Abstract

There is increasing empirical evidence that vertical product differentiation is an important determinant of international trade. Whereas all empirical studies focus 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, with increasing trade costs higher quality goods are exchanged. Trade liberalization thus leads to a decrease in the average quality level of trade flows. Third, the number of trading partners is positively related to the product quality. For all three effects strong empirical support is found using detailed export trade data of fifteen EU countries.

JEL Classifications: F12, F14
Keywords: Trade Costs, Quality, Vertical Product Differentiation, Competition.
1. Introduction

Aspects of vertical product differentiation in international trade attract a growing attention among economists.\footnote{We define vertical product differentiation as the behavior of firms to produce goods of different quality and price. Throughout the paper quality and vertical differentiation are used as synonyms.} The 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 80s 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 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.\footnote{2}

Our models 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 in 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 from 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 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 three important ways. First, it provides a general equilibrium trade model in which firms that are heterogeneous with respect to the quality they produce. Second, the model set-up allows us to explain how beachhead costs and economic size of countries affect the quality composition of trade. Third, our model provides an appealing answer to the question of why countries trade in certain product groups with each other and why not.

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.

\footnote{2} 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.
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 homogenous 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 export 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 our paper is to analyze the role that quality plays for trade between identical economies. The empirical part of our paper 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 et al., 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.\(^3\) The vast majority of trade models would predict that the coefficient of

\(^3\) 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
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.

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 all countries included in the sample.

Table 1: SHARE OF QUALITY TRADE IN MANUFACTURED GOODS’ TRADE (YEAR 2004)

<table>
<thead>
<tr>
<th></th>
<th>(1) CoV</th>
<th>(2) Unweighted</th>
<th>(3) Unweighted</th>
<th>(4) Unweighted</th>
<th>(5) Weighted</th>
<th>(6) Weighted</th>
<th>(7) Weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU 15</td>
<td>75.39 %</td>
<td>74.29 %</td>
<td>59.66 %</td>
<td>17.61 %</td>
<td>61.55 %</td>
<td>41.81 %</td>
<td>8.72 %</td>
</tr>
<tr>
<td>Obs.</td>
<td>155174</td>
<td>155174</td>
<td>155174</td>
<td>155174</td>
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<td>155174</td>
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<tr>
<td>EU 15 +</td>
<td>74.95 %</td>
<td>76.54 %</td>
<td>63.38 %</td>
<td>17.52 %</td>
<td>63.29 %</td>
<td>46.93 %</td>
<td>7.90 %</td>
</tr>
<tr>
<td>Obs.</td>
<td>173011</td>
<td>173011</td>
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<td>173011</td>
<td>173011</td>
</tr>
<tr>
<td>World</td>
<td>164.97 %</td>
<td>74.42 %</td>
<td>66.17 %</td>
<td>14.89 %</td>
<td>82.84 %</td>
<td>70.22 %</td>
<td>17.39 %</td>
</tr>
<tr>
<td>Obs.</td>
<td>752724</td>
<td>752724</td>
<td>752724</td>
<td>752724</td>
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</tbody>
</table>

Notes: The numbers in percentage report the share the lies outside the range of ±10 %, ±20 %, ±30 % respectively.

The results indicate that the coefficient of variation is substantial for trade between developed countries and it even becomes higher for overall trade. 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, like 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 Austria exports to 11 EU countries and the average unit value per ton is 2,070 Euro. Five unit values lie outside the ±20 % wedge and are therefore assumed to constitute quality trade. This counting exercise allows us to

of variation over all product lines and exporting countries. We report the final result as percentage multiplying the coefficient of variation by 100.
calculate the percentage of products that are traded for quality reasons. The numbers in columns (2), (3) and (4) of Table 1 report the results.

The results indicate that quality is apparently an important determinant of trade between developed countries and between developed and developing countries. The numbers of the three wedges are not very different for the three samples. Applying the 40 % wedge, one finds that around 60 % of trade between EU countries may be counted as quality trade. This share shrinks to about 18 % when using the 60 % wedge.

In columns (5) to (7) the same approach as before has been applied, but now the numbers are weighted by the magnitude of the trade flows. We observe a slight decrease in the results, but the numbers still point to the fact the quality is a crucial element of trade.

Finally, we ask the question how the quality trade has evolved over time. We therefore estimate the coefficients of columns (2) and (3) for all years in the sample, namely from 1995 to 2004. Figure 1 depicts the development of the indicators over the ten years period.

Figure 1: SHARE OF QUALITY TRADE IN MANUFACTURED GOODS’ TRADE, 1995 - 2004

It might come at some surprise that quality trade seems to maintain its importance over the period from 1995 to 2004. What might be the reasons for this development? 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,

\[
C_s = \left( \int_{i \in \Theta} c_i^{1-\sigma/\sigma} di \right); \quad \sigma > 1
\]

\( \sigma \) 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
where 1/\(a_j\) equals marginal costs, i.e. the unit labor requirement for variety \(j\). Note that high quality varieties have higher prices because the production requires higher marginal costs, 1/\(a\).\(^4\)

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

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

\[
\bar{m} = \int_{i=0} p_i^{1-\sigma} di + \phi \int_{h=0} p_h^{1-\sigma} dh
\]

where \(p_i\) 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 in country 0. The second term shows the price of imported goods from the domestic market to the foreign market including their iceberg type of trade costs \(t>1\). \(\phi = t^{-\sigma}\) 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 (HFT) literature. However, unlike the standard HFT models, 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

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\(^4\) 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 the consumer, both, price and advertising, may be signal quality. However, the focus of our paper is not on incomplete information, but on the supply side behavior of heterogeneous firms.
(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, $a_j \in (0,1)$, are distributed by a Pareto distribution. The probability density function for $a_j$’s and its cumulative density function are respectively given as

$$g[a] = \rho \left( \frac{a}{a_0} \right)^{\rho-1} \quad \text{and} \quad G[a] = \left( \frac{a}{a_0} \right)^{\rho} .$$

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.

Figure 1: CUMULATIVE DENSITY OF FIRM DISTRIBUTION AND CUTOFF SHIFTS

Unlike the standard HFT 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 order to have similar markets. This implies that each potential entrant draws $‘a’$ subject to the Pareto distribution without any payments and then is

5 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, $n=n^*=0.5$. 


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 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:

$$F_x(a) \equiv f_x(n + n^*)a^\rho = f_xa^\rho$$

where $f_x$ is assumed to 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 domestic market. The firms that cannot pay the costs due to small sales cannot be an exporter. The total number of rival firms in the foreign market that has a higher quality than $a$ expressed as $(n^* + n)a^\rho$.

Next, we characterize the domestic marketing costs. Depending on the quality they produce firms, which sell in the domestic market, are assumed to undergo the following beachhead costs. If their profits do not cover the domestic marketing fixed costs, they are not able to produce and to sell their products (non-producer, N-type). The costs are defined as

$$F_D(a) \equiv f_d (na^\rho + n^* a^\rho) \text{ if } a > a_x^*$$

$$F_D(a) \equiv f_d (na^\rho + n^* a^\rho) \text{ if } a < a_x$$

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 $a$. $na^\rho$ denotes the number of the domestic brands higher than ‘$a’$. $n^*a^\rho_x$ constitutes the total number of

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6 These are true to the foreign country: $F^*_x(a) \equiv f_xa^\rho, F^*_D(a) \equiv f_d (na^\rho + n^* a^\rho) \text{ if } a > a_x$ and $F^*_D(a) \equiv f_d (na^\rho + n^* a^\rho) \text{ if } a < a_x$. 

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the import 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 $a$. This means that the costs for lower quality producers increase cumulatively.\footnote{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.} In other words, the beachhead costs are proportional to the number of brands that produce a higher quality than $a$. 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 need not pay domestic and export marketing costs.

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 reputation of high quality, but instead is producing with high marginal costs; while the lower brand needs more sales promotion costs to persuade people to switch their consumption from high brand to lower brand.

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 in the home country are given by
\[ \pi_D[a] = B_D(a) - F_D(a) \]  
where \( B_D \) denotes pure profits in domestic market,

\[ B_D[a] = B[a] = \frac{E^w}{\sigma} N^w \left( \frac{s}{\Delta} \right) \left( \frac{1}{a} \right)^{1-\sigma} \]

Note that \( \Delta = n \int_0^{\Delta_0} a^{\sigma-1} dG[a \mid a_D] + n^* \phi \int_{\Delta^*}^{\Delta_0} a^{\sigma-1} dG[a \mid a_D] \)

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

\[ \pi_X[a] = B_D(a) + B_X(a) - F_D(a) - F_X(a) \]  
where \( B_X \) denotes pure profits from foreign market.  

\[ B_X[a] = \phi B^*[a] = \frac{E^w}{\sigma} N^w \phi \left( \frac{1-s}{\Delta^*} \right) \left( \frac{1}{a} \right)^{1-\sigma} \]

Note that \( \Delta^* = n^* \int_0^{\Delta_0} a^{\sigma-1} dG[a \mid a_D] + n^* \phi \int_{\Delta^*}^{\Delta_0} a^{\sigma-1} dG[a \mid a_D] \) 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, \( s \). 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.

3.2. An Initial Equilibrium - Autarky and Some Simple Relations

Before considering trade between the two countries, we first study the autarky equilibrium, i.e. \( \phi = 0 \). Note that \( \Delta = 0.5 \lambda a_D^{\sigma-1} \) and \( \Delta^* = 0.5 \lambda a_D^{\sigma-1} \) in autarky, where

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8 These are true to the foreign country,

\[ \pi_D^*[a] = B_D^*[a] - F_D^*[a] \quad \text{where} \quad B_D^*[a] = B^*[a] = \frac{E^w}{\sigma} N^w \left( \frac{1-s}{\Delta^*} \right) \left( \frac{1}{a} \right)^{1-\sigma} \]

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

9 Since we use 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.

10 We assume that \( s \) is not a very large number. We exclude the case of extremely asymmetric economies. This is consistent to the actual European countries case shown in our empirical section.
\[ \lambda = \frac{\rho}{\sigma - 1 + \rho}. \] 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

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

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

\[ \pi_D^*[a_D^*] = B_D^*(a_D^*) - F_D^*(a_D^*) = 0. \]

Using these two cutoff level conditions, we can derive a relationship, \( \frac{s}{1-s} = \frac{a^D_\rho}{a^D_*} > 1. \)

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, \( a_D > a^*_D \). 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.

3.3 Trade and Equilibrium

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. 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 constants \( s > 0.5 \). However, \( B > B^* \) is always satisfied.

\[ s \frac{a^D_\rho}{n a^D_*} = \frac{a^D_\rho}{a^D_*}, \]

where \( n a^D_\rho \) is the number of firms in the home country and \( n = n^* = 0.5. \)

\[ \frac{s}{1-s} = \frac{a^D_\rho}{a^D_*} > \frac{a^D_\rho}{a^D_{\sigma-1}} = \frac{\Delta}{\Delta^*}, \]

due to \( \rho > \sigma - 1 \), which is from the condition \( \sigma - 1 - \rho < 0. \) From the definition of \( B \) and \( B^* \), this results in \( B > B^* \).

11 Under autarchy, the firm share is just proportional to the relative demand, i.e. \( s = \frac{n a^D_\rho}{n a^D_*} = \frac{a^D_\rho}{a^D_*}, \)

12 The per-firm pure profits in the large market are larger than in the small one.

13 This approach also helps to highlight trade costs, which is one of the most important factors in our paper.

14 \( B = B^* \) cannot hold as long as \( s > 0.5 \). If \( B = B^* \) holds, then \( a_Y = a^*_X \) can be derived from (5)=0 at the cutoff \( a_Y \).

Thus, \( B = B^* \) and \( a_Y = a^*_X \) 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 \( s > 0.5 \).
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, $a=0$, $B$s are zero due to infinitive marginal costs ($1/a=\infty$) and $F$s are zero because no higher quality brands exists which would make marketing costs necessary. The loci of all $B$s and $F$s intersect at the origin. The gap between $B_D$ and $F_D$ corresponds to net pure profits for $D$-firms and the gap between $B_X$ and $F_X$ represents net profits for exporting firms. 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

$$\sigma - 1 - \rho < 0.\tag{15}$$

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, but they also benefit from low fixed costs. Between $a_X$ and $a_D$, producers are not able to

---

15 Note that our feasible parameter values for $\sigma$ and $\rho$ are $\sigma-1+\rho>0$ (regularity condition, as it is mentioned below).
export and therefore only sell their goods on the domestic market. Below \( a_D \), no firm starts producing or selling (N-type).

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 (4) and (5), the four cutoff levels, \( a_D, a^*_D, a_X, a^*_X \) are given by following four conditions.

\[
\frac{s}{\Delta} a^\sigma n - f_d(a^\nu n + a^\nu n^*) = 0 \tag{6}
\]
\[
\frac{1-s}{\Delta} a_D^\sigma n - f_d(a^\nu n + a^\nu n) = 0 \tag{7}
\]
\[
\phi \frac{1-s}{\Delta} a_X^\sigma n - f_x(a^\nu n^*) = 0 \tag{8}
\]
\[
\phi \frac{s}{\Delta} a_X^\sigma n - f_x(a^\nu n^*) = 0 \tag{9}
\]

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

\[
\Delta \equiv n\int_0^{a^\sigma} a^\sigma dG[a \mid a_D] + n^*\int_0^{a^*} a^\sigma dG[a \mid a_D]
\]
\[
\Delta^* \equiv n^*\int_0^{a^*} a^\sigma dG[a \mid a_D] + n\phi\int_0^{a^\sigma} a^\sigma dG[a \mid a_D]
\]

The first two cutoff conditions (6) and (7) 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, (8) and (9) 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:

\[
\text{Note that the sufficient condition for } a_X < a_D \text{ is } \frac{f_d\phi}{f_x} < 1 \text{ (see Appendix A).}
\]
\[ \Delta = \frac{\rho}{\sigma + \rho - 1} \frac{n a_D^{\sigma + \rho - 1} + n \phi a_x^{\sigma + \rho - 1}}{a_D^{\rho}} \quad \text{and} \quad \Delta^* = \frac{\rho}{\sigma + \rho - 1} \frac{n a_D^{\sigma + \rho - 1} + n \phi a_x^{\sigma + \rho - 1}}{a_D^{\rho}} \]

(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.\(^{17}\)

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

**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. The high beachhead costs of lowest quality firms preclude them from entering any market. Intermediate quality firms only produce for the domestic market, but are unable to export.

From the Pareto distribution, average exporting price, \( \bar{P}_E \), and average price of all produced varieties, \( \bar{P} \), can be derived as

\[
\bar{P} = \frac{1}{1 - \frac{1}{\sigma + \rho} a_D} \quad \text{and} \quad \bar{P}_E = \frac{1}{1 - \frac{1}{\sigma + \rho} a_X} \quad \text{\(^{18}\).}
\]

Due to \( a_X < a_D \), \( \bar{P}_E > \bar{P} \) always holds. To summarize,

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

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\(^{17}\) 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 need not explicitly specify the condition for existing \( N \) type of firms. Even if there are no \( N \) type firms, it never affects our main results.

\(^{18}\) The average from 0 to \( a_X \) in the Pareto distribution, \( g[a] \), can be expressed as \( (\rho/(\rho+1))a_X \).
Note that Result 2 constitutes a sharp contrast to the prediction of HFT models. In the all other HFT 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 in the HFT models are always lower than the average price of all products produced and sold within a country. However, this HFT’s outcome cannot support underlying assumption of empirical evidences that high unit value products have higher quality: high productivity export firms have low price, while low productivity domestic firms produce high price goods. (See Baldwin, 2005 about this shortcoming in the HFT models and the inconsistency with quality literature.)

3.3 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 (6) to (9)) Figures 3 and 4 illustrate the results. The numerical simulation with the appropriate parameter values yield 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 (6) to (9), delivers $a_D > a_D^*$, which is consistent with the cutoff relation under autarky.

Figure 3: DOMESTIC MARKET (LARGE)

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19 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. 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).

3.4 Comparative Statics

Having derived the key conditions of our model, we are able to do some comparative statics which provides 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 export prices and thus export cutoff levels, $a_X$ and $a^*_X$.

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. In order to know the effect of an increase in the market asymmetry between countries, we solve our model by a numerical simulation using different market shares. The results for the domestic and foreign export cutoff levels, $a_X$ and $a^*_X$, are illustrated in Figure 5. Note that the export cutoff levels are proportional to the export prices.

As we can see in Figure 5, as the domestic market increases, $a_X$ decreases since sales in 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.
Different market sizes lead to different market competition and therefore to different cutoff levels across countries, while the mass of varieties is assumed to be identical between countries, \( n=n^*=0.5 \). Note that the number of firms at home and abroad is given by the market size of both countries. The market size therefore determines the market share of each firm.

**Result 3: The country with the larger market size has a higher export cutoff level and a higher average price of exports.**

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 simulations results for the domestic and foreign export cutoff levels, \( a_X \) and \( a^*_X \), when different \( \phi \) are applied. (The domestic market is assumed to be the larger market, \( s = 0.6 \).)

A decrease in trade costs allows more and more firms in both countries 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 attractive to export sales, the increase in \( a^*_X \) is stronger than the increase in \( a_X \).
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 it another way, lower trade costs (due to geographical distance and trade liberalization) decrease the threshold for exporters but increase the threshold for producer. This results from more market competition due to trade liberalization. With a rise in $a_X$ towards 1, the average export prices fall. 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 $a_D$. The average price (unit value) of exports must therefore decrease with lower trade costs. If trade costs decrease, the highest quality D-type firms are able to enter the export market. As a consequence, the average price of exports falls.

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

**Result 5:** As trading partners are located geographically further away, the quality of the exported goods increases and therefore the export prices are ceteris paribus higher on average. It follows that the distance is positively correlated with the average export prices.
Intuitively, the components of the commodities in the trade with distant partners are 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.

### 3.4. Some Extensive Testable Hypotheses

Up to the last section, we studied a two-country model for the simplicity’s sake. Due to the assumption of the non-output-input linkages across sectors and identical distribution in firm productivity, our results can be reinterpreted in multi-sector as well as in trade liberalization process and several testable hypotheses can be derived.

#### 3.4.1 Trade Liberalization Effect

Likewise, we can reinterpret Results 4 and 5 as the impact of trade costs reduction in the process of trade liberalization and economic integration. First, the decreased $\phi$ by trade liberalization allows more inefficient $D$-type firms to export, which leads to an increase in the export cutoff level and thus to a decrease in the average export price. Hence, our model implies that trade costs reduction results in a decrease of average export prices over time.

**Result 6:** When trade costs decrease over time as a result of trade liberalization, it allows more and more firms to enter export market, and thus the average export price decreases over time.

#### 3.4.2 Trade Costs in Multi-sector Framework

Finally, we reintroduce a multi-sector framework, $S\in(0,1)$. Since we assume a quasi-linear utility function and a symmetric firm distribution across sectors with neither comparative advantage nor different factor endowments, the basic outcomes can be applied in a multi-sector framework.

Since one sector is perfectly independent of all the others from the supply and demand sides, introducing a multi-sector framework is innocuous to the model. Keeping this simplicity, we now introduce only the asymmetry in trade costs across sectors. We know that at the disaggregate product level, trade costs vary substantially due to product characteristics. The trade costs difference across products is likely to be much larger than within a certain product. Owing to the simplicity of our basic model, the above-mentioned results can be re-interpreted. The product (sector) with high trade costs faces high export average prices; whereas the product (sector) with low trade costs allows more firms to enter export markets and thus has lower average prices.

**Result 7:** Due to product characteristics, products (sectors) with high trade costs have high export prices, while the products (sectors) with lower trade costs have lower export prices. As a result, the composition of trade changes with distance towards products with lower trade costs.
4. Empirical Evidence

4.1. Data

In order to test our model empirically, we use detailed trade data for exports of manufactured goods of fifteen EU countries for the years 1995 to 2004. We define manufactured goods as all products ranging from subheading 811300 to 961800 (HS1992). 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 goods like for example ‘aircraft propellers, rotors and parts thereof’ (880310) to ‘spades and shovels’ (820110). We have chosen manufactured goods since they offer the biggest variety of goods and since the sectors included in this group are the less distorted by special provisions, like the Common Agriculture Policy for the agricultural sector.

The fifteen EU countries are all Members of the European Union during the time period covered by our sample. The countries are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Spain, Sweden, and United Kingdom. In the focus of the empirical analysis in this section are the trade flows in manufactured goods among these 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 sample to EU trade allows us to analyze the role of quality for trade between countries that have similar factor endowment, 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 much the variations within a country and it is far smaller than for other country groups, like Asian or South American countries. Furthermore, the main economies within this group, mainly Germany, France, Italy, Spain, and the UK, which produce 87 % of EU’s GDP, are very similar in all three aspects.

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 GDP vary from 32 billion US Dollars in the case of Luxemburg to 274 billion in the case of Germany for the year 2004.

The period 1995 to 2004 was marked by a further integration of the EU internal market. The most visible step towards a unified market has certainly been the introduction of the Euro as official currency in 1999. Two years later, euro coins and notes entered into circulation in the twelve participating Member States, namely Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain. The introduction of the Euro facilitated commercial exchanges between Member countries, even though the precise amount of the positive effect is still a topic of active debate (Baldwin, 2006). But also other measures, like the Schengen Agreement that eases the movements of persons across borders, contributed to the integration process. For our model further integration translated into a reduction of non-tariff barriers and thus a decrease in trade costs.
Estimating the quality level of export 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 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 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 3 & 4). Third, market size effects are analyzed (Result 5). Fourth, we verify the claim that quality and the number of trading partners are related. Finally, we look at the effects of trade liberalization.

4.1. 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 (Av. 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 worrying 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 (2002, MANUFACTURED GOODS)

<table>
<thead>
<tr>
<th>SCTG Commodity description</th>
<th>Domestic Shipm. Value</th>
<th>Av. U.V.</th>
<th>Foreign Shipm. Value</th>
<th>Av. U.V.</th>
<th>Diff. (%)</th>
</tr>
</thead>
<tbody>
<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>104.83</td>
<td>+754.83</td>
</tr>
<tr>
<td>39 Furniture, mattresses &amp; mattress supp., lamps, lighting 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>
<tr>
<td>41 Waste and scrap</td>
<td>37,896</td>
<td>0.17</td>
<td>5,170</td>
<td>0.46</td>
<td>+165.58</td>
</tr>
</tbody>
</table>

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 the export value, 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.

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.

Table 3: UNIT VALUE COMPARISON OF DOMESTIC SHIPMENTS AND EXPORTS (HS 8301, HS 8803)

<table>
<thead>
<tr>
<th>Importer</th>
<th>Padlocks, locks, claps with locks, and keys (HS 8301)</th>
<th>Parts of aircraft, spacecraft, etc. (HS 8803)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>47.96 +680.97 1.64 Denmark</td>
<td>1.64 Netherlands</td>
</tr>
<tr>
<td>Austria</td>
<td>44.67 +627.48 1.99 Ireland</td>
<td>1.99 Japan</td>
</tr>
<tr>
<td>Sweden</td>
<td>34.50 +461.80 2.32 Finland</td>
<td>2.32 Sweden</td>
</tr>
<tr>
<td>Spain</td>
<td>30.74 +400.54 6.57 Sweden</td>
<td>6.57 Sweden</td>
</tr>
<tr>
<td>U.K.</td>
<td>23.36 +280.48 15.00 Denmark</td>
<td>15.00 Denmark</td>
</tr>
<tr>
<td>Greece</td>
<td>23.20 +277.83 1.28 France</td>
<td>1.28 France</td>
</tr>
<tr>
<td>Japan</td>
<td>22.99 +274.48 38.05 Germany</td>
<td>38.05 Germany</td>
</tr>
<tr>
<td>Belgium</td>
<td>22.00 +258.23 2.36 Japan</td>
<td>2.36 Japan</td>
</tr>
<tr>
<td>Italy</td>
<td>21.94 +257.38 11.37 Canada</td>
<td>11.37 Canada</td>
</tr>
<tr>
<td>Netherlands</td>
<td>21.56 +251.15 4.01 Austria</td>
<td>4.01 Austria</td>
</tr>
<tr>
<td>Finland</td>
<td>20.80 +238.68 1.27 Italy</td>
<td>1.27 Italy</td>
</tr>
<tr>
<td>Portugal</td>
<td>20.48 +233.53 1.16 Portugal</td>
<td>1.16 Portugal</td>
</tr>
<tr>
<td>Canada</td>
<td>17.21 +180.27 6.96 Belgium</td>
<td>6.96 Belgium</td>
</tr>
<tr>
<td>Germany</td>
<td>15.75 +156.50 19.38 Spain</td>
<td>19.38 Spain</td>
</tr>
<tr>
<td>Ireland</td>
<td>13.25 +115.75 1.15 United Kingdom</td>
<td>1.15 United Kingdom</td>
</tr>
<tr>
<td>Luxemburg</td>
<td>-          - 0.21 Luxemburg</td>
<td>- 0.21 Luxemburg</td>
</tr>
</tbody>
</table>

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, the table 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 small countries have the higher unit values than big economies. Empirical evidence of a positive relationship between the GDP ratio and the quality level would support the model’s prediction. In section 4.3, this hypothesis is tested more thoroughly.

4.2. Trade Costs and the Quality Level

Our model of section 3 claims that with increasing trade costs the quality level of trade flows raises. 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 increasing trade costs. The consumer at the final destination then starts preferring the higher quality goods since it becomes more and more inexpensive compared to low quality goods. In contrast, the model in this paper assumes that high quality producers face lower beachhead cost, which allow them to penetrate more easily export markets.

The outcome of both approaches is similar. The effect of the type of beachhead costs in our model is the same as the effect of per unit trade cost underlying the reasoning of Alchian and Allen (1964). Our model might been 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 is raising with increasing trade costs. 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 a 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 are able to overcome increasing trade costs.

Even though both model types seem to yield contradicting predictions, we are able to reconcile both. 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.

---

20 We may recall that traditional trade models assume that the unit value is not related to distance.
21 We take the great-circle formula and a more sophisticated approximation (based on the economic geography of a country) to estimate the distance between countries.
In order to test empirically for results 3 (Alchian-Allen effect), the following functional form might be specified:

\[ p_{ijk} = \alpha + \beta \text{dist}_{ij} + \gamma_k \text{prod}_k + \mu_{ij} \]

In this equation, \( p_{ijk} \) denotes the logarithm of the unit value exported from country \( i \) to country \( j \) of product group \( k \); \( \text{dist}_{ij} \) measures the logarithm of distance between country \( i \) and country \( j \). The parameters \( \alpha_k \) and \( \beta \) are to be estimated together with product fixed effects, \( \gamma_k \text{prod}_k \). \( \mu_{ij} \) denotes a Gaussian white noise error term. Our model would predict a positive relationship between the unit values, which measure quality, and distance, which approximate trade costs.

It is not reasonable to estimate this equation with simple OLS, since the absolute values of unit values vary substantially across product groups. 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 applied.\(^{22}\) The hypothesis to be tested is whether the unit value within each product group increases with distance. In order to make the increase of the bolts quality and of medical instruments with distance comparable, we need to control for product specific effects which requires substantial computational power.

A more elegant way to estimate the effect of trade costs on distance is to work with deviations from the mean. Similar to Hummels and Skiba (2004)\(^{23}\) we work with the following functional form:

\[ p_{ijk} - \bar{p}_{ki} = \alpha + \beta (\text{dist}_{ij} - \bar{\text{dist}}_{ki}) + (\mu_{ijk} - \bar{\mu}_k). \]

If the Alchian-Allen effect holds, then the distance deviation from the mean of each product group \( k \) should be positive. It would indicate that quality and trade costs are positively correlated. Since country specific effect might also influence the result, we further use fixed effect for importing and exporting countries.

Column (1) of Table 4 documents the regression results when all 641624 export flows from 15 EU countries towards 173 countries in the world (including the 15 EU countries) are taken into account. The regression yields a highly significant distance

\(^{22}\) 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.

\(^{23}\) 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 than 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 the estimation.
coefficient 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. Finally, in the last columns (3) and (4) the sample only includes trade flows within the EU 15. Whereas in column (3) we use the simple great-circle distance, in column (4) the population weighted distance is applied. The distance coefficients become smaller now, but are still of substantial magnitude and again highly statistically significant.

Table 4: QUALITY TRADE (MANUFACTURED GOODS, 6 DIGIT HS 1992)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.05</td>
<td>0.237***</td>
<td>0.232***</td>
<td>0.259***</td>
</tr>
<tr>
<td></td>
<td>(62.614)</td>
<td>(0.025)</td>
<td>(0.025)</td>
<td>(0.025)</td>
</tr>
<tr>
<td>Distance</td>
<td>0.149***</td>
<td>0.153***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.004)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weighted Dis.</td>
<td>0.144***</td>
<td>0.172***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.005)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Est.</td>
<td>FE</td>
<td>FE</td>
<td>FE</td>
<td>FE</td>
</tr>
<tr>
<td>Obs.</td>
<td>641624</td>
<td>165455</td>
<td>148371</td>
<td>148371</td>
</tr>
<tr>
<td>Products</td>
<td>1360</td>
<td>1357</td>
<td>1356</td>
<td>1356</td>
</tr>
<tr>
<td>R²</td>
<td>0.024</td>
<td>0.030</td>
<td>0.013</td>
<td>0.013</td>
</tr>
</tbody>
</table>

In Table 5 we have listed the regression results for all 15 EU countries individually. One observes that the distance coefficients vary substantially from country to country, ranging from 0.312 in the case of the Portugal to 0.016 in the case of Sweden. All coefficients are positive and statistically significant, except of the case of Germany, Greece, Italy, the Netherlands, Sweden, and the UK. It seems to be a tendency that smaller economies have higher distance coefficient 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 (MANUFACTURED GOODS, YEAR 2004)

<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>C</td>
<td>-0.03</td>
<td>-0.075</td>
<td>-0.013</td>
<td>-0.091*</td>
<td>0.123*</td>
<td>-0.021</td>
<td>-0.044</td>
<td>0.240**</td>
</tr>
<tr>
<td></td>
<td>[0.036]</td>
<td>[0.049]</td>
<td>[0.044]</td>
<td>[0.053]</td>
<td>[0.066]</td>
<td>[0.087]</td>
<td>[0.162]</td>
<td>[0.109]</td>
</tr>
<tr>
<td>Wei. Dis.</td>
<td>0.126*</td>
<td>0.241***</td>
<td>0.262***</td>
<td>0.454***</td>
<td>0.215**</td>
<td>0.027</td>
<td>0.084</td>
<td>0.218***</td>
</tr>
<tr>
<td></td>
<td>[0.066]</td>
<td>[0.045]</td>
<td>[0.042]</td>
<td>[0.050]</td>
<td>[0.087]</td>
<td>[0.110]</td>
<td>[0.159]</td>
<td>[0.033]</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>0.008</td>
<td>0.058</td>
<td>0.041</td>
<td>0.051</td>
<td>0.021</td>
<td>0.012</td>
<td>0.007</td>
<td>0.025</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>ITA</th>
<th>LUX</th>
<th>NET</th>
<th>POR</th>
<th>ESP</th>
<th>SWE</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-0.038</td>
<td>-0.127**</td>
<td>-0.033</td>
<td>0.265**</td>
<td>0.026</td>
<td>-0.009</td>
<td>-0.071</td>
</tr>
<tr>
<td></td>
<td>[0.074]</td>
<td>[0.057]</td>
<td>[0.069]</td>
<td>[0.111]</td>
<td>[0.049]</td>
<td>[0.044]</td>
<td>[0.121]</td>
</tr>
</tbody>
</table>

24 The R² reported do not correspond to ordinary OLS R², since we estimate a fixed-effect model.
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.

4.3. Market Size Effect

Our model yields the prediction that market size is positively correlated with the average price of exports (Result 5). Intuitively, we know that firms in the larger market find it less attractive to export due to the smaller demand in the export market. As a consequence, in the larger market only high quality firms are willing to export. The market size of an economy should therefore be positively correlated with the average export price.

To test this result empirically, a measure of market size needs be included in the estimation, which then takes the following form:

\[ p_{ijk} - \bar{p}_i = \alpha + \beta (dist_{ij} - \bar{dist}_i) + \gamma (ms_i - ms_j) + (\mu_{ijk} - \bar{\mu}_i) \]

A country’s GDP might constitute the most appropriate measure of 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 exporting and importing unit of both variables. Since country specific effect might also influence the result, we further use fixed effect for importing and exporting countries.

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 6: MARKET SIZE EFFECT IN THE EU (MANUFACTURED GOODS, 6 DIGIT HS 1992)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.124***</td>
<td>0.073***</td>
<td>0.148***</td>
<td>0.097***</td>
</tr>
<tr>
<td></td>
<td>[0.023]</td>
<td>[0.023]</td>
<td>[0.023]</td>
<td>[0.023]</td>
</tr>
</tbody>
</table>

Notes: FE stands for fixed effects regressions; ***, ** denotes significance at the 1 %, 5 %, and 10 % level, respectively; robust standard errors in parentheses.
Table 7: MARKET SIZE EFFECT BY COUNTRY (MANUFACTURED GOODS, 6 DIGIT HS 1992)

<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>C</td>
<td>0.013</td>
<td>-0.059*</td>
<td>0.248***</td>
<td>0.187**</td>
<td>0.056*</td>
<td>-0.055***</td>
<td>-0.016</td>
<td>0.119*</td>
</tr>
<tr>
<td></td>
<td>[0.033]</td>
<td>[0.034]</td>
<td>[0.038]</td>
<td>[0.073]</td>
<td>[0.032]</td>
<td>[0.015]</td>
<td>[0.132]</td>
<td>[0.068]</td>
</tr>
<tr>
<td>Weig. Dis.</td>
<td>0.126*</td>
<td>0.241***</td>
<td>0.262***</td>
<td>0.454***</td>
<td>0.215**</td>
<td>0.027</td>
<td>0.084</td>
<td>0.218***</td>
</tr>
<tr>
<td></td>
<td>[0.066]</td>
<td>[0.045]</td>
<td>[0.042]</td>
<td>[0.050]</td>
<td>[0.087]</td>
<td>[0.110]</td>
<td>[0.159]</td>
<td>[0.033]</td>
</tr>
<tr>
<td>GDP Ratio</td>
<td>0.019***</td>
<td>-0.029</td>
<td>0.112***</td>
<td>0.080***</td>
<td>0.016</td>
<td>0.045*</td>
<td>-0.073</td>
<td>0.070***</td>
</tr>
<tr>
<td></td>
<td>[0.009]</td>
<td>[0.030]</td>
<td>[0.015]</td>
<td>[0.028]</td>
<td>[0.010]</td>
<td>[0.025]</td>
<td>[0.057]</td>
<td>[0.025]</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>1295</td>
<td>1233</td>
<td>1310</td>
<td>1006</td>
</tr>
<tr>
<td>R²</td>
<td>0.008</td>
<td>0.058</td>
<td>0.041</td>
<td>0.051</td>
<td>0.021</td>
<td>0.012</td>
<td>0.007</td>
<td>0.025</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>ITA</th>
<th>LUX</th>
<th>NET</th>
<th>POR</th>
<th>ESP</th>
<th>SWE</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.024</td>
<td>-0.093</td>
<td>0.031</td>
<td>0.174**</td>
<td>0.099***</td>
<td>-0.021</td>
<td>0.048</td>
</tr>
<tr>
<td></td>
<td>[0.063]</td>
<td>[0.090]</td>
<td>[0.050]</td>
<td>[0.072]</td>
<td>[0.027]</td>
<td>[0.020]</td>
<td>[0.037]</td>
</tr>
<tr>
<td>Distance</td>
<td>0.167</td>
<td>0.132***</td>
<td>0.112*</td>
<td>0.432***</td>
<td>0.364***</td>
<td>0.01</td>
<td>0.118</td>
</tr>
<tr>
<td></td>
<td>[0.131]</td>
<td>[0.032]</td>
<td>[0.061]</td>
<td>[0.059]</td>
<td>[0.075]</td>
<td>[0.035]</td>
<td>[0.133]</td>
</tr>
<tr>
<td>GDP Ratio</td>
<td>0.066***</td>
<td>-0.043*</td>
<td>0.121***</td>
<td>0.055**</td>
<td>0.085***</td>
<td>-0.037***</td>
<td>0.066***</td>
</tr>
<tr>
<td></td>
<td>[0.010]</td>
<td>[0.025]</td>
<td>[0.011]</td>
<td>[0.027]</td>
<td>[0.018]</td>
<td>[0.009]</td>
<td>[0.013]</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>R²</td>
<td>0.018</td>
<td>0.016</td>
<td>0.023</td>
<td>0.036</td>
<td>0.025</td>
<td>0.013</td>
<td>0.010</td>
</tr>
</tbody>
</table>

Notes: FE stands for fixed effects regressions; ***,**,* denotes significance at the 1 %, 5 %, and 10 % level, respectively; robust standard errors in parentheses.

Table 6 and 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. The estimated coefficients reveal that market size is positively correlated with quality. There seems to be evidence that the market size differences affect the quality composition of trade via the competition effect described above.

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 of Sweden recording a negative coefficient.
4.4. Measurement Error and Trade Partner Effect

We have already used different distance measures and different samples 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: $1358 \times 15 \times 14 = 285180$. 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 extremely 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. It becomes therefore crucial to think about the predictions of our model in the case of very high trade costs.

Let us first consider the case of a country, for which we do not observe any trade relations with other countries due to high trade costs and therefore very small actual trade flows that do not appear in the data. As seen in the previous discussion, higher trade costs result in less exporters. Above a critical level of trade costs this mechanism translates into the observation of zero-trade flows. (Rigorously, the highest quality producers ($a=0$) are always indifferent between exporting and not exporting because the pure profit is zero due to the infinitive marginal costs and marketing costs are zero.)

Empirically, a country is likely to have many missing trade relations with those partners that are located at a substantial geographical distance. As a result, the estimation of the average export price for these countries becomes downward biased since only the trade flows towards closer destinations are taken into account. The large number of missing trade partners decreases the observed average export price. In empirical estimations, we should find that the number of trade partners is negatively correlated with the average export price. In addition, as the foreign market size becomes smaller, countries are less likely to be trade partners. In other words, the critical level of trade costs for observed non-trade is higher the smaller the market size of the exporting country.

An appropriate way to include zero-trade flows in the estimation is by using 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. Running a two-step Heckman model for the same specifications as in section 4.2 and 4.3, we obtain the results reported in Table 8. The Heckman estimation confirms the results found earlier.
Another way to test for the robustness of our results is to study whether the number of trade relations decreases, as the distance between trade partners increases (decrease in $\phi$). This effect is accentuated if the country has a large domestic demand. If the large country is located sufficiently distant, no trade will occur with smaller countries.

Result 7 claims that the number of trading partners is negatively correlated to the average price of an exported good. The reason is that when trade costs are small due to proximity more firms enter the export market and drive quality down. The empirical test of this hypothesis requires the counting of trading partners of each reporting country for each product. The average price of a product is supposed to be smaller the higher the number of trading partners.

Table 9: TRADE PARTNER EFFECT

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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</tr>
</thead>
<tbody>
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<td>C</td>
<td>1.208***</td>
<td>0.725***</td>
<td>0.764***</td>
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<td>[0.057]</td>
<td>[0.056]</td>
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<td>-0.099***</td>
<td>-0.085***</td>
<td>-0.085***</td>
</tr>
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<td>[0.009]</td>
<td>[0.010]</td>
<td>[0.010]</td>
<td>[0.010]</td>
<td>[0.010]</td>
</tr>
<tr>
<td>Distance</td>
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<td>0.118***</td>
<td>0.147***</td>
<td>0.147***</td>
<td></td>
</tr>
<tr>
<td></td>
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<td>[0.005]</td>
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<td>[0.006]</td>
<td></td>
</tr>
<tr>
<td>GDP Ratio</td>
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<td>0.020***</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>[0.003]</td>
<td>[0.003]</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Obs.</td>
<td>148371</td>
<td>148371</td>
<td>148371</td>
<td>148371</td>
<td>148371</td>
</tr>
<tr>
<td>Product</td>
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<td>1356</td>
<td>1356</td>
<td>1356</td>
<td>1356</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.009</td>
<td>0.014</td>
<td>0.014</td>
<td>0.014</td>
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</tbody>
</table>

The empirical evidence suggests that the number of trading partners can indeed be explained by the possibility to produce products with high average unit values. Products with low average unit values are exported to a smaller number of countries than products with higher average unit values. This observation may help us to answer the question why certain countries trade with each other or not. If developing countries

32
produce products with high trade costs and in addition are located far from majors markets, the trade costs become prohibitive for exports.

Table 9 summarizes the regression results when different specifications are applied. Over all, the results demonstrate that there is a strong negative relationship between the number of trading partners and the quality level.

The results presented above corroborate the model predictions and thus the Alchian-Allen effect. They also state that trade cost shape to a large extent the content of exports. If trade costs are indeed pivotal to the trade pattern, then it might be important to study the difference in trade costs between product groups.

Pooling all observations and looking at the relative change in unit value due to trade costs (distance and other variables), gives us an additional important piece of information. Imagine a country, in which two types of dental instruments are produced (HS 901841 and HS 901849). Assume that the country produce only two low quality levels of medical instruments of type HS 901841, but many different quality levels of type HS 901849. The basic estimation from above would now yield the result that for each product group the relative unit value increases with distance. This approach, however, misses the fact that the low quality goods HS 901841 will be exporter two fewer destinations than the HS 901849 goods. Why is this important?

It helps us to understand why the content of trade might change with distance. If trade costs influence the content of trade flows via the Alchian-Allen effect, then we might also expect that trade costs change the content of trade 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. The average unit value gives us some insight about the relative vertical price position of each product group. Second, we take the mean distance that each product group is traded. For our estimation we simply regress the logarithm of the average unit value on the logarithm of the mean distance. Why does this approach make sense?

If only the quality 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. This means, the lower average unit value product groups are exported towards closer destinations than high average unit value product groups.
Table 10: COMPOSITION EFFECT

<table>
<thead>
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</thead>
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<tr>
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<td>[0.060]</td>
<td>[0.060]</td>
<td>[0.071]</td>
<td>[0.071]</td>
</tr>
<tr>
<td>GDP ratio</td>
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<td>0.005</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.021]</td>
<td>[0.020]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obs.</td>
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<td>16661</td>
<td>16661</td>
<td>16661</td>
</tr>
<tr>
<td>Product</td>
<td>1358</td>
<td>1358</td>
<td>1358</td>
<td>1358</td>
</tr>
<tr>
<td>R²</td>
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<td>0.112</td>
<td>0.112</td>
<td>0.112</td>
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</tbody>
</table>

The estimation results presented in Table 10 suggest that the composition of trade indeed changes with distance. Lower quality goods get replaced by higher quality goods as distance increases. Remarkably, the distance coefficient is now stronger than before. As a consequence, the sorting seems to take place at a faster pace than within product groups.

### 4.5 Trade Liberalization Effect

Trade liberalization leads to a reduction in trade costs. As described above, in the period under consideration the EU made several steps towards a more unified market. Our model predicts that the average price of exports (quality) drops with a decrease in trade costs since lower quality firms are now able to enter the export market. At the same time, the number of trade relations should raise since more and more export destinations become in reach of exporting firms.

In order to show the evolution of average prices over time, we calculate the average unit price over all subheadings for each year from 1995 to 2004. It is important to note that since the unit values are in absolute terms, one need to correct for changes in exchange rates as well as for inflation. Since the trade flows are reported in current US Dollars, which showed some major exchange rate fluctuations towards the European currencies over this time period, an exchange correction is applied. Furthermore, we corrected for inflation using the EU consumer price index.

The evolution of the average unit price in manufactured goods is depicted in Figure 7. As predicted by the model, the unit price decreases over most of the time period under consideration. The last three years, however, there seem to be a reverse trend. Did the integration come to an end? It is certainly true that from 2002 onward the enlargement was not any more negotiated, but prepared by all actors involved in the process. The EU economies might have re-oriented their trade flows towards new destinations in the new member states.
As expected, the number of overall trade relations follows the opposite trend and increases each year. The effects of trade liberalization cannot only been analyzed with respect to the average unit price and trading partners, but also by studying the evolution of the main variables introduced above. As trade costs come down, the coefficient of the distance variable will also fall.

Table 4: THE EVOLUTION OF QUALITY TRADE IN THE EU (MANUFACTURED GOODS)

<table>
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<td>[0.017]</td>
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<td>[0.033]</td>
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<tr>
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<td>0.201***</td>
<td>0.177***</td>
<td>0.192***</td>
<td>0.182***</td>
<td>0.189***</td>
<td>0.193***</td>
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<td>0.195***</td>
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<tr>
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<tr>
<td>Prod.</td>
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<td>1325</td>
<td>1325</td>
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</tr>
<tr>
<td>R²</td>
<td>0.065</td>
<td>0.05</td>
<td>0.055</td>
<td>0.066</td>
<td>0.074</td>
<td>0.076</td>
<td>0.078</td>
<td>0.073</td>
<td>0.077</td>
<td>0.078</td>
</tr>
</tbody>
</table>

Notes: FE stands for fixed effects regressions; ***,**,* denotes significance at the 1 %, 5 %, and 10 % level, respectively; robust standard errors in parentheses.

5. Summary and Conclusion

This paper shows one possibility how to model quality in a heterogeneous firms framework. Our model correctly predicts important features of international quality trade. Many extensions and improvements are possible. For example, the model could be extended by adding dynamics of product innovation. Finally, it has to be noted that we stretch the use of unit value data as far as it can go.
6. References


**Appendix A: 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

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

which means firms "a" make positive profits from export market. Using equation (9),

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

the above condition can be reduced to $a_X^{\sigma-\rho} < a^\sigma$. 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

$$\left(\frac{a_D}{a_X}\right)^{\sigma-\rho} = \frac{f_D \phi}{f_X} 0.5 \left(1 + \left(\frac{a_D^*}{a_D}\right)^\rho\right) \frac{(1-s)/\Delta^*}{s/\Delta}$$

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 $a_X^* < 1$. 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 (7) and (9) as the same.

**Appendix B: 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, as seen in (10). 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, \( \frac{s}{1-s} = \frac{a_D^p}{a_D^p} > 1 \), as shown in section 3.2, \( a_D > a_D^* \) always holds. Equivalently, we get

\[
\frac{B}{B^*} = \left( \frac{s}{\Delta} \right) \frac{\left( \frac{a_D^p}{a_D^p} \right)^{1-\sigma+p}}{\left( \frac{a_D^*}{a_D^*} \right)^{1-\sigma+p}} > 1
\]

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, (8) and (9), we get

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

\( (a_D \) and \( a_D^* \) are assumed to be the same levels as in autarky, 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 (8) and (9), 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 autarky, 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.

Table X: The Evolution of Quality Trade in the EU (Manufactured Goods)

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<th></th>
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<th></th>
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</tbody>
</table>

Notes: FE stands for fixed effects regressions; *** denotes significance at the 1%, 5%, and 10% level, respectively; robust standard errors in parentheses.

Data Appendix

TABLE 1A--Exporting Countries included in the sample

- Austria
- Belgium
- Denmark
- Finland
- France
- Germany
- Greece
- Ireland
- Italy
- Luxemburg
- Netherlands
- Portugal
- Spain
- Sweden
- United Kingdom

TABLE 1A--Countries included in the sample