B^* \) from B’s definition. If \( B \) converges to \( B^* \), \( B = B^* \), the above mentioned equation of the export cutoff levels between two countries tells us \( a_X^* = a_X \).

Now, we check the possibility of \( B = B^* \). If \( a_X^* = a_X \) and \( B = B^* \) hold, \( B = B^* \) also leads to \( a_D = a_D^* \) from the domestic cutoff level conditions (6) and (7). Therefore, from \( a_X^* = a_X \) and \( a_D = a_D^* \), \( \Delta s \) are equalized. However, \( s > (1-s) \) results in \( B > B^* \). This is a contradiction to \( B = B^* \).

Hence, we can say that \( B \) is never equal to \( B^* \), in other words, \( a_X^* \) is larger than \( a_X \). Therefore, the gradual reduction of trade costs from autarchy, as is the way of our discussion in main text, can always keep the relationship of \( B > B^* \) and thus \( a_X^* > a_X \). The large demand market has a small number of exporters while the small one has large number of exporters.

7.3 Data

Exporting countries included in the sample:

- Austria
- Belgium
- Germany
- Greece
- Netherlands
- Portugal
Definition and data source of each variable used in the estimations:

\( p_{ijk} \) denotes the logarithm of the unit value (value per quantity) exported from country \( i \) to country \( j \) of subheading \( k \) (six digit HS 1992). The unit value can only be constructed for those products for which quantities are reported. The value is reported in current U.S. Dollars 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 UN COMTRADE database, which is published by the Statistics Division of the United Nations. The data has been downloaded in March 2006 from the website: http://unstats.un.org/unsd/comtrade/Copyright.aspx; special access is required to download UN COMTRADE data.

\( \text{dist}_{ij} \) 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.

\( \text{prod}_k \) stands for the fixed effect dummies of each subheading (six digit HS 1992). If a subheading is \( k \), the dummy is one; otherwise, the dummy takes the value of zero.

\( \text{ex}_i \) and \( \text{im}_j \) are the fixed effect dummies for the exporting and importing countries. If the exporting country is \( i \), then \( \text{ex} \) is 1 and zero otherwise. The same holds for the importing countries.

\( \text{ms}_i, \text{ms}_j \) 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 the Statistical Division of the United Nations.
and are recorded in current U.S. Dollar. The second measure of market size is the logarithm of the population size. The data on population size come also from the Statistical Division of the United Nations. Both samples have been downloaded in March 2006 from the following website: http://unstats.un.org/unsd/default.htm. The data is freely available.