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Quality in Exports

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Abstract

The measurement of quality is a difficult task given that quality typically is an unobserved product characteristic. In this paper we develop a new "Quality Indicator" based on a structural model with an identifiable quality parameter. We follow the methodology proposed by Di Comité, Thisse and Vandenbussche (2014). This method offers an easy way to generate product-level quality ranks of exported products (manufacturing CN8). Moreover, it overcomes some of the flaws present in other quality measures. The quality metric used here is an improvement over existing ones, since it disentangles quality from cost and taste effects. A failure to do so, results in quality effects that are wrongly identified. Product-level export price data come from Comext (Eurostat) and cost data are obtained from the firm-level database ORBIS. When we apply this method on individual EU countries exports' of products to a common destination, we obtain distributions of "export quality" and its change over time in the period (2007-2011). A striking finding is the large extent of quality dynamics going on in the EU market. We show that quality can run in a different direction than market share i.e. products with the largest market shares, need not have the highest quality. We also estimate a price elasticity of quality which is positive and significant. This suggests that quality upgrading results in a higher willingness to pay by consumers and therefore offers a way to escape cost competition.

JEL Classification: D43, F12.
Keywords: Quality measurement, country-product data, European market.

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EXECUTIVE SUMMARY

In this paper we develop a new “Quality Indicator” based on the methodology proposed by Di Comité, Thisse and Vandenbussche (2014). Using this "export quality" indicator we rank EU countries and manufacturing industries in terms of their quality position in the integrated EU market and its change over time between (2007-2011). The quality metric ranks products in a common destination market, which for our purposes is the EU15 market. Once we identify the quality rank of each product being exported by EU member states and their world competitors, we identify the quality distribution of each member state, and investigate its tails, such as the top percentile of the quality distribution and aggregate them by exporting country/industry.

The disaggregate nature of our data also allows us to get an estimate of the “price elasticity of quality rankings” which is strongly positive. Similar to Khandelwal (2010), we find that an increase in quality raises the willingness-to-pay for products *more* in product markets characterized by a long quality ladder, where a quality ladder is defined as the high-to-low difference in quality in a product market. The quality metric used here is an improvement over existing ones, since it allows for a distinction of quality by separating it from cost and taste effects.

While quality is an important determinant of competitiveness, it is not the only one. This becomes clear when we compare country rankings based on the market share distribution of their products versus country rankings based on quality distributions.

Below we summarize a number of results obtained.

- Rankings of countries in terms of average market shares are very stable over time.
- Germany is a country with high market shares in levels and growth rates, but is not a quality leader on the EU15 market.
- Japan is a country with relatively low market shares in the EU15 but with a clear quality edge in many of its export products.
- China is a country with high market shares in the EU15 but ranks at the very bottom of the quality ladders.
- Based on the averages of the market share distributions, China's position has increased faster than any other country between 2007-11.
- Based on the average of the quality distribution, the “Nordic” countries, Finland, Sweden and Denmark feature at the top of quality ranks of EU countries.
- Based on the number of top quality products (right-tail of quality distribution), France leads the quality rankings amongst EU member states.
- Belgium, Portugal and Spain have recently fallen in their quality rankings compared to before the crisis.
- The Netherlands exports a relatively *low* number of top quality products to the EU market, but ships high values in them. Its growth in average market shares across products exceeds that of any other EU country.
- New EU member states have a bimodal quality distribution, with many low quality products and a lower number of high quality products.
- New EU member states engage most in quality upgrading of products and are moving out of low quality products, in favour of high quality ones.
- Top quality products are typically “niche products” that have a smaller market for them than low quality products.
- The price elasticity of quality is positive and significant and lies around 0.5.
- An increase in quality raises the willingness-to-pay and more so in industries with long quality ladders.

While not pursued here, quality ladders can also be studied at the sectoral level, by taking the average of product ladders within a particular industry. Quality ladders can then be regressed on a number of industry characteristics such as the skill intensity of workers, the capital intensity and total factor productivity of firms.

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I. INTRODUCTION

The purpose of this paper is twofold. First, we want to assess what is the position of each member state in terms of market shares and its dynamics in the EU market.

We consider for each country, the distribution of market shares of all its exported products, with a product defined at its most disaggregate level (CN8). Thus, for each product sold in the EU market, we will consider the market share distribution and its shifts over time by all the important players on the EU market which consist of all the EU member states and their world competitors (China, US and Japan). EU member states and their world competitors together represent over 90% of all sales in the EU market and can be considered representative to allow for the assessment of relative market share positions and changes.

Second, we want to go deeper in our understanding of export performance by considering the role of quality. While market shares distributions across EU member states are useful to assess the overall export performance of a country, it does not necessarily tell us anything about the type of goods that a country is exporting. Market shares of products are typically the result of a combination of costs, quality and a taste for the product involved.

For policy makers and their decision-making it may be important to know whether a country is obtaining high market shares from low quality products, or from high quality products. To address this, we also consider the quality of export products. This is not a trivial issue, since quality is unobservable and difficult to measure.

The methodology we use to determine quality of products has been developed by di Comité, Thisse and Vandenbussche (2014).([1]) In short, this newly developed methodology moves beyond prices as an indicator for quality at product-level but argues in favour of a markup concept where both prices, variable costs and competition effects are considered necessary for the computation of quality ([2]). In the absence of variable cost information, high prices could be driven either by high variable cost and/or high quality but cannot be disentangled.

Quality can be an important way to escape cost competition. Higher quality typically raises the willingness-to-pay of consumers and may result in higher markups. ([3]) Via rent-sharing, high markup industries can pay higher wages to their workers and have more leeway to engage in innovation. Thus, the creation of quality, also referred to as vertical product differentiation, offers an opportunity for firms and countries to escape cost competition and to sustain employment and higher wages.

This note will reveal which EU member states are exporting low quality products and which EU member states are selling high quality products where we compare quality within narrowly defined product-markets. In addition, our approach also allows us to look at quality dynamics by looking at the "stability" of quality rankings in the EU market of exported products. The quality dynamics analysis will tell us which countries are upgrading quality towards more high quality products and which countries are losing their quality positions. Characteristics of the distribution of quality rankings will be used to benchmark all EU member states against each other and their world competitors.

The quality measure that we develop and use is a measure that relies on a comparison of varieties and their quality in a common destination market for reasons laid out in di Comité, Thisse and Vandenbussche (2014). Our choice for the EU15 market as the common destination market in which we evaluate the quality and quality rankings of products, is inspired by the fact that EU countries still orient the majority of their exports to this destination market. Limited data availability for other destinations is another reason why we focus on the EU in this paper.

([1]) di Comite et al (2014),"Verti-zontal Differentiation in Export Markets", Journal of International Economics, May, vol. 93.

([2]) Since we will be using quality ranks, competition effects affecting similar varieties in the same destination cancel out.

([3]) We define a markup here as the difference between the unit price and the variable (proxy for marginal) cost per unit where variable costs consists of the sum of materials (intermediates) used in production and labour costs.

While the EU market is a convenient destination market to consider, the di Comité, Thisse and Vandenbussche (2014) approach is not restricted to one market but can be applied to any common destination market in which there are competing varieties, provided cost information at product-level can be obtained.

The analytical results presented in this study will immediately raise the important policy question of whether EU member states that specialize in low quality products have a sustainable strategy for the future. The results obtained on the price elasticity of quality indeed suggest that countries can escape cost competition through quality upgrading.

The rest of the report is structured as follows.

The next section II compares quality metrics currently used in literature and their limitations. In section III we explain the theoretical model by Di Comité et al (2014) on which our quality metric is based. In section IV, we illustrate the methodology with an example and discuss our data. Section V starts by considering market share distributions. Section VI then continues with quality distributions by country. In section VII, we estimate the price elasticity of quality. Section VIII considers quality ladders and how the price elasticity of quality changes. Finally section IX concludes with some policy aspects.

II. QUALITY MEASUREMENT: WHAT APPROACH TO CHOOSE?

Currently, there are several alternative approaches to quality measurement in the literature.

The first approach to quality measurement is based on "constant elasticity of substitution" (CES) (or nested CES) utility functions. The CES function, which is very popular for its mathematical elegance, also holds serious limitations, especially for the identification of quality and taste factors in product demand. Earlier contributions on quality measurement using CES type of utility functions can be found in Feenstra (1994), Broda and Weinstein (2006) and more recently also Baldwin and Harrigan (2011).

A policy paper by Benskovskis-Worz (2012), builds on this earlier literature and estimates quality using a CES approach. But as Benskovkis and Worz (2012) correctly point out in their conclusions: "*the (CES) estimation procedure is limited to a common elasticity of substitution between all products, which is too simplistic…(since) it is likely that the substitution elasticity is overestimated which in turn leads to excessive volatility on quality*…".

This renders the CES-type of quality measurement questionable for accurately measuring quality.

A second approach to quality measurement is the Khandelwal (2010) method, which is based on a discrete choice framework and is being used quite often in the literature. But Anderson, Palma and Thisse (1992) pointed out that the discrete choice framework is mathematically very similar to a CES type of demand structure. Thus, quality estimates based on this framework will suffer from the same limitations as the CES based quality estimates, making it less suitable for quality measurement.

A third and new approach for quality measurement has been developed recently by di Comité, Thisse and Vandenbussche (2014). This paper aims to address some of the limitations of the CES approach to measurement of quality. This new approach allows for a clean theoretical separation of quality from taste effects in trade, which cannot be achieved under a CES approach. Below we highlight some of the limitations of the CES approach to quality measurement and argue in favour of the di Comité, Thisse and Vandenbussche (2014) approach as an alternative.

In all existing trade models, a high quality variety (everything else equal) faces a demand that lies further out than the demand for a low quality variety of the same good. Quality represents a parallel and outward shift of the demand curve, which always results in a higher price i.e. a higher willingness to pay for the high quality variety than for the low quality variety. For equal prices, high quality goods thus have a higher market share.

This is also true in the Khandelwhal (2010) discrete choice approach. In models characterized by parallel demand shifters only, it makes sense to identify high quality goods by their market share. In other words, when we have equal prices, the variety with the higher market share must have the higher quality, which is the metric that Khandelwal (2010) developed and that many nowadays use in the literature.

However, the Khandelwal (2010) approach overlooks the fact that in addition to parallel slope shifters, demand can also shift out due to slope shifters that also affect export market shares but do not represent quality shifts. Di Comité, Thisse and Vandenbussche (2014) allow for both parallel and slope shifters in their demand structure. While the parallel shifters represent quality, they show that the slope shifters in demand, correspond to taste shifts or horizontal differentiation of varieties.

Suppose that a firm exports the same quality good to all its destinations, but that consumers in different countries have a different "taste" for the product. The product may be well-liked in some countries but not so well-liked in others. To model this country-heterogeneity in taste effects, one needs slope shifters i.e. shifters of demand that allow for the demand of the same quality variety to vary by destination country but in such a way that market price and the willingness-to-pay are not affected, but market shares are.

Thus, allowing for additional slope shifters as in di Comité, Thisse and Vandenbussche (2014), implies that differences in market shares between varieties of the same good, can now be decomposed into market share shifts due to quality, versus market share shifts due to taste. In other words, when comparing the market shares of two different quality varieties in the same destination country, a vertical demand shifter will account for the quality differences between varieties, while the slope shifters will account for the "taste" for each of these quality varieties in the destination country.

A failure to account for slope shifters in demand, therefore can result in a very distorted measure of quality, given that one may wrongly attribute any market share shift, to quality. This would imply ruling out strong taste effects, which, as shown by di Comité, Thisse and Vandenbussche (2014) increase demand for a variety but without affecting its price.

What is now crucial to understand in order to differentiate the existing approaches to quality measurement is that with an approach that only allows for parallel shifts in demand, such as Benskovkis-Worz (2012) and Khandelwal (2010) and others, all the changes in market shares, with equal prices will be attributed to quality. This may result in a very biased estimate of quality.

A discrete choice model has the same limitation. In a discrete choice model, a stronger "taste" for a product also results in a higher price for that product. This suggests that the "taste" parameter in this model does not only incorporate horizontal attributes but must be a mixture of horizontal and vertical attributes that cannot be disentangled clearly.

The di Comité, Thisse and Vandenbussche (2014) approach and their definition of horizontal differentiation in a trade model is set in the spirit of the industrial organisation literature (Sutton, 1992) where the distinction between horizontal and vertical differentiation has been more central and are more sharply distinguished. True horizontal attributes do not raise the willingness to pay. Since taste effects are a source of variation of quantities but not of prices, this offers possibilities for empirical identification of taste versus quality that are clearly separated. The empirical evidence presented by di Comite et al (2014) based on Belgian firm-product data, is overwhelmingly in favour of the conclusion that prices and quantities of export products in destination markets are indeed driven by a different set of fundamentals.

To measure quality, the main problem in CES type of frameworks lies on the theory side i.e. quality (vertical) differentiation cannot be separated from horizontal differentiation (taste). Typically, both are captured by the elasticity of substitution, which is assumed constant across varieties. Empirical work has remedied for this by introducing a firm-product specific demand shock that accounts for sales variation of the same firm-product across countries without affecting prices (Bernard, Redding and Schott, 2011). Horizontal differentiation between products in such a CES type of model is then the combination of a constant parameter of substitution and a variable shock at the firm-product level. But because the parameter of substitution also enters the equilibrium price equation, a clear separation of horizontal and vertical differentiation is difficult to attain with the CES. Therefore we need a set of consumer preferences which allows for a clear separation of quality and taste since both shift demand in different ways. Otherwise quality differences between varieties could be confounded with taste differences, and vice versa.

Similarly, a model with only horizontal differentiation (slope shifters only), would not work either because as shown by di Comité, Thisse and Vandenbussche (2014), without quality differentiation, one would wrongly attribute the high sales of high priced varieties within a country entirely to taste differences, which is unlikely. Since quality also affects demand, it should be incorporated in any model in order to allow for a correct identification of taste effects.

Important to note is that while both quality and taste affect the demand for a variety, they may work in opposite directions i.e. a high quality product, may not be well-liked, thus while the higher quality would raise the variety's price, its market share could actually be lower than that of a low quality good when sold at the same price. For example, a high alcohol high quality beer may not be preferred by all beer consumers over a lighter beer. For most consumers, the high alcohol content beer, while recognized to be the higher quality one, may be too strong for most consumers' taste even when sold at the same price. This is just one example where the Khandelwal (2010) metric on quality would clearly provide the wrong answer as to which good is the higher quality one. This metric tends to associate higher quality products with higher market share. But the demand for a variety is ultimately determined by the interplay of the quality and taste and to correctly infer quality from market shares, one has to disentangle the vertical slope shifters from the parallel ones.

Based on the above we prefer to adopt the approach to quality measurement proposed by di Comité, Thisse and Vandenbussche (2014). An additional advantage is also its simplicity in terms of empirical analysis as explained later.

III. THE VERTI-ZONTAL MODEL OF TRADE

The model by di Comité, Thisse and Vandenbussche (2014) has been developed to assess firm performance in export markets using micro-level trade data. ([4]) But we will show that for empirical purposes it can be used at any level of aggregation and also allows us to assess country performance at product-level, which is the approach we follow in this paper.

This model extends the Melitz and Ottaviano (2008) model in which the role of costs was identified to be important to explain price competitiveness and firm heterogeneity. Similar to the canonical models by Melitz (2003) and Melitz-Ottaviano (2008), it continues to assume that firms differ in their productivity (cost), which empirically has been shown to work well in explaining firm *selection* into export markets (Bernard et al, 2003).

But ever since, several empirical studies have pointed out that firm-level cost differences alone cannot explain the variability in firm-sales observed in different export markets. Researchers with access to firm-product level data have noted that even when controlling for firm-productivity still leaves substantial unexplained data variability (Manova and Zhang, 2011; Eaton et al, 2011; Kee and Krishna, 2008; Bernard, Redding, Schott, 2011).

Early theory attempts to include next to costs, additional firm heterogeneity are those models that augment firm differences in productivity, with quality differences (Baldwin and Harrigan, 2011). Quality differences between firms are then introduced as firm-product specific parallel demand shocks. Khandelwal (2010) assigns higher quality to similar products with higher market shares, for equal prices. Thus, several studies point in the direction that next to costs, quality is also another important determinant to assess a firm's competitiveness.

Di Comité, Thisse and Vandenbussche (2014) go a step further and argue that the combination of costs and quality prices, empirically do not offer a sufficient explanation for sales variability observed across countries. The missing source of variation is idiosyncratic at the level of the country-product which they refer to as "taste". Taste differences between consumers may then account for the different performance of the same firm-product in different countries. The parameter in the model that drives the variation in firm-product sales across countries, can be given a clear interpretation in the consumer utility function and can be interpreted as taste.

Di Comité, Thisse and Vandenbussche (2014) argue that a failure to account for taste differences may result in the wrong inferences about how much variation can be explained by quality. The main innovation of this model is that it allows consumer preferences and the resulting demand to vary across countries and across products which is quite novel since earlier models such as Melitz(2003) and Meltiz & Ottaviano (2008) only considered symmetric demand for all products competing in a market.

The structural identification strategy of the quality parameter that we propose in this paper is aimed at identifying un-observable quality at the product-country level as a function of observables. In addition to export prices (proxied by unit values) we also require information on product-level markups, which then allows us to proxy for product-level costs.

Markups are not so readily available and need to be estimated. Several estimation methods exist in the literature that can be considered for this purpose. In this paper we use a simple one, referred to as the "Price-cost margin" method which was proposed by Tybout (2003). This method uses firm-level data on variable input costs and sales which results in a firm-level Lerner Index. ([5])

Thus, as a first step in the creation of a quality indicator we will estimate product-level markups and identify the model's parameters. In a second step, this will then allow for the creation a "relative quality" indicator for each product exported to a common destination market.

([4]) For a more exhaustive exposition of the model, we refer the reader to di Comite, F., J. Thisse and H. Vandenbussche (2014),"Verti-zontal differentiation in monopolistic competition", Journal of International Economics.

([5]) The price-cost margin method is compared to alternative measures of markup measurement available in the literature in Vandenbussche (2012).

Most existing trade models assume symmetric demand for all varieties in all destination markets (i.e. Melitz and Ottaviano, 2008), but here we allow quality to vary between products and taste to vary between countries and products. This implies that each variety (country-product combination) in a destination market is now characterized by a unique demand. This model is labelled "verti-zontal model" of differentiation because it captures both horizontal and vertical differentiation.

The model further assumes a continuum of firms in each exporting country and a representative consumer per destination country. The number of competing products (substitutes) present in a destination market may vary per country as well as the extent to which the products are good substitutes for one another. Thus the "competition effects" which differ per destination market act as another parallel demand shifter for each variety in each market. When there are a lot of good substitute products present in a destination market, the residual demand for a variety being exported to that market will be lower than in a market where there are few good substitutes.([6]), ([7])

III.1. CONSUMER DEMAND

Most existing trade models formulate consumer demand as resulting from a representative consumer per country that is characterized by "love-for-variety", as suggested by Dixit-Stigliz (1977). These consumer preferences imply that a country consumes positive quantities of all varieties on offer in the market. The demand that follows from Dixit-Stiglitz preferences is the constant elasticity of demand (CES).

Instead of assuming a constant elasticity of demand, a linear demand is assumed by di Comité, Thisse and Vandenbussche (2014) which stems from a quadratic utility function. One important advantage of this linear functional form is that the elasticity of demand is allowed to vary along the demand curve. Countries have one representative consumer which displays a "love-for-variety" in each destination country. Also, a large number of competing varieties is assumed to exist in every destination markets. ([8])

This linear demand model was also used by Melitz and Ottaviano (2008). But in their model, each variety sold in a destination market is characterized by the same demand. This demand symmetry in the Melitz-Ottaviano model holds for a particular variety across destination countries as well as between different varieties going to the same destination market.

The model of di Comité, Thisse and Vandenbussche (2014) is characterized by *asymmetry in demand* across varieties and across countries allowing demand to be as flexible as possible.

First, varieties can differ in qualities. Following the literature, a higher quality variety typically has a demand with an intercept on the price axis that is higher. In other words, quality acts like a demand shifter, shifting the linear demand out in a parallel way. This is similar to Baldwin and Harrigan (2011), Eckel and Neary (2006) and others.

Second, consumers' tastes can differ along two lines. First, within a country consumers may like some varieties in the market more than others. Second, this taste preference may vary across consumers in different countries.

A concrete example can clarify this. Imagine that we study the beer market. The model by di Comité, Thisse and Vandenbussche (2014) now allows the representative consumer in one country to prefer "Heineken" beer (Dutch exports) to "Carlsberg" (Danish beer), whereas a representative consumer in another country may prefer "Carlsberg" over "Heineken".

In notational form this results in the following demand curve, where subscript *i* indicates a representative consumer (=destination country *i*)

([6]) The high prices of French wines on the Chinese market are a good example of "low competition effects".

([7]) Empirical findings seem to suggest that unit values go up in distance, which some models ascribe to transport cost specifications (additive transport costs) or to selection effects where firms send their high quality products to more distant markets. Here we put forward an alternative explanation by saying that prices also vary by the competition effect in the destination market which may offset distance effects as in the case of French wines exported to China.

([8]) In fact, the model assumes a mass of varieties in every destination market.

and subscript *s* refers to a particular variety (product) belonging to a wider product market *S* (sector):

$$p_{s,i} = \alpha_s - \beta_{s,i}. q_{s,i} - \gamma. Q_{s,i} \qquad (1)$$

Where $p_{s,i}$ is the unit value of variety s in destination i; α_s is the willingness to pay for the first unit of variety s in desination i; $\beta_{s,i}$ is the slope of the linear demand which varies by variety s and destination i; γ is a parameter of substitutability between varieties and $Q_{S,i}$ represents the consumption of all other varieties available in the differentiated product market in destination i.

The above equation clearly shows that the export price of a variety *s* in destination country *i*, is now assumed to be a function of a parameter, α_s, which is the willingness to pay for the very first unit of variety *s* on the market *i*. In what follows we refer to α_s, as the quality of the variety. ([9])

Di Comité, Thisse and Vandenbussche (2014) show that $\beta_{s,i}$ has a spatial interpretation similar to the "taste mismatch" of a consumer. The slope of the linear demand in this model can therefore be interpreted as the "taste-mismatch" between a consumer's ideal variety and the variety on offer. A flat slope of the linear demand curve points to a variety that is well-liked by local consumers and has a large market size, whereas a steep slope points to the opposite. ([10])

The γ parameter in (1) is similar to Melitz and Ottaviano (2008) ([11]) ([12]) and captures the extent to which varieties are close or distant substitutes from each other from the point of consumption (i.e. different brands of beer are better substitutes for one another than beer and wine). This parameter is not indexed which implies that it is assumed to be constant between varieties in the market and constant across countries. ([13]) Put differently, it is assumed that beer and wine have the same substitutability in every country.

In terms of market structure, the model assumes that firms are monopolistically competitive by setting their price as a monopolist, but at the same time firms strategically react to the average price in the market. In contrast to oligopoly, individual firms do not react to individual prices set by other firms in the market, but firms are characterized by "weak interactions", meaning that they react to market aggregates such as the average price in the market. In other words, when setting a price for its product, a firm is not going to verify the individual prices of all other firms offering a similar product, but instead is going to consider the average price in the market for the product it offers. The model further assumes that firms know that they cannot influence market outcomes since they are atomistically small. They just observe market averages and act upon it.

([9]) This demand function is derived from quadratic preferences where consumer's income is spent on the differentiated good as well as on a numeraire good. The numeraire is like a Hicksian composite good that captures all other goods in the economy. Income effects are assumed to affect the consumption of the numeraire good but not of the differentiated good. This implies that the types of products that we consider in the model are typically goods where the consumption would not be affected much with varying levels of income. This would apply to most consumption goods, where a typical example would be "beers", "chocolates" or other food products. However, we do acknowledge that income differences between countries can affect this parameter. But what has to be kept in mind is that this would affect all goods sold in a richer market in the same direction i.e. the willingness to pay for differentiated goods would all be higher in a richer market. This implies that quality comparisons are best done within the same destination market, but may include a bias when comparing across markets. Ideally to make quality comparisons across destination markets, quality measures should first be cleaned with income effects. The approach we take in this paper is to limit quality comparisons of goods within the same European destination market, which minimizes the bias from income effects.

([10]) In models without product differentiation the parameter beta is often associated with overall market size. But in these models, each variety is assumed to have the same market size. Here we argue that beta_s captures the market size of a particular variety.

([11]) Different from Ottaviano, Tabushi, Thisse (2002), the β parameter in (1) captures the degree of horizontal differentiation net of the substitutability of varieties. Thus, the γ parameter in (1) is the only one that captures product substitutability.

([12]) The reader should note that Melitz-Ottaviano(2008) use a slightly different notation. The love-for-variety parameter in their model is represented by the γ parameter (β in vertizontal). The parameter on the competition effect in demand is captured by the η parameter in Melitz-Ottaviano (γ in verti-zontal).

([13]) This is clearly a limiting assumption since it implies that the substitutability between a motor and a scooter does not vary across countries, which is a plausible assumption and simplifies the analysis substantially. While it is analytically feasible to allow gamma to vary between every pair of variaties, empirically it would be very difficult to estimate the different gamma for each variety pair.

What (1) shows is that the more consumers already consume of substitute products in the market (the bigger $Q_{S,i}$), the smaller the demand that a particular variety *s* will face in country *i*. The presence of other varieties in a market is a downward demand shifter for any variety *s* exported to country *i* and can be considered as a "competition effect". Similarly, the stronger the substitutability between products, the lower the degree of product differentiation captured by a larger parameter gamma, the lower the demand for any particular variety on offer in the country of destination.

Important to note is that the verti-zontal model is a static model without dynamics involved where parameters on quality, taste and others are exogenously given as it is the case in most trade models. In a more dynamic setting, however, we would expect firms to endogenously choose the value of the parameters in order to maximize their profits, but this lies outside the scope of the current framework.

III.2. FIRMS' MAXIMIZATION

The supply side of the model assumes that there are constant returns to scale in production i.e. marginal costs are independent of the quantity produced and do not vary with output and there are no fixed costs in production.([14]) However, there is firm heterogeneity in the sense that the cost of producing a variety varies amongst firms.

The profit maximization of a firm exporting variety *s* to country *i* thus becomes equal to:

$$\mathrm{Max}\pi_s = p_{s,i}.\,q_{s,i} - c_s.\,q_{s,i} \qquad (2)$$

where $p_{s,i}$$p_{s,i}$, refers to the export price of variety *s* to destination *i*, and $q_{s,i}$ refers to the quantity of variety s exported to destination market i.

Note that the marginal cost of production of variety s (c_s), *is assumed to* be independent of the destination market. In other words, no matter where the variety *s* is shipped to, its cost of production is the same. Also, it can be noted that the model does not impose a link between quality and marginal cost. This corresponds to assuming that higher quality of products can come either from fixed costs such as R&D or other sunk cost outlays that require longer term investments but do not necessarily affect the marginal cost of production. This assumption can easily be relaxed ([15]). The advantage of the approach here is that we can disentangle the separate role of cost versus quality, whereas in a model that assumes that higher quality requires higher marginal cost, a rise in one of the two variables always implies a rise in the other variable.

Profit maximization i.e. the first order condition of (2) with respect to price yields the following equilibrium values for prices and quantities for export market *i*. The equilibrium price resulting from the model is:

$$p^*_{s,i} = \frac{\alpha_s + c_s}{2} - \frac{\gamma}{2}.\,Q_{s,i} \qquad (3)\ ([16])$$

This expression clearly shows that equilibrium prices are increasing in the quality of variety *s* (α_s) but also in the cost (c_s) *at* which they are produced. This is why it is important that c_s controls for costs of production other than quality. The last term on the RHS also shows that prices of the same variety may differ across countries due to market competition effects in the destination country *i*. The equilibrium quantity shipped by each firm of its variety s, resulting from the model is:

$$q^*_{s,i} = \frac{\alpha_s - c_s}{2\beta_{s,i}} - \frac{\gamma}{2\beta_{s,i}}.\,Q_{s,i} = \frac{1}{\beta_{s,i}}\left(p^*_{s,i} - c_s\right) \qquad (4)$$

Equation (4) gives the equilibrium expression of exported quantities of variety *s* to country *i*. We clearly see that quality α_s enters the equation with a positive sign hence higher quality products will sell more (everything else equal). But we also see that the higher the cost at which the quantity is produced, the lower the quantity shipped to any destination country. Parameter $\beta_{s,i}$, which reflects taste may reduce or reinforce market shares for

([14]) While firms can be either single product or multiple products, what matters is that for each variety they maximize profits separately. This implies that any type of complementarities and cannibalistic behaviour between products inside firms is ruled out.

([15]) Kugler and Verhoogen (2012), for example, argue that higher quality products also require more expensive inputs.

([16]) Note that (α-γQ) corresponds to the zero-profit cost cutoff (c_{Di}) in Melitz-Ottaviano (2008) variety s in country i. By comparing equation (3) and (4), it can be noted that while quality (captured by α_s) *is affecting* both prices and quantities, the taste parameter $\beta_{s,i}$ *is only affecting* quantities but not prices. ([17])

In other words, how much you sell to a destination country depends not only on the quality that you sell but also on how much local consumers like your product. While the quality affects the price consumers are willing to pay, taste does not affect the willingness to pay for the product that is being sold but it does affect how much is being sold in each destination *i*.

III.3. TOWARDS AN EMPIRICAL IDENTIFICATION STRATEGY FOR QUALITY

The model allows for an estimation of the "relative quality of the exported product" and the indicators that arise from it. The following data series are needed for estimation of quality at the most disaggregate firm-product level:

- export prices proxied by unit values at (firm-product) product level of the exporting country to a destination market by year (p_t),
- export quantities at the firm-product level to the same destination market by year,
- costs of production (or an estimate) of the product in the market from where it is shipped (c_s) and/or markups at the level of the exporting product level (p_s - c_s),
- consumption of all substitute products (*Qs,i*) available to consumers in the destination market *i* which is needed to capture "competition effects" in the destination market.

These data series are required to separately identify the parameters for quality (α_s) *from* the taste effects ($\beta_{s,i}$).

In the model, quality corresponds to the value of the parameter α_s *which is vari*ety (product)-specific. We can identify quality from the model in the following way.

From the model's equilibrium price in (3) we rewrite this as:

$$\alpha_s - \gamma . Q_i = 2 . p^*_{s,i} - c_s \qquad (5)$$

From (5) it can be noted that the data requirements to assign a quality level to each product are cumbersome, since it requires many data series, some of which are not readily available like γ. Fortunately the procedure to establish a quality *rank* for each product, within a particular product and destination market, is quite easy and straightforward.

If we compare two varieties *s* and *r*, belonging to the same product-market([18]), that are exported to the same destination market *i* and subtract them from each other, the common term $\gamma . Q_{S,i}$, *that capture* competition effects in the same country-product market and corresponds to all other varieties present in the destination market, will drop out and we get:

$$(\alpha_s - \alpha_r) = 2\left(p^*_{s,i} - p^*_{r,i}\right) - (c_s - c_r)$$

$$= \left[\left(2p^*_{s,i} - c_s\right) - \left(2p^*_{r,i} - c_r\right)\right] \qquad (6)$$

The above expression gives the "relative" quality ranking of each variety in a particular destination market i. While the LHS consists of two unobservables, the RHS is made up of observables, provided costs (*c*) or markups (*p*-*c*) and prices (*p*)

([17]) This is a direct consequence of the assumption that consumers have access to a mass of varieties (continuum) and not just one or a few. In the case of the latter, profit maximization shows that firms trade-off quantities and price and set lower prices in markets where they sell more. Also, in markets with just a few rivals where firms behave strategically, price and quantity in the market will be traded-off and high selling varieties will lower the price for all varieties in the market. However, in the case of a mass of varieties where firms neglect the effect they have on market outcomes, this trade-off no longer holds. As a result, independent of taste variations across countries, the same variety will be sold at the same price. This outcome is specific to the linear functional form. The linear demand thus seems the only functional form of demand that allows for a clear separation of horizontal versus vertical differentiation.

([18]) The definition of a product-market can be very narrow, say at the eight digit level of trade statistics (CN8) or can be more widely at the CN6, CN4 or CN2 level. For example, a product-market at the CN8-level would be "chocolate pralines", while at the CN4, it would include all "products of cocao".

can be observed. While the exact quality level of α_s *and* α_r *cannot be determined on the ba*sis of (6), this equation does allow for the identification of a variety's ranking by destination market i.e. the variety with the higher (2p –c) in the destination market, has the higher quality ranking.

In a way, the ranking of products can be considered equally relevant information than the exact quality levels. The main difference is that by taking rankings we linearize the distance between quality levels. ([19])

III.4. THE PRICE-COST METHOD (PCM)

From equation (6) above, it can be noted that what is needed for the identification of "quality rankings" is an estimate of marginal cost (c) at the firm-product level or alternatively a measure of firm-product markups (*p*-*c*) and information on unit values. Since costs or markups are rarely observable, they need to be inferred indirectly. To do so, we use the Price-cost method (PCM), which is described below and compared to alternative estimation methods. ([20])

The PCM-method considers the definition of the Lerner index that arises from the ratio (Turnover – variable costs) (€)/turnover (€):

$$PCM_i = \frac{p_i.q_i - c_i.q_i}{p_i.q_i} = \frac{P_i - c_i}{p_i} = 1 - (c/p)_i \quad (7)$$

where (c/p) *in (7)* is the "average firm-level variable cost per euro of sales" i.e. how much a firm spends on inputs for each euro of output. Variable input costs such as labor expenses and material costs can typically be found in firm-level company accounts data. ([21]) Thus, variable costs of the firm typically are the sum of the wage bill and material costs. To explain this, suppose total variable costs of a French firm represent 80% of turnover. This implies that for each euro of sales, 0.8 are spent on variable costs and the Lerner index equals 0.2 (=1- c/p) which results in a markup ratio (p/c) of 1.25 (=1/[-(0.2-1)]) which is equivalent to a 25% markup.

The PCM method may give higher markups in more capital intensive industries or industries with higher fixed or sunk costs.([22]) While this can be considered as a flaw, for our purposes, it may be less harmful. Note from (6) that higher markups for a variety *s*, are going to results in higher quality estimates of the product. This upward bias for firm-products with higher capital intensity or fixed costs can capture the fact that these are also likely to be higher up the quality ladder.

While the PCM-method allows one to obtain firm-level markups from company accounts data (for instance the Bureau van Dijk Orbis data([23]), it does not allow for firm-product level markups. The reason is that input factors, such as the cost of employees and material costs, are typically only available at firm-level but are not broken down by products. Thus, it should be noted that PCM results in a short-run variable markup at firm-level, where costs, c, and price p are averaged over all the products in the case of multi-product firms.

Here we need to point out an important caveat i.e. company accounts data typically do not report how many products a firm sells or where it sells to. In order to assess quality of products in export markets on an EU wide scale, one needs to turn to country-product level data. In doing so we lose the firm-heterogeneity dimension, but in return we get a much wider coverage. Fortunately, the verti-zontal model, used here to construct the competitiveness indicators, is sufficiently flexible to allow for an interpretation at country-product level (where the "country" is the one of origin of the exports). The prices in equations (6) are now

([19]) The quality of a Mercedes car may not be considered comparable to the quality of a Neuhaus chocolate praline since they represent very different products. Yet, the quality rank of a Mercedes car in the car market may be comparable to the quality ranking of Neuhaus pralines in the market for chocolates. Quality rankings thus offer an easy way to distinguish the quality position of products in every product category. We can determine which country's export products systematically rank high or low in the quality rankings. Top quality products for one country however, can be very different from the type of top quality products of another.

([20]) For a comparison of PCM to other markup methods, see Vandenbussche (2012).

([21]) There are a few exceptions such as the UK, Denmark and others where firm report the "cost of goods sold" instead of materials.

([22]) As shown by Konings, Roeger and Zhao (2011).

([23]) ORBIS is a pan-European database with company accounts for most EU countries.

interpreted as country-product (s) ([24]) export prices and the relative quality ranking to identify is thus going to be at country-product level. The export prices can thus be obtained from trade data (COMEXT, Eurostat).

With (p) country-product level data, we obtain unit values by dividing export flows in value (in EUR) by export flows in physical units (kg, liters,…) at the CN8 level.

Even when carrying out the analysis at country-product level, we still need to have a proxy for the cost of the product in order to calculate the country-product markup. For this purpose, firm-level data can be of use to us.

By multiplying the Lerner index in (7) obtained from firm-level data in the country where exports originate, by the product-level export unit value which is destination specific (*i*), one gets a country-product (*s*) markup for each destination market (*i*). To see this consider the following:

$$Markup_{s,i} = p_{s,i}\left(1 - \frac{c_s}{p_{s,i}}\right) = p_{s,i} - c_s \quad (9)$$

$p_{s,i} = \alpha_s\text{-}\beta_{s,i}.\, q_{s,i}\text{-}\gamma.\, Q_{s,i}$ which gives us the markup we need in order to identify the relative quality of each country-product(s) in each destination i according to equation (6).

Firm-level company accounts are available in a dataset like ORBIS where firms are classified by their "main line of activity" through their "primary 4 digit NACE revision 2 industry classification". This implies that when computing the "average variable cost per euro of sales" (*c/p*) it is assumed to be the same for all CN8 products that correspond with this 4-digit primary NACE code. ([25]) What has to be kept in mind is that the price in *c/p* is an average price across products at the firm level and is likely to differ from the unit value at product level arising from the trade data. Still, the markup obtained this way, varies by product and by year as a result of the unit value ($p_{s,i,t}$) which is country (of origin)-product (*s*), destination (*i*) and time-specific. The firm-level data on variable input costs thus help us in getting an estimate of the "average variable cost per unit of sales" (*c/p*) needed at product-level. Also note that the monetary value in which both c and p are expressed in the company accounts is not important, since what we need in the analysis is the "share" (c/p) which is unit-less as both c and p are expressed in the same monetary terms. ([26])

It has to be kept in mind that the quality measure derived from the model is a relative quality measure. Therefore we cannot quantify the exact levels of quality embedded in each product, but we do know the quality ranking of each product vis-à-vis other competitors of the same product in Europe. ([27])

In the next section, we first further illustrate the methodology explained above with a concrete example. In subsequent sections of the paper we will then apply the methodology on a large set of countries and products. We consider country rankings based on product-level market shares and product-level distributions of relative quality derived from the model.

([24]) Note that previously, a variety *s* stood for a firm (in country of origin)-export product combination in destination *i*. From now on we interpret a variety *s* as the country (of origin)-export product combination in destination *i*.

([25]) There is no direct correspondence between NACE rev. 2 and CN8, but one first has to concord NACE rev. 2 to CPA (which lists the principal products within the NACE) and then concord CPA to CN8 products.

([26]) In our empirical analysis where we get c/p from Orbis, we obtain company accounts variables all expressed in euros.

([27]) Other competitiveness indicators exist in the literature, but typically they measure very different things. For example, the Competitiveness indicator by the IFO institute measures competitiveness by means of indicators as "the number of days for setting up a business". -

IV. AN EXAMPLE TO ILLUSTRATE THE METHODOLOGY

IV.1. LERNER INDICES, VARIABLE COST SHARES AND MARKUPS

Below we report *median* firm-level Lerner indices and markups obtained by applying the PCM-method (described previous section) and using ORBIS firm-level data for three countries whose choice is only inspired by illustrative purposes: France, Germany and Spain.

These markup estimates are not ready to be used as product-level markups (this requires additional information on destination specific unit values) but they are useful to obtain "average variable cost per euro of sales" (c/p) which will then be complemented with information on unit values to determine product-level markups that vary over time and by destination country, which is what we need to identify relative quality (see (6)) at product-level.

Results in Table IV.1 show that the median firm in France operating in consumption goods (sector 10 to 16 nace rev 2) in the period 2003-11, has a share of variable costs in turnover of 73%. Put differently, for every euro of sales value, a share of 0.73 is "typically" spent on materials and wage expenditures. For Germany the corresponding figure is 0.77 and Spain the comparable number is 0.80. ([28])

Table IV.1: **Average variable cost shares, Lerner Indices and Markups**

median firm values	France	Germany	Spain
average variable cost in turnover (c/p)	0.727	0.767	0.805
material cost share in turnover	0.455	0.566	0.602
wage billl in turnover	0.224	0.168	0.173
Lerner index (1-(c/p))	0.272	0.232	0.195
Markup ratio (p/c)	1.37	1.30	1.24

Source: ORBIS. Note: in order to reduce the effects of outliers we report median values. Results are values for the median firm across the six consumption good industries 10-16 (nace rev 2) and over the time period 2003-2011.

When we further split these numbers into the share that materials versus wage expenditures represent we get the results listed in Table IV.1 in the second and third row respectively. For France, the median firm in consumption goods spends 45% of its sales on materials used in products and 22% on wages. For Germany the corresponding figures are 56% for materials and 17% on wages, while the median Spanish firm spends 60% of every euro earned, on material inputs while wages constitute 17% of every euro sold. We also report the Lerner index of the median firm across all types of consumption goods and find the Lerner for France to be highest i.e. 0.27 and for Spain to be lowest i.e. 0.19. And finally, markups (p/c) can also be calculated for the median firm using the PCM method where for France the "typical" markup in consumption goods is 37% over variable cost, in Germany it is 30% and a Spanish firm typically has a markup of 24%. ([29])

A relevant question at this point is whether these markup estimates arising from the PCM-method can be considered as reliable. For this purpose we compare the results obtained here to those from alternative methods used in the literature and find PCM-markups to be in line with estimates derived by alternative approaches ([30]).

VI.2. From Firm-level to Product-level markups

In this section we construct relative quality indicators for food products as **an example** of how the methodology developed above can be used to assess quality of products in export markets.

For this purpose we consider four CN8 products:

1) 18062010: "chocolates with cocao content higher than 31%"

2) 18062030: "chocolates with cocao content lower than 31%"

3) 18062050: "chocolates with cocao content higher than 18%"

([28]) These numbers hides a lot of underlying firm-level heterogeneity in variable cost shares both across but especially within each 4 digit Nace sectors.

([29]) It can be verified that these results on the median firm do not differ too much from the "industry averages" calculated from Orbis. This is re-assuring since it suggests that the underlying assumption of constant returns to scale required in PCM is not substantially violated at firm-level.

([30]) See Vandenbussche (2012) LIME note for a discussion on this.

4) 18062080: "Chocolate flavor coating"

The reason for choosing the above CN8 products is twofold. First it is a nice example of a "consumption good" which fits the theory quite well. Second, the CN8 classification implicitly entails a quality "ranking" of products. The reason is the "cocao contents of chocolates" typically determines the quality of chocolates.

Thus, the classification of these CN8 products listed above, provides us with a useful *external validation* to assess our theory. If, the model's predicted quality parameter corresponds with the product ranking according to the CN8 classification and cocao content, this implies that our method correctly assigns quality to products. Thus, the CN8 classification is a useful yardstick to assess the quality parameter arising from the model.

For the sake of illustration we consider three countries of origin i.e. France, Germany and Spain. For each of these countries we collect the exports to the EU15 from COMEXT over the period 2003-2011 for the 4 products listed above. This results in a balanced panel of data with the following dimensions: 3 exporting countries, 4 exported products, 1 common destination market ([31]) and 9 years of observations. From the product-level values and weight data, we construct a country-product (s) "unit value" that varies by year, t, and which proxies the price (€) of the trade flow per physical unit of goods exported by each country,i, to the common destination market which in our example we take to be the EU-15 (ps,i,t).

In a next step, we identify the NACE 4 digit industry that corresponds to "chocolates products" to compute ([32]) the "variable costs in turnover" (c/p) of the median firm in the corresponding NACE industry by country. By combining this with the unit value from the COMEXT trade data, the relative quality ranking of each *variety* (country-product) in the EU15 can be constructed based on the equation in (6). This suggests that once we determine for each *variety* the value of (2p –c), we know its relative quality i.e., if equation (6) is positive then we can say that the quality of variety s in the EU15 is higher than the quality of variety r. By relating (2p-c)s/(2p-c)r we can say that quality s dominates quality r when the ratio >1 and vice versa when it is below 1. ([33])

Quality Rankings From the Model: Can we trust them?

Table IV.2 below shows that the highest quality chocolates i.e. those with the highest content of cocao (product group 1), is ranked by the model as "top" quality or "second" quality in 100% of the cases. Whereas the lowest quality chocolates i.e. where only the "coating is made of chocolate flavour" (product group 4), is ranked by the model as the "bottom quality" in 80% of the cases.

Table IV.2: **Quality Rankings: can we trust the model?**

Quality Ranking of CN8 classification	Quality Ranking by the Model
Product 1: GE, FR, ES exports of "18062010"	Ranks "top" or "second" in 100% cases
Product 2; GE, FR, ES exports of "18062030"	Ranks "second" or "third" at 90% of cases
Product 3: GE, FR, ES exports of "18062050"	Ranks "third" or "bottom" at 55% of cases
Product 4: GE, FR, ES exports of "18062080"	Ranks "third" or "bottom" at 80% of cases

Source: COMEXT merged with ORBIS data

This suggests that the model recognizes that product-group 1 in the majority of cases is ranked as the "top" quality product and product group 4 in the majority of cases is ranked as the "bottom" quality product. This is reassuring since it suggests that the model provides us with a relevant indicator

([31]) A common destination market is essential to compare quality rankings of similar products for which we choose EU15. But the choice of destination market in principle could be any destination.

([32]) The NACE code (rev 2) that corresponds closest to the 4 chocolate products listed above (18062010, 18062030, 18062050, 18062080) is NACE "1082" titled: "*Manufacturing of cocoa, chocolate and sugar confectionary*".

([33]) Note that the difference of alphas is not the same as the ratio of alphas, so the ratio of $(2p\text{-}c)_s/(2p\text{-}c)_r$ does not equal the ratio of alphas. However, since it varies monotonically with (α_s/α_r) it clearly indicates quality ranking and can be interpreted as an ordinal indicator of relative quality.

of quality resulting in a correct quality ranking of products. ([34])

Comparing Country-Product Quality Rankings

Now that we have established the model's parameter to be a good proxy for relative quality, we can establish a ranking of countries per product segment, over the period 2003-11 in the "top" segment, as shown below. This is shown in Table IV.3.

Table IV.3: **Quality rankings by country in the "top quality" segment (chocolates with cocoa content higher than 31%)**

TOP quality

RANK_country										
1	ES	ES	FR	FR	FR	FR	FR	FR	FR	
2	FR	FR	ES	ES	ES	DE	DE	ES	ES	
3	DE	DE	DE	DE	DE	ES	ES	DE	DE	
	03	04	05	06	07	08	09	10	11	time

Source: Own calculations
ES: Spain, FR: France, DE: Germany

Thus, we have given an example on how a relative quality indicator can be constructed at country-product level. In section VI we use this methodology on a much larger set of countries and products.

IV.2. DATA AND COUNTRY-LEVEL ANALYSIS

In the remainder of our empirical analysis we now consider all the CN8 products exported by each European Member state to the EU market for which we have sufficient information to obtain a relative quality measure within each CN8 product groups. We do not just compare quality rankings amongst EU countries but also involve their main competitors in the world i.e. the US, Japan and China.

We construct a quality indicator as well as a market share indicator at country-product level to assess the position of each country and its evolution over time in terms of quality and more generally in terms of its overall market share.

For this purpose we collect product-level exports from most EU countries to a common EU destination, as well as the exports of Japan, China and US to that destination. This destination market consists of the EU15 which offers a consistent definition of the EU destination market over time.

The quality indicator developed in earlier sections, relies on observables such as export prices, export quantities, but also importantly on costs and markups of exported products:

- The data on export *quantities* and values of exported products that we use in our analysis come from Eurostat for all the years 2005-2011.
- *Prices* or "unit values" of products at CN8 level were obtained by dividing export values by export weight (kilograms) which results in a "price" per kilogram exported.
- For *costs*, we turn to a firm-level dataset ORBIS which covers most EU as well as US, Japan and China.

We match the 4-digit Nace Rev. 2 primary Industry classification of Orbis with the CN8 product classification (via CPA codes) in order to have an idea of the cost of each exported product, by each country. Our cost data are variable costs data consisting of wage costs and material costs.

ORBIS does not report on very small firms and thus has a bias towards larger firms. But since exporters tend to be larger firms, we expect variable costs estimates coming from this data to make a good proxy. Nevertheless, to take this potential bias into account, we consider the variable cost of the median firm in the sector as a proxy for the costs of all the CN8 products that

([34]) Note that the ranking of chocolates on the basis of cocao content is not always considered to be a correct quality indicator, suggesting that the CN8 classification while a relevant external quality validation is not full proof. For example, "cocao content tells you nothing about the beans used, how the beans were fermented and dried, nor does is say anything about the steps in the manufacturing process that affect flavour" (http://www.thechocolatelife.com/forum/topics/deconstructing-cocoa-content). This is information that the market will take into account and arguably should be incorporated in the model's quality indicator, potentially explaining the (small) divergence between the two rankings.

map into this industry classification. Arguably, the median variable cost will have a lower bias than the average variable cost, since the average may lean more towards reflecting the costs of smaller firms given that the mass of smaller firms is typically larger than the mass of large firms.

Thus, for each country in our sample (all EU countries, US, China and Japan) and for each NACE 4-digit sector that CN8 products map into, we take the cost level of the median firm for that country-sector to be a proxy for the marginal cost of a country-product variety exported by that particular country. ([35]) Variable costs are measured in euros (EUR).

In terms of products, we consider all CN8 product codes that did not change over time between 2005-2011. This resulted on average in about 4,000 exported products for each of the EU exporting countries and its world Competitors on the EU market: US, Japan, China.

Also, we only include CN8 products that map into the NACE revision 2, in the manufacturing (sector 10 to 32) and that belong to chapters CN2 from 01 to 97.

When putting the data together we came across a number of difficulties. In some EU countries, accounting rules are such that material costs are never reported for any firm. ([36]) For those countries we use an alternative to arrive at a variable cost at firm-level i.e we divided the "Cost of goods sold" over "Operating Revenue".

The "Cost of goods sold" typically includes all direct and variable cost embedded in products, but may also involve some fixed (indirect) costs and as such the cost figure used for these countries may be over-estimated compared to other EU countries that operate under a different accounting system. Such over-estimation of costs would result in lower value added and since our quality metric is a value added concept would result in under-estimation of quality.

We do not worry too much about it for two reasons. First, despite the potentially over-estimated costs for countries like Japan and US, these countries typically feature as high quality exporters. This is in line with our priors given the high level of development of these countries. Second, if there was a systematic bias driven by the accounting system, a country like China, which uses a similar accounting system to the US and Japan, would also feature amongst the high quality exporters. However, this is not the case. Thus the absence of a systematic bias in the cost data is re-assuring to us suggesting that the ratio of "Cost of goods sold" over "Operating Revenue" which also results in a "cost per euro of sales" is a good proxy for firm-level variable costs.

Another problem we encounter for the Netherlands is that the wage bill is reported but material costs often not and no cost of goods sold is given. As a result, many Dutch firms are lost in the data when estimating total variable costs (sum of wage bill and material costs), while for a country of similar size like Belgium the total variable costs is available for many more firms. As a result in our final dataset, we could retrieve cost information for many more products exported by Belgium than for the Netherlands.

Thus the number of products in our sample is not necessarily a proxy of country size i.e. Belgium in our data exports over 5,000 products, while Netherlands only 3,000 with Belgium having a population of 11 million people and the Netherlands of 15 million. To reduce the impact of exporting country size on our findings, we normalize our findings. But still country size differences may matter for market share levels.

Quality and market share distributions per exporting country are considered between zero and one and we focus on the moments of the distribution, such as the average or the top 1 percentile (the right hand tail). The numbers of exported products per country on which we base our analysis are given in the Appendix A.

For the remainder of our analysis, we leave out Cyprus and Malta because of the low number of observations. We also leave Greece out of the analysis because of its particular status in the crisis years. Denmark has very few observations before 2007, so for that country we start the analysis in

([35]) Since rankings are always determined *within* the same year, there is no need for deflation since both numerator and denominator are expressed in euros of the same year. But we may need to verify divergence of inflation rate differences in Europe between countries

([36]) This is the case for UK, Denmark, Lithuania, Ireland, Greece, Cyprus, Malta, Latvia, Japan, US and China.

2007. Ireland is included but its position may be heavily influenced by the presence of foreign multi-nationals, thus making their exports not directly comparable with the other EU countries where the presence of MNEs is much lower.

Box IV.1: **Some caveats**

A potential problem that comes to mind, especially for countries outside the Eurozone is that exchange rates with the euro may introduce a bias in our quality measures. In the period that we study, Japan typically had a strong currency, which may in part explain their consistently high value added per product, while China may have been characterised by a weak currency, suggesting that its prices in euros are low and result in low markups of products.

While this is a valid concern, we believe it is not a too serious one. For one, from the company accounts of firms outside the Eurozone, we never use absolute values in the analysis but always "shares", where numerator and denominator are expressed in the same monetary units and should therefore drop out. Recall that from the company accounts we obtain the ratio of variable cost over sales (c/p), to get a "share of variable cost in turnover per euro of sales". So in the event of exchange rate misalignments, this would affect both numerator and denominator, which is why its impact should be minimal. However, the unit values that we use in our analysis that stem from COMEXT data could be subject to an exchange rate bias. To construct them, we use values in euros, so especially for non-euro countries, exchange rate effects cannot be excluded.

However, our methodology appears to arrive at plausible conclusions, with a country like Japan and the US, consistently providing high quality products, while a country like China features at the low quality end.

Another potential problem of our analysis may be related to the fact that the model considers the cost, c, to be the marginal cost of production but not of quality i.e. in the model, all quality expenses come from investment in R&D, sunk cost outlays etc. However, in reality and therefore showing up in the data, part of the material and labour cost may have been used to improve quality. At first sight this may be appear as a contamination of our quality measure, since products with high quality but more expensive inputs would show up as having a lower markup and lower quality level in our metric where in reality they have a high quality level.

However, this is unlikely to be the case, since firms are rational and prefer more profits over less, thus will only invest in high quality inputs, provided the profits increase they can obtain with them exceeds the additional costs. Thus, even when the variable production costs (wages and materials) that we obtain from firm-level data, include some quality costs, our quality metric developed by the model is still expected to yield the correct quality rankings, provided firms are rational i.e. any cost spent on quality on the input side must be offset by a larger increase of profits. ([1])

And finally, we have treated the EU15 as an integrated market in this paper, implicitly assuming that price differences between EU15 destination countries are minimal. But this may not hold perfectly. A country like Germany probably exports relatively more to nearby countries such as the Netherlands and Belgium, whereas a country like Spain may export relatively more to Portugal and France. If the price competition in Netherlands and Belgium is tougher than in Portugal and France, then we cannot exclude that our quality measure, which is a function of prices, attributes lower quality to German products than to Spanish products. Since the method

([1]) In the model, the expression for profits is given by: $\pi_{s,i} = \frac{1}{\beta_{s,i}} . [p_{s,i}(\alpha_s) - c_s]^2$

For a given $\beta_{s,i}$, profits move with quality, similar to how markups move with quality. It can then be shown that firms will only invest in quality and allow for higher marginal cost, provided markups and profits go up as a result of quality. This implies that the quality metric used in this paper is expected to give correct quality rankings both in the case where higher quality comes from R&D and fixed costs (as assumed by the model in section III), as well as when higher quality comes from higher marginal cost.

(Continued on the next page)

Box (continued)

we are using, i.e. considering the EU 15 as a common destination market for all countries, implicitly assumes that all countries export in the same way to all EU15 countries and that price competition in the EU15 is the same. While this can be remedied by treating each destination country within the EU market separately, this would require an additional and substantial data work.

V. MARKET SHARES DYNAMICS

V.1. DISTRIBUTIONS

Before we turn to quality measurement, we start by documenting product-level market share distributions for all products (CN8) exported by countries to the EU market. We use EUROSTAT trade data (COMEXT) to assess market shares in the EU market at product-level and their relative ranking. At the most detailed product-level (CN8) we collect from the EUROSTAT statistics, export values and tonnes of shipments. We consider twenty-four EU member states ([37]) and their three largest world competitors (US, Japan, China). For each product exported, we assess a country's relative market share in that product and rank it amongst all its competitors. A normalization of product-level ranks between zero and one (=highest market share), then allows us to plot the country-level distribution of market shares of export products. In order to consider the dynamics in export market shares, we consider the market share distribution in different years.

We start by showing the market share rank distribution of Germany in Graph V.1. The solid line refers to the distribution in 2005 while the dashed line shows the distribution of market share ranks for all products exported by Germany to the EU market for 2011. Comparing the solid to the dashed line allows for a comparison over time, indicating which products have gained relative market share. It is clear from the distribution that most of Germany's export products do very well and typically have high market shares. The average product exported by Germany has a (normalized) market share rank in the EU market of 0.84 which correspond to an average market share in levels for its products of around 20%. ([38])

The shape of market share distributions varies widely amongst EU member states, which is shown below. Finland, for example, has a distribution of market shares that averages around 2% in both years that we consider i.e. 2005 and 2011, which corresponds to a normalized market share rank of 0.33 that can be read off Graph V.2. The hump in the market share rank distribution, and thus the mass of products exported by Finland, clearly lies on the left, suggesting that the majority of Finish products have a relatively small market share in the EU market.

One obvious difference between Finland and Germany of course is the difference in country size with Finland being a much smaller county. While this is a valid concern that should be kept in mind, it is the case that global value chains, outsourcing and offshoring imply that a country's physical capacity to export is less constrained by its factor endowments than in the past. Countries like Belgium and the Netherlands, which are both relatively small but open countries, have an average market share across export products in the EU market of 10% to 12% respectively which puts them in the top group of exporters despite their relatively small home market. International trade theory predicts that countries will export products for which they have a large home market. However, we should interpret the “size” of the home market carefully since a small country may have a relatively large home market in a particular product, which it is then more likely to export. The case of "beer exports from Belgium" is a good illustration of a small country that became a large exporter of a particular beverage, driven by a historically large home market for this product.

Market share distributions are heterogeneous across countries. A country like Poland displays a very different distribution, where market shares of products are more evenly dispersed with a peak around 3.5% market share in 2005 (corresponding to a rank of 0.44). In 2011, the entire distribution seems to have shifted to the right in 2011 compared to 2005, resulting in higher market shares for products exported by Poland with the average of the market share distribution in levels closer to 4% (corresponding to a rank position of 0.52 in Graph V.3).

When we compare the distribution of EU member states to the one by China in Graph V.4, we see a similar shape for China compared to distribution of market shares by Germany. But the average market share for Chinese products in the EU market is smaller and averages around 14% in 2005 which

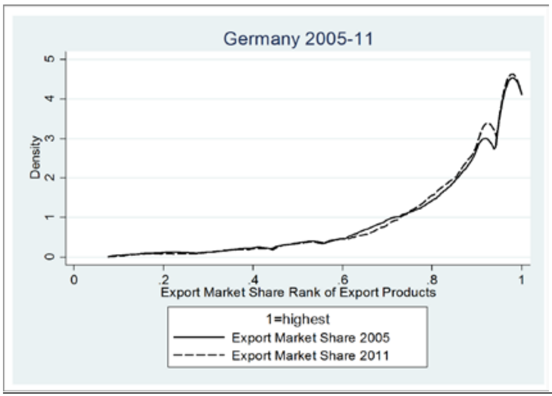
([37]) Unfortunately we could not include Cyprus, Malta and Greece for reasons of insufficient data.

([38]) The reader should refrain from interpreting the horizontal axis in Figure 1a as market shares held by products. Instead, the horizontal axis reflects a normalization of market share ranks, so while the numbers are comparable across countries, they should not be interpreted as market shares.

already climbed to 19% in 2011 (0.66 versus 0.70 respectively in ranks).

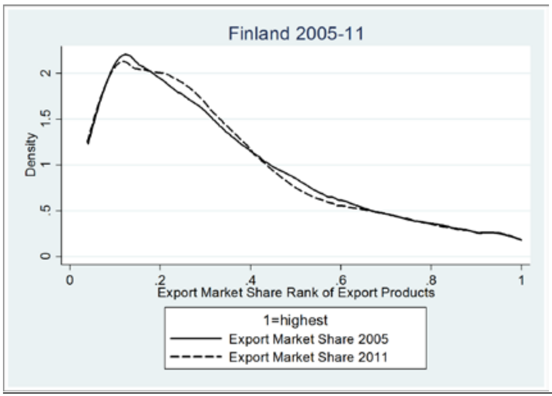
Appendix B provides market share distributions for all countries involved in the analysis, but not included in the text for brevity.

Graph V.1: **Distributions of Market Share Rank of German Export Products to EU15**



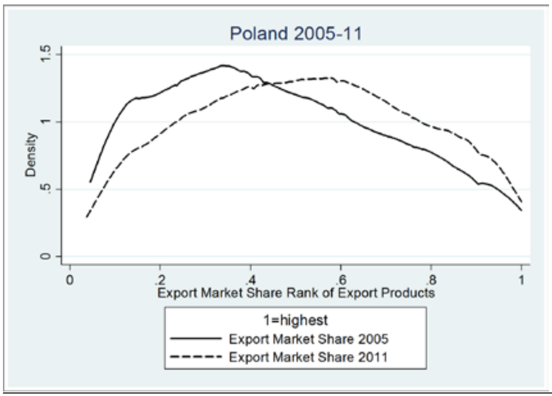
Source: COMEXT 2005-2011, Eurostat

Graph V.2: **Market share ranks of Finish Export products to the EU 15**



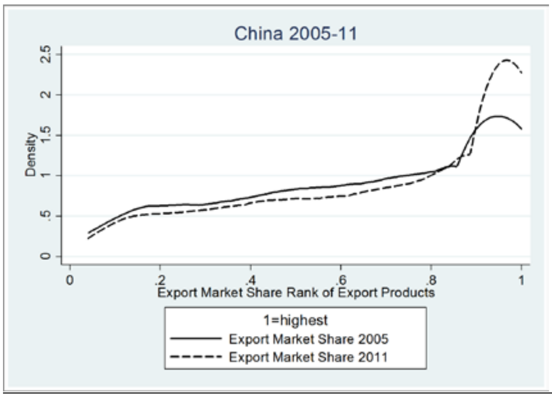
Source: COMEXT 2005-2011, Eurostat

Graph V.3: **Market share Ranks of Polish export products to the EU15**



Source: COMEXT 2005-2011, Eurostat

Graph V.4: **Market share ranks of Chinese products exported to EU15**



Source: COMEXT 2005-2011, Eurostat

V.2. COUNTRY RANKING BASED ON "AVERAGE MARKET SHARES"

After obtaining the market share distribution for every EU member state and for its three world competitors, we then use an important property of the distribution to compare countries in terms of their market share and how "successful" they are in the export of their products to the EU market. One of the most relevant characteristics of the distribution is its mean. The average market share of each country in our sample reflects how well its average product is selling in comparison to other countries.

This results in a dynamic country ranking in terms of market shares levels and changes between 2007 and 2011 ([39]). We thus consider country rankings both before and after the crisis which can be plotted together in one graph to capture dynamics.

We start in Graph V.5 by considering only EU member states. The format of the graph allows us to evaluate “levels” and “changes” of market shares at the same time. Each dot refers to a country's competitive position in terms of market shares in quantities. From the horizontal axis we read off a country's average market share ranking in the year 2007 while from the vertical axis we read off that same country's position based on the distribution of the market shares (quantities) of its export products in 2011. The axes have not been rescaled so the numbers reflect *actual* average market shares. Observations in Graph V.5 below the 45°-line indicate countries that have dropped while observations above the 45°-line have increased their market share. An important observation is that most countries lie exactly on the 45°-line. This suggests that countries' positions in terms of average market shares appear relatively stable over time, at least between 2007 and 2011.

The definition of market share used here, is the share of a country's exports to the EU15 in the total exports to EU15 by the thirty countries in our sample. ([40])

Based on Graph V.5 we conclude that Germany's export products on average perform best in the EU market. Germany has both in 2007 and 2011, the highest market shares, with average market shares for its products close to 20%. The Netherlands, Italy and France follow at some distance from Germany with their products on average holding a market share of 12%. Belgium, with an average market share of 10% comes next in the ranking followed by Spain and the UK that rank in 6th and 7th position respectively. All other EU member states have a substantially lower average market share with Poland and Austria performing best, and the Baltic States, which are very small countries, having the smallest average market shares.

In terms of market share changes, the Netherlands is the country that did relatively best, since it is the country whose average market share improved most between 2007 and 2011 when we compare it to other member states. Austria's average market share also improved.

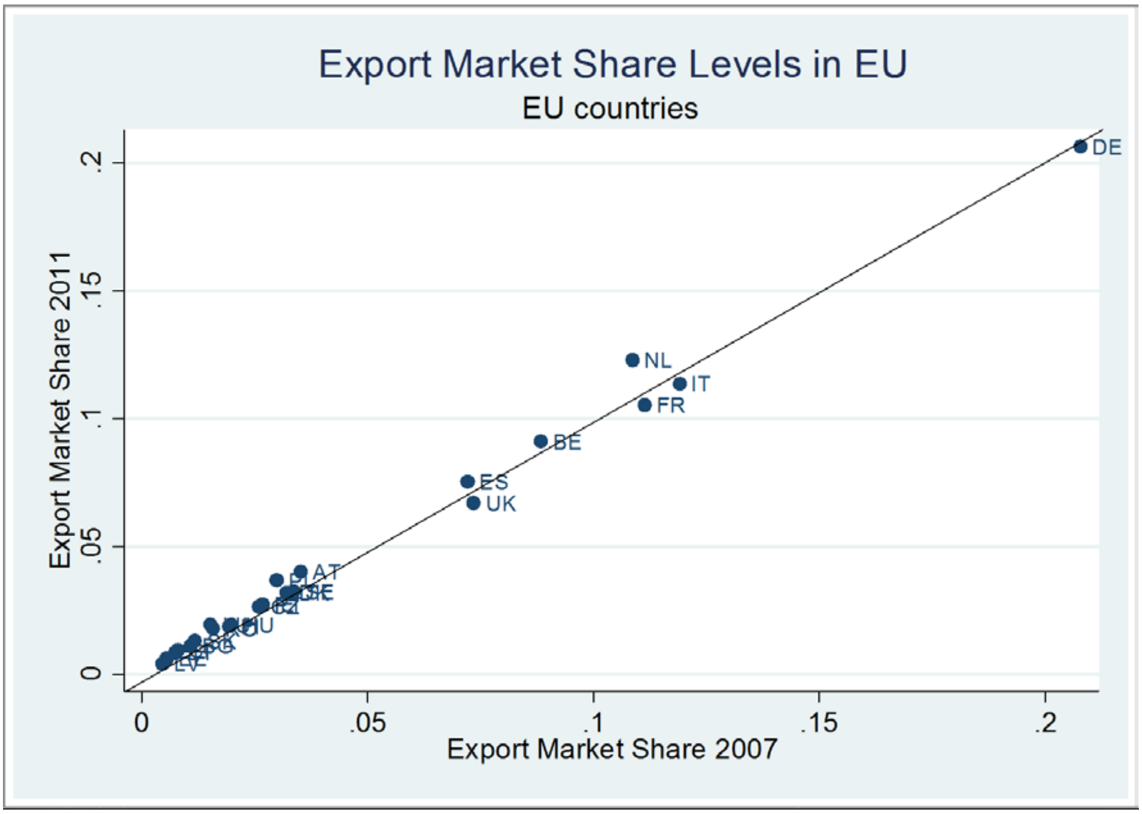
In Graph V.6 we now use average market shares measured in quantities (weights) and add the world competitors US, China and Japan. China is closest in market shares, to Germany. The average market share of Chinese products is about 5% below those of Germany but Chinese market shares are growing. In fact, China is the country whose average market share increased most over the period 2007-2011.

The US' products in market share levels perform most similarly to the UK exports with average market shares in the EU market of around 7% and their position did not change very much, while Japanese products are typically characterized by low but stable market shares in the EU market.

([39]) The data for Denmark are only available from 2007 onwards, so in order to keep that country in the sample we compare 2007 to 2011 for all countries.

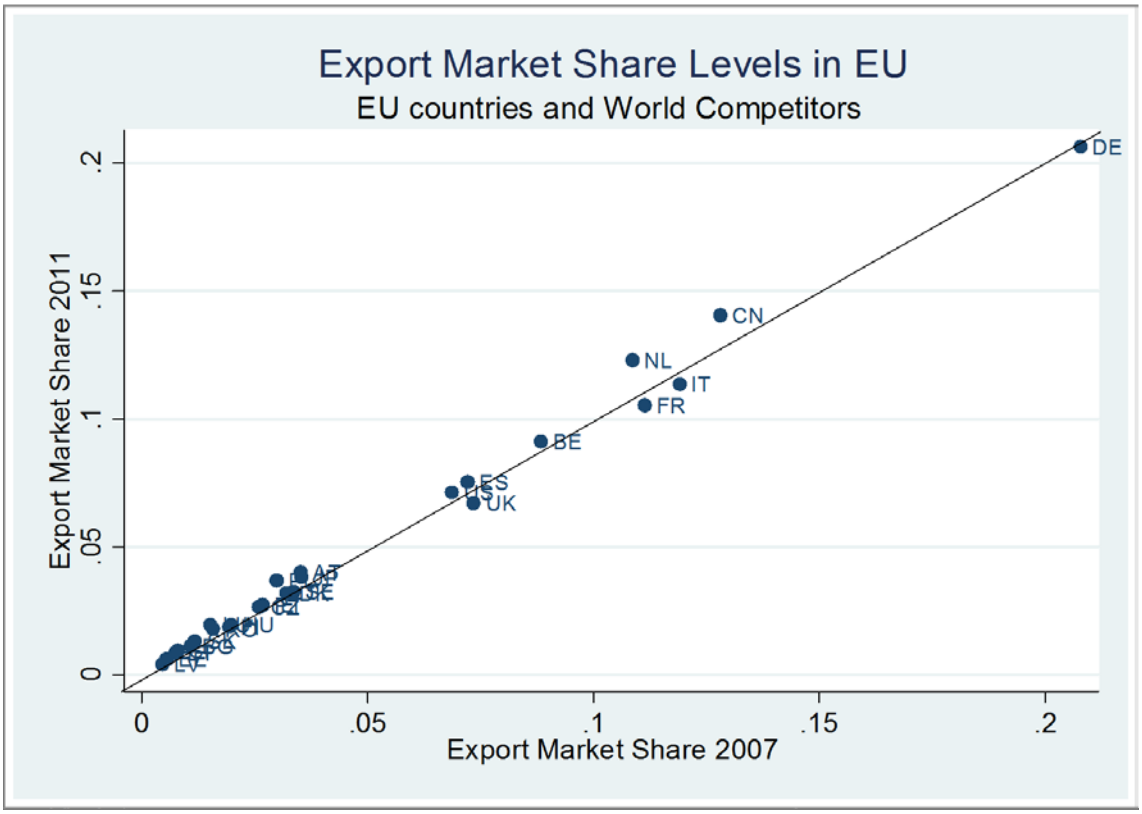
([40])
$$market\ share_{ij}\ in\ EU15 = \frac{Exports\ of\ product\ i\ by\ country\ j\ to\ EU15}{\sum_{j=1}^{30} Exports\ of\ product\ i\ to\ EU15}$$

Graph V.5: **Ranking of Countries using the Average Export Market Shares in EU15 (in values)**



Source: Own calculations

Graph V.6: **Average Export Market shares for EU and World Competitors in EU15 (in values)**



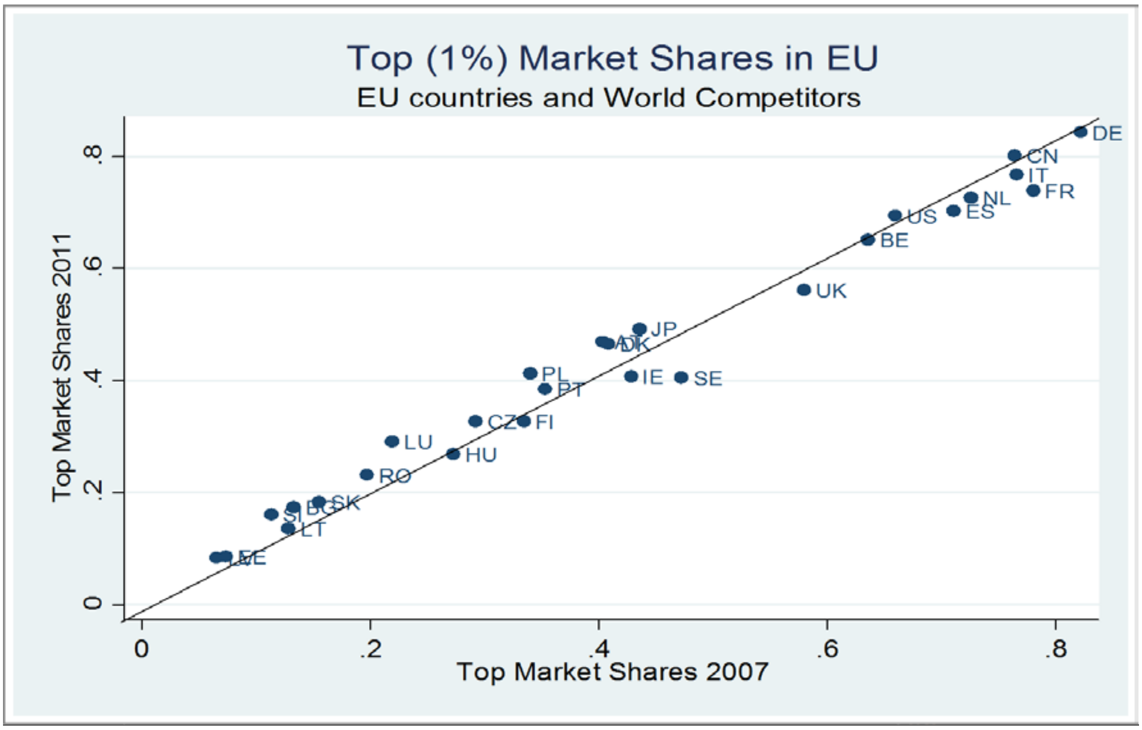
Source: Own calculations

V.3. COUNTRY RANKS BASED ON "TOP PERCENTILE OF MARKET SHARES"

An alternative way of ranking countries would be to look at a different characteristic of the market share distribution. For example, it may be interesting to look at which countries consistently export products with top market shares in Europe. For this we now consider the ranking of countries based on the number of export products in the top percentile of the market share distribution. The ranking that follows from this alternative metric is shown in Graph V.7. When we compare EU members states to their world competitors on the EU market, we see that again Germany leads the rankings when this metric is used, followed by China, Italy and France. For example, in the case of Germany we find that 1% of all exported products have a market share in values higher than 0.82 (82%), while for Hungary the top 1% of products have a market share that exceeds 0.30 (30%), which corresponds with a very thin right hand tail or few products with high market shares and many products with low market shares for Hungary.

Based on the right tail of the market share distribution, countries like France, UK and Sweden seem to have lost out over time with a worse relative position in 2011 than in 2007. All in all the ranking of countries, when using the top 1% market share cutoff of products, does not differ that much when compared to where we considered the average of the market share distribution as we did previously.

Graph V.7: **Ranking of Countries based on the TOP Market Shares in EU**



(1) Legend: DE: Germany; CN: China; IT: Italy; FR: France; NL: Netherlands; ES: Spain; US: United States; BE: Belgium; GB: United Kingdom; JP: Japan; DK: Denmark; IE: Ireland; SE: Sweden; PL: Poland; PT: Portugal; CZ: Czech Republic; FI: Finland; HU: Hungary; RO: Romania; LU: Luxembourg; BG: Bulgaria; LT: Lithuania; LT: Lithuania; EE: Estonia

Source: Own calculations

VI. QUALITY

VI.1. DISTRIBUTIONS

While relative market shares and their dynamics over time are a useful indicator, they do not reveal much about the underlying determinants. Are countries successful in exporting their products because they have a cost advantage and can set low prices? Or, do countries ship high quality products for which consumer demand is strong, despite the fact that these high quality products are sold at high prices? While both cost and quality tend to affect prices in the same direction, there is one important difference between the two which is why we want to disentangle them. Both cost and quality raise prices, but they have a very different effect on demand. When the production costs of a product increase and quality is kept the same, the product's price is likely to increase and its market share will erode. This can be thought of a shift "along" the demand curve. Downward sloping demand curves imply that price increases correspond with lower sales.

When quality rises, the price of a product will also rise, but this does not necessarily mean that market shares will fall. If the consumer recognizes the higher quality of the product, he/she may be willing to pay a higher price for it and continue to buy it. This is why in economic terms we refer to quality as an outward and parallel "demand shifter". The effect of higher quality on market share is thus determined by the trade-off between a higher price, which typically narrows the number of consumers buying, and a taste for high quality products by which every consumer prefers high quality to low quality in the case they did not have to worry about the accompanying price.

The discussion thus far points out clearly that the determinants of high market shares are either low costs high quality on a combination of the two. In fact we can add a third determinant which is less well understood economically, but intuitively very easy to grasp. It may simply be the case that a product fits the taste of local consumers. This may explain why products of average quality and cost levels can still perform well in export markets because consumers like the product better than substitute products. In such a case, the high market shares accompanying high taste products cannot be ascribed to the exceptional quality or cost of the product.

In our objective to focus on the quality dimension, it is therefore important that we separate the effect of quality from cost and taste factors which are also affecting market shares.

Thus far, the most common practice to assess quality was to consider prices as a proxy for quality. However, in the absence of cost information, prices can be misleading for reasons explained above i.e. a high price can just be a reflection of high costs but need not guarantee high quality.

The methodology by di Comité, Thisse and Vandenbussche (2014) establishes a quality *rank* for each product, within a particular product and destination market. Its implementation is quite easy and straightforward which is what we will pursue below. The ranking of products in terms of quality has the advantage that the quality position of very different products can be compared across CN8 (see earlier footnote in section III).

Over the period 2005-2011, our data consists of close to 800,000 observations where observations consist of products, their export prices ([41]) and the cost at which they are produced.

This allows us to construct distributions of quality ranks by exporting country which gives us the frequency of exported products in every quality rank category. As such we know whether a country is mainly exporting low quality goods or whether it is predominantly present in the high quality goods.

We start by documenting the quality distribution of products exported by China. Graph VI.1 shows the quality rank distribution, normalized between zero and one, for all products exported by China to the EU market. The solid line gives the shape of the distribution in 2005, while the dashed line depicts the distribution in 2011. We clearly see that the distribution is skewed towards the left, which is towards low quality ranked products. The change over time in the distribution has not been that

([41]) Typically unit values are defined by the ratio of export values over the weight that is being shipped, and are used here as proxies for prices.

strong i.e. China continues to specialize in low quality products.

Graph VI.1 also shows the quality rank distribution for Japanese products on the EU market. Japan is clearly at the other extreme of the quality ladder with most exported products featuring as top quality products. This can be seen by the skewness of the distribution to the right where quality ranks are highest and where most Japanese products belong to.

The distributions of most European member states look very different. We start by considering Germany and France in Graph VI.2. The German distribution of quality ranks of export products to the EU market is much more symmetric than for the two Asian countries. Germany is much more present in the "middle" quality ranked products, which is even reinforced in 2011.

The French distribution of quality ranks in Graph VI.2 looks better in the sense that it is more in favour of higher quality goods, suggesting that on average the quality rank of French products is higher than that of German products. Italian and UK distributions resemble that of France more than that of Germany but will not be shown for brevity (see Appendix D for quality rank distributions of all countries considered).

Belgium and the Netherlands in Graph VI.3 show quality rank distributions that are even more skewed towards middle and lower quality products. Noteworthy is that the distributions have shifted quite strongly over time for both countries but in the direction of lower quality ranked products in 2011 than in 2005. The loss in quality rankings for these countries, suggests that other exporting countries must have climbed the quality ranks during that same period.

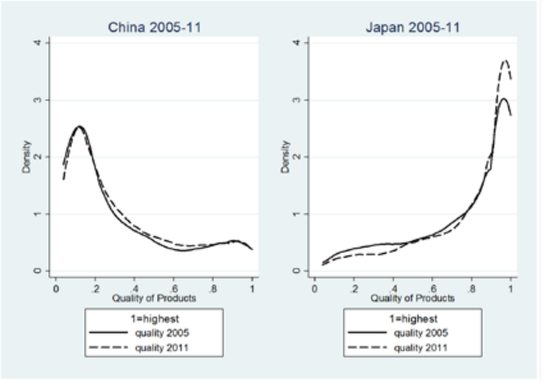
One clear example of an EU member state that has climbed the quality ranks is Denmark which is shown in Graph VI.4. A first observation is that Denmark's distribution of quality ranks in 2005 looks much more similar to Japan's with most export products belonging to the high quality end. While not shown here for brevity, we can say that this shape also characterizes the other "Nordic" countries notably Sweden and Finland. Second, Denmark's distribution has shifted over time in favour of high quality products with more export products obtaining high quality ranks and fewer products with lower quality ranks.

Quality upgrading is also going on in the newest EU member states. In Graph VI.4 we illustrate the case of the Czech Republic that experienced quite a dramatic distribution shift over time. In 2005, the Czech Republic's distribution looked very much like the one of China, with many low quality products being exported. But 6 years later in 2011, the distribution of quality exported by the Czech Republic looks very different with many more products featuring as middle and high quality products.

A similar trend is present for the distribution of other new EU member states. We illustrate this for Latvia in Graph VI.5. The bi-modal distribution in 2005, suggests that Latvia had many low quality products and some high quality products, but nothing much in between. Over time, the distribution of quality has shifted, given by the dotted line, and clearly illustrates that Latvia is moving out of the low quality products and is increasing its number of high quality products. A similar distribution shift characterizes countries like Poland, Hungary, Bulgaria, Romania, Slovenia, Slovakia and the Baltic states. This suggests that new EU member states have been upgrading quality and therefore reducing the cost competition with countries like China.

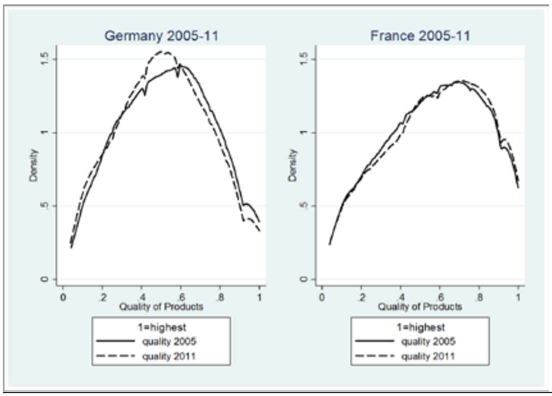
Appendix C provides quality rank distributions for all countries included in the analysis.

Graph VI.1: **China-Japan : Distributions of Quality Ranks**



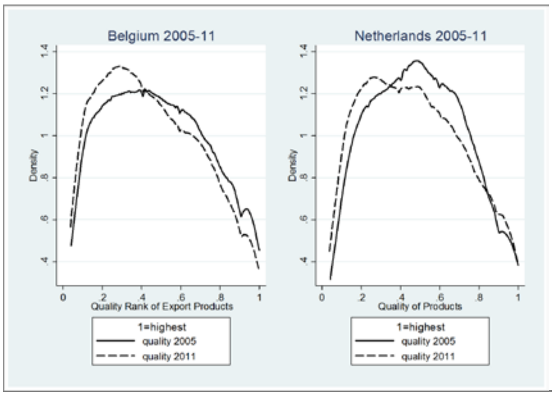
Source: Own calculations

Graph VI.2: **Germany – France: Distribution of Quality Ranks**



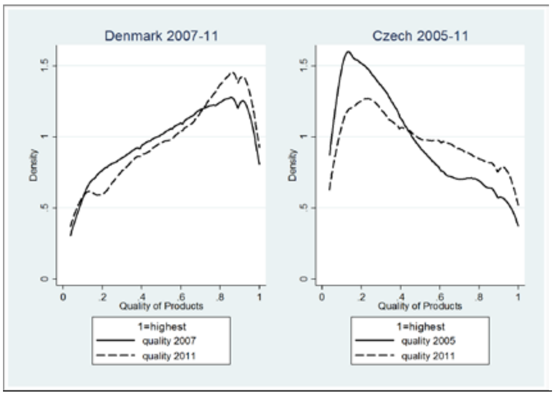
Source: Own calculations

Graph VI.3: **Belgium –Netherlands: Distribution of Quality Ranks**



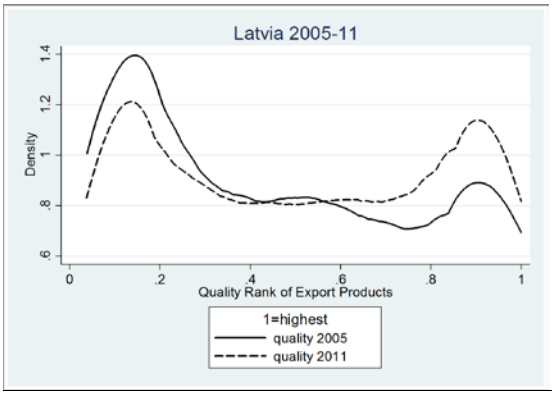
Source: Own calculations

Graph VI.4: **Denmark-Czech: Distribution of Quality Ranks**



Source: Own calculations

Graph VI.5: **Latvia: Distribution of Quality Ranks**



Source: Own calculations

VI.2. COUNTRY CLASSIFICATION - AVERAGE QUALITY RANK DISTRIBUTION

Now that we have constructed the quality rank distributions for each exporting country, we can compare countries to each other based on their distribution characteristics.

Graph VI.6 shows country rankings of quality where we use the average of the quality rank distribution to position each country versus the others. The format of the graph allows us to evaluate "levels" and "changes" of quality ranks at the same time. The horizontal axis gives us the average quality rank of a country in 2007([42]), while the vertical axis gives us the average quality rank in 2011. Observations below the 45°-line are countries that have fallen behind and whose average export product has dropped in quality rank. Observations above the 45°-line are countries whose average quality ranking has improved over time. We start by considering EU member states only. ([43])

([42]) Data for Denmark only start in 2007 which is why we take this as our first year.

([43]) Here we refrain from normalizing the axes of the graph between zero and 1 on the axes. This would require dividing every country's average quality rank in each year by the quality rank of the country with the highest average quality rank. The average quality rank of Japan went up substantially between 2007 and 2011 which would mean that dividing every other country's average quality rank in 2011 by the new number for Japan would imply a graph where all countries end up below the 45°-line, suggesting that their quality rank decreased over time, which is not actually the case true. When normalizing the axes between 0 and 1, a country's position not just reflects its change of

It can be observed that the ranking of countries based on the quality they export is quite different from the ranking of countries based on the distribution of their export market shares. Also, in contrast to market shares, the rankings of quality is less stable over time and shows more volatility with some countries' positions moving quite strongly over time. The quality champions both before and after the crisis are Finland, Sweden and Denmark. Since we base this classification of countries on the entire quality rank distribution, Finland's top position in this ranking does not seem to come from a "one company effect" since its quality distribution clearly shows that many Finnish export products have high quality ranks. Our analysis shows that many manufacturing products exported by Finland (and that feature in our data 3,500 products in total), are situated in the high quality ranks.

Countries that also perform strongly in quality exports are Ireland, France, Italy, UK and more recently also Austria. Countries that have dropped in the quality rankings are Luxemburg, Belgium, Portugal, Romania and to a lesser extent also Germany.

On the gaining side are European member states whose average export quality has risen compared to 2007 such as Latvia and Estonia.

Adding world competitors to the comparison as we do in Graph VI.7 adds to our insights. We now see that in the EU market, Finland which was the top quality champion amongst EU member states, is preceded by US and even more so by Japan. Japan, despite having relatively low market shares in Europe, when it comes to quality of its export products seems to be very competitive. At the other extreme of the ranking we find China as the lowest quality exporter with an average quality rank well below most EU member states. Involving the world competitors in the rankings thus puts the performance of EU member states in perspective. None of the EU countries have an average quality rank that is as low as that of China. This means that most EU countries' products are of higher quality than the Chinese ones. But, based on our analysis, the Chinese position in terms of average quality, is improving over time.

VI.3. COUNTRY CLASSIFICATION - TOP QUALITY PRODUCTS

Finally, we can also use another metric arising from the quality distribution. An interesting result would be to know which country has many products in the top of the quality distribution and to base country rankings on this. Put differently, we now look at the thickness of the right-hand tail of the quality rank distribution by country. For this purpose we focus on the top 1% quality for each country. The thicker the right-hand tail of the distribution, the more a country specializes in exporting top quality products to the EU market. This ranking is informative of the extent to which countries specialize in high quality products or not and how their position changed between 2007 and 2011. Results are shown in Graph VI.8. ([44])A couple of observations stand out. The ranking of countries is similar to the one based on the average of the quality distribution. But amongst EU member states, France now appears the country that exports most top quality products (in terms of numbers) to the EU market in 2007, but shares this first position with Finland in 2011. Japan is the absolute quality leader in the EU market when it comes to the number of top quality products it exports, followed by the US.

quality rank over time but also its new position versus Japan. Therefore we refrain from doing that here and simply use the average quality ranks stemming from the analysis. The normalization of axes was less of a problem in the case of market shares, because there countries positions were much more stable which gave more intuitive graphs even after the axes normalization.

([44]) In view of the stable position of Japan in terms of top quality products, we can normalize the axes between zero and one in this case.

Graph VI.6: **EU Rankings using Averages of Quality Ranks Distribution**

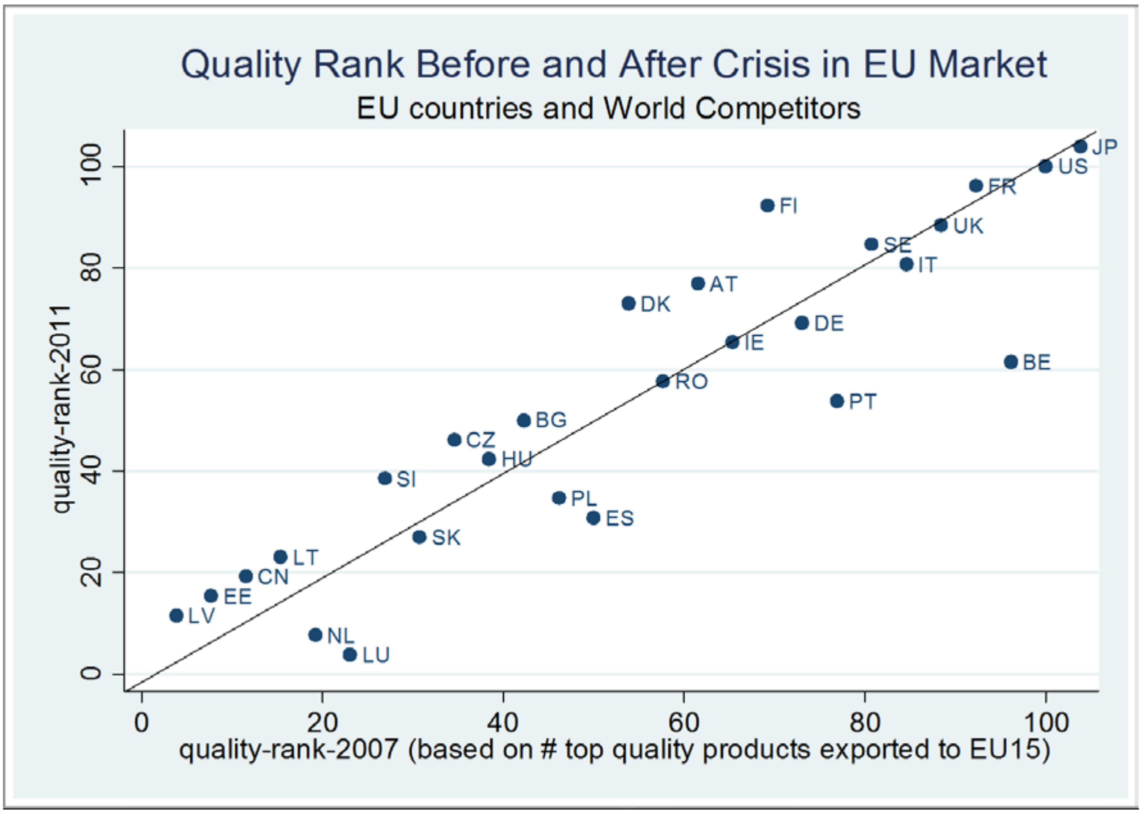
Source: Own calculations

Graph VI.7: **EU & World Rankings using Average of Quality Rank Distribution**

Source: Own calculations

The strong declines in top quality products can be noted for Belgium, Portugal and Spain. The strongest rise in top quality products is for Finland, Austria and Denmark. The improvements in quality ranks of the new EU member states is also clear from Graph VI.8.

Graph VI.8: **Ranking by countries based on TOP quality products**



Source: Own calculations

VI.4. COUNTRY CLASSIFICATION – EXPORT VALUES OF *TOP* QUALITY

Now, instead of considering the quality distribution in terms of number of products, we consider the export *values* in top quality products in order to measure how much export value comes from top quality products.

We refrain from looking at the share of export values in total products exported because the total number of exported products in our data is not necessarily the population of products for all countries, but only those products that we could retain by merging EUROSTAT (COMEXT) trade data with ORBIS cost data.

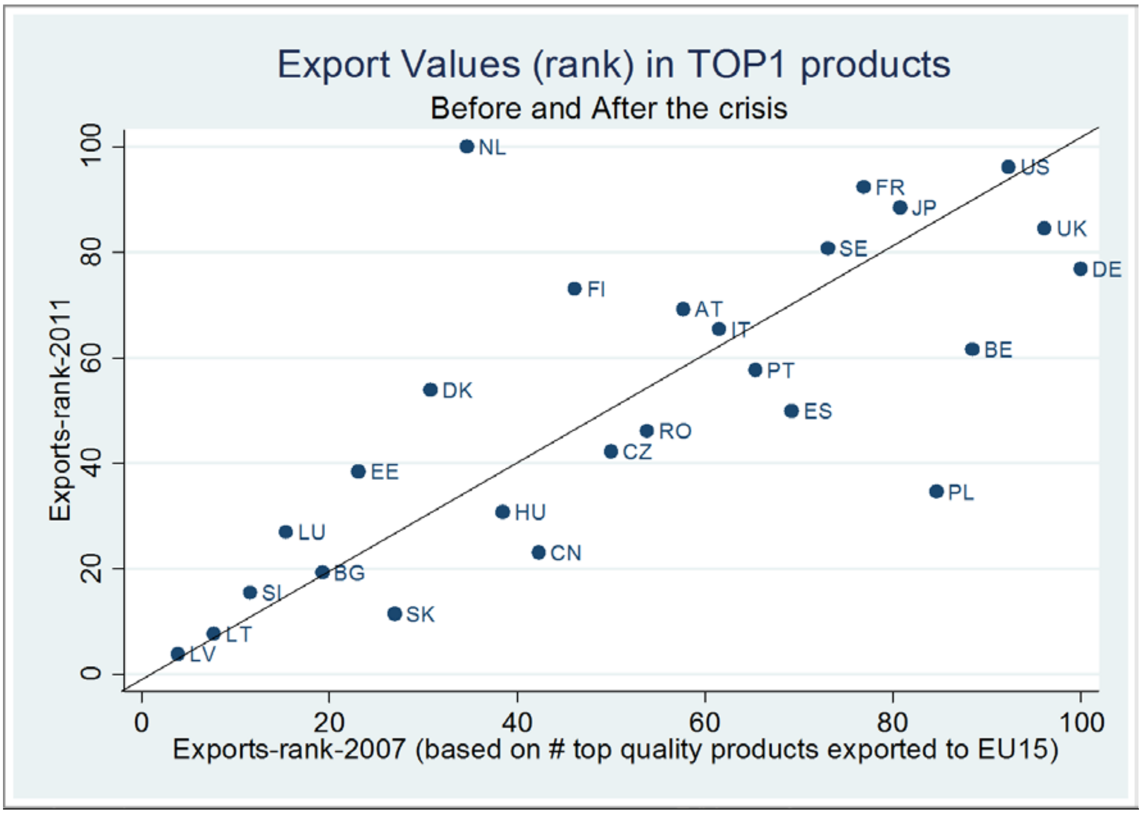
Graph VI.9 gives us the country position in the cross-country distribution of the export values of top quality products. It shows that "export *values* in top quality products" ([45]) provides complementary information to the "*number* of top quality products exported" on which we based rankings earlier.

A couple of observations stand out. For the Netherlands, which is a country that features in our data as exporting relatively few high quality products, export values in these top quality products has increased a lot. Moreover, its export values in high quality products have risen substantially after the crisis. While in 2007, the Netherlands was doing less than average in Europe, five years later in 2011 they export most value in their top quality products. Amongst EU countries, France comes second and the UK in 3rd position in 2011.

Also, remarkable is the position of Germany. In 2007, Germany was still the country exporting most value in its top quality products to the rest of

([45]) Export values used here may introduce a bias in favour of large countries

Graph VI.9: **Country classification : Export values of Top Quality Products**



Source: Own calculations

the EU compared to the other member states, but in 2011 finds itself in a 5th position amongst other EU competitors.

The US and Japan are consistently amongst the countries whose top quality products represent most export value to the EU market. China's position in terms of absolute export values in top quality products supplied to the EU market, remains relatively low compared to the US or Japan. But its quality position in terms of the intensive margin, i.e. the *value* shipped, is much higher than what it was based on the extensive margin, i.e. the number of quality products. Thus, while China exports relatively few high quality products to the EU market (Graph VI.7), within these few products it exports a lot of value (Graph VI.9).

VI.5. QUALITY AND MARKET SHARES

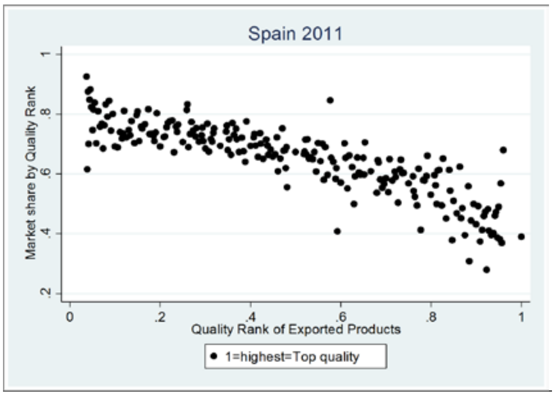
Finally, we would like to know whether high quality products typically have lower market shares than low quality products?

Scatterplots in Graph VI.10 suggest that there is a negative relationship between market share ranks (in tons) and quality ranks of export products and this is the case for all countries.([46]) Thus, high quality products tend to be more "niche" products than low quality products. For example in Graph VI.10 we show this relationship for Spain in 2011. On the horizontal axis we depict normalized quality ranks of products that are increasing. On the vertical axis, we read off the average market share rank of products where we take an average

([46]) It is well-known that weights are not ideal to measure market shares. However, what has to be kept in mind is that our comparison of weights is always carried out for varieties (country-product exports) within the same disaggregate product market (cn8).

market share per quality rank category. We clearly see a negative relationship between the two. This implies that across products, high quality products have lower market shares than low quality products. For Spain in particular, this relationship has a steepness coefficient of -0.88 in the year 2011. All other countries also display this same negative relationship which turns out to be strongly statistically significant when regressing average market share ranks on quality ranks for all countries or for each country separately. This reflects the fact that higher quality products typically represent "niche markets".

Graph VI.10: **High quality Products are Niche Products (average market share in tons)**



Source: Own calculations

However, it should be noted that quality typically pushes out the demand curve of the quality variety and is likely raise consumer willingness to pay for the variety. This is what we will explore further in a later section when we consider the price elasticity of quality.

VII. PRICE ELASTICITY OF QUALITY RANKS

The quality indicator that we developed and documented above is a measure that is available at product-level. This allows us to verify to what extent quality raises consumers' willingness to pay for a variety (country-product). The availability of a quality indicator at a very disaggregate product-level indeed allows for a regression where we can test the effect that a change in quality has on prices. For this purpose we run the following specification:

$$\mathrm{lnp_{cit}} = \alpha + \beta.\,\mathrm{ln\_quality_{ci}} + \gamma.\,\mathrm{lncost_{ci}} + \delta_{it} + u_{cit} \qquad (1)$$

Where the left-hand side variable p, are the unit values from the COMEXT trade data that proxy for export prices of products shipped to the integrated EU destination market and originating from the countries considered in our sample (most EU countries and their world competitors US, China and Japan). We consider annual price data between 2005 and 2011 for every product i, shipped by country c.

The variable quality in (1) is the normalized quality rank for each exported variety (country-product). The quality rank measure refers to the ranking of a country-product in a particular product market (cn8) and stems directly from the theory as explained in section III. To mitigate for the potential endogeneity of the *quality* ([47]) variable, in the regression we use and instrumental variable approach (IV) and engage in a number of robustness checks.

The cost variable in (1) is a unit variable cost for each product operating in a particular CN8 product market. The variable costs that we consider consist of the sum of material costs and wage costs at firm-level as a share in turnover as explained in section III. ([48]). In regression (1) we consider a normalized cost rank for each exported variety. To mitigate for the potential endogeneity of the *cost* variable we also include it in the instrumental variable approach. ([49])

By considering variables in logs on both sides of the equation, we can interpret the estimated coefficients beta and gamma as price elasticities of quality and cost respectively.

The results obtained from (1) on the estimated elasticities are verified under different regression specifications with and without the inclusion of fixed effects. Our preferred specification is one where we include product fixed effects (δ_i) and year (η_t) fixed effects and country fixed effects (ρ_c). The insertion of these fixed effects ensures that we consider the cross-sectional relationship between quality and prices within product markets. The variable u_{cit} should then be white noise only.

Also, to enhance robustness we will verify results on the unrestricted sample of unit values as well as a sample where we trim the top and bottom percentiles to control for outliers.

The results for the simplest OLS regressions i.e. without controlling for the potential endogeneity, of quality and cost, are reported in columns (1) and (2) of Table VII.1. In the first column we run an OLS regression of quality on price without explicitly controlling for costs and without including any type of fixed effects. In the regression, we use all the available quality information in every year. The average price elasticity of quality ranks that we obtain from column (1) is 0.88 which correspond to the coefficient beta in (1) which is positive and highly significant.

In the second column of Table VII.1, we additionally include a control for variable cost. The average price elasticity of quality ranks (controlling for cost) now lies around 0.5, while

([47]) Price may affect quality, therefore we need to correct for the possibility of reverse causality.

([48]) From the company accounts ORBIS we obtained the total variable cost (c.q) as a share in turnover (p.q) at firm-level. This resulted in a c/p variable cost share per firm. For each primary Nace industry we retained the median c/p ratio and mapped it via the CPA concordance into CN8 product-level cost shares. A multiplication of the unit value (p) at product-level (cn8) with the cost share (c/p) ultimately gave us a variable cost per unit (c) of the CN8 product. Taking ranks and normalizing the cost rank by the number of exporting countries per cn8, results in the normalized variable cost used in specification (1) that lies between zero and one.

([49]) In the presence of economies of scale, a lower price may result in higher sales and lower unit cost of production. To control for this potential reverse causality running from price to cost, we need to ensure that price cannot affect cost.

the average price elasticity of variable cost across all products lies around 0.4.

A first and important observation is that controlling for costs appears important when estimating the elasticity of quality. In the absence of a cost control, the elasticity appears over-estimated at 0.8. After controlling for costs, it lies around 0.5. It is clear that in the absence of a proper cost control, the quality variable is likely to pick up both cost and quality effects. When additionally inserting a control for variable cost, the estimated average elasticity of 0.5 of quality ranks on price, now represents the effect of an increase in quality rank while *keeping average cost constant*. The coefficient on the cost variable of 0.4 similarly can be interpreted as the average effect of cost on prices across all products when *keeping quality constant*. Thus, what these results suggest is that cost controls are very important to get more accurate estimates on the quality rank elasticity. Most of the literature on quality thus far has not considered cost controls, but simply considered unit values to be a proxy for quality. However, unit values do not just rise for quality reasons but also when costs rise, prices tend to go up. Therefore it is important to separate the underlying drivers of rising prices as we do here.

In column (3) we mitigate for potential endogeneities by applying an instrumental variable (IV) approach where we use one and two year lags of the quality and cost variable as instruments. ([50]) We also include country, product and year fixed effects. The elasticity of both quality and cost ranks are positive and significant and now lie again around 0.5 and 0.4 respectively. The insertion of various types of fixed effects raises the goodness-of-fit (R-squared) of the regression substantially, but does not alter the estimated elasticity much.

Thusfar, we have considered unrestricted price data, but typically price data can be noisy and characterised by outliers. To make sure that results are not driven by the tail observations, in column (4) we trim the data by keeping only prices that lie above or below the bottom and top 1st percentile. We continue to use the IV approach. Despite this trimming proceduce, it is re-assuring that the estimated elasticity for quality ranks while slightly lower does not change much, suggesting that results are robust and not plagued too much by endogeneity and outlier issues in the data.

An alternative specification than (1) would be to define each variable in the regression (price, cost and quality) in levels. We subtract their average value for the EU and taking logs of this distance from the average. Thus for the LHS variable, this would result in $\ln(p - \bar{p}_{EU})$ and similarly so for the other variables. To account for the potential endogeneity of quality and cost, we continue to use an IV approach using lags as instruments. The elasticity arising from this estimation is easier to interpret, given that we now have level variables on both sides of the regression, and is shown in column (5). Results are quite close to what we had before and they can be interpreted as follows: when the difference between the quality of variety and the EU average quality increases by 10%, the difference in the price of that variety and the EU average price of that variety, is likely to increase by 6%.

From the results in Table VII.1, we are pretty confident that the price elasticity of quality is positive and significant and lies around 0.5. The interpretation of this elasticity is that when the normalized quality rank rises with 10%, prices on average rise by 5%. The exact value of the elasticity varies with a specification but is quite robust. ([51])

These estimates of pass-through elasticities are close to other estimates that can be found in the literature. A study by Nijs et al. (2010) ([52]) finds the pass-through of costs to the consumer price to lie between 0.41 and 0.7. Thus, we can say that the elasticities reported here are in line with the literature.

([50]) We use a two-stage least squares (IV) approach.

([51]) This corresponds to the model by di Comité et al (2014) that predicts similar elasticity for cost and for quality.

([52]) Nijs, Vincent R., Kanishka Misra, Eric T. Anderson, Karsten Hansen, and Lakshman Krishnamurthi (2010), "Channel Pass-Through of Trade Promotions" Marketing Science, Vol. 29, No. 2, 250-267.

Table VII.1: **The Price Elasticity of Quality**

	Dependent Variable: ln_price c,i,t					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	OLS	OLS	IV			
ln_quality c,i,t	0.88***	0.51***	0.52***	0.47***	0.61***	-0.43***
	(536)	(97.13)	(51.24)	(52.25)	(245)	(29.31)
ln_cost c,i,t		0.41***	0.43***	0.38***	0.37***	0.30***
		(79.54)	(43.37)	(42.15)	(145)	(29.45)
ln_ladder i,t						0.539***
						(142)
lnquality x lnladder						0.33***
						(91)
Country Fixed Effects			YES	YES	YES	YES
Product Fixed Effects			YES	YES	YES	YES
Year Fixed Effects			YES	YES	YES	YES
F-test			(a)	(a)	(a)	(a)
Sargan-test			(a)	(a)	(a)	(a)
R squared	0.16	0.16	0.67	0.68	0.9	0.68
# observations	737,366	737,366	442,460	432,849	46,763	442,074

(1) in (3)-(6) we use 2SLS instrumental variable (IV) with one and 2 year lags as instruments
c: country of origin shipping the product to EU market; i: product;
t: yearly time indicator between 2005-2011
The quality indicator was normalized between zero and one before taking logs
The cost indicator was normalized between zero and one before taking logs
(a) passed at the 1% significance level
t-statistics between brackets; ***/**/* indicates 1% to 10% significance respectively
average lnladder=3
Source: Author's calculations

VIII. QUALITY LADDERS

Besides the Price elasticity of quality ranks, our approach also allows us to consider "quality ladders". The notion of quality ladders was first introduced by Khandelwal (2010), who proxied quality by a variety-fixed effect to capture the time-invariant part of quality combined with a time-fixed effect to account for the variation of quality over time. A downside of his approach is that a variety-fixed effect is likely to capture both quality and cost effects. Khandelwal (2010) argues that this is not an issue since theoretically he has a model where quality can only increase as a result of marginal cost and therefore he does not need to disentangle quality from marginal cost since both always move in the same direction.

However, in reality many quality improvements come about through fixed cost outlays. Therefore, a variety-specific fixed effect is not the best way to control for quality as it controls at the same time for a cost increase, a quality increase or a combination of both. Also, Khandelwal (2010) argues that, conditioning on price, products with a larger market share, must have a higher quality. The quality metric developed by di Comite et al. (2014), however distinguishes quality from other effects that may impact market shares but have nothing to do with quality. Conditioning on price, products may simply have a larger share because they appeal more to consumer taste without necessarily having a quality advantage.

In this paper we can thus define more accurate "quality ladders" where quality is distinguished clearly from cost effects and where taste effects do not enter the quality calculations. Our approach directly computes the quality distance in levels between varieties based on the unit value and cost information at product-level.([53]) As such, we can separate quality from variable cost elements and identify separate elasticities for both. Also, the theoretical framework on which we base our quality indicator allows quality to increase for reasons different from marginal cost.

Quality ladders are useful since they give information about the extent of product differentiation in a particular product market. A short quality ladder implies that all products are close substitutes and there is not much possibility for differentiation. A longer quality ladder suggests that consumers appreciate product differentiation and are willing to pay for it. It also means that countries have the technical capacity to differentiate their product from other products in the market they compete in. Quality ladders may thus reflect innovation efforts in a product market.

An interesting hypothesis put forward by Khandelwal (2010) ([54]), is that low wage competition is felt much stronger in industries where quality ladders are short. He postulates that an increase in quality in a product-market where quality ladders are long is a fruitful avenue for firms to escape low wage competition. Improvements in quality are expected to raise the willingness-to-pay especially when quality ladders are long.

To investigate this hypothesis on our data with our improved quality measure, in table VII.1 we interact the quality rank at country-product level, with the length of the quality ladder at the level of the product-market (cn8). Results are reported in the last column (6).

Similar to Grossman and Helpman (1991) we define the quality ladder as the distance between the high-to-low quality variety in each product market and take the log of this difference. The regression thus becomes:

$$lnp_{cit} = \alpha + \beta.ln\_quality_{ci} + \gamma.lncost_{ci} + \mu.lnquality_{ci} * lnladder_i + \Omega\ lnladder_i + \delta_i + \rho_c + \eta_t + \varepsilon_{cit} \qquad (2)$$

From column (6) we see that the interaction, captured by the coefficient μ, is positive and significant. This implies that the longer the quality ladder, the more quality improvements raise price and this confirms the Khandelwal (2010)

([53]) The difference in quality (alpha) of variety i and variety j in the model is given by the following expression $\alpha_i - \alpha_j = [2p_i - c_i + \gamma Q] - [2p_j - c_j + \gamma Q]$. Parameter gamma is an unknown, which is why quality (alpha) levels are not known. But the distance in quality is known as the γQ term, which is similar for all varieties exported to the same destination and product market, drops when taking the difference between two quality levels. The quality difference between the highest and lowest variety in the same product market is called the "quality ladder", which is similar to the Khandelwal (2010) definition.

([54]) A. Khandelwal (2010),"The Long and Short of Quality Ladders", Review of Economic Studies hypothesis. In the hypothetical case, where the log of the quality ladder is close to zero, for example where the distance between high-to-low varieties in the market is very small, raising quality would actually reduce price by a small amount. However, when introducing an interaction term, this is how we obtain the full effect of quality on price:

$$\frac{\partial lnprice}{\partial lnquality} = -0.43 + 0.33 * (\overline{lnladder})$$

Since the average value of the quality ladder (in logs) equals 3. The full effect of quality on price is around 0.47. This is almost identical to the price elasticity of quality ranks that we had without including the interaction term with the quality ladder ([55]) which is re-assuring.

Quality ladders can also be studied at the sectoral level, for example by taking the average of product ladders within a particular industry. Quality ladders can then be regressed on a number of industry characteristics such as the skill intensity of workers, the capital intensity and total factor productivity of firms.

Another future possibility is to regress measures of industry level employment on the quality ladder and import penetration by sector. One result obtained by Khandelwal (2010) on US data is for example that effect of low-wage penetration on industry level employment depends on the quality ladder. He finds that long-ladder industries with high exposure to low-wage countries suffer smaller employment declines. Thus these findings reveal that industries with similar characteristics may exhibit heterogeneous impacts from international trade because of inherent differences in vertical specialization.

It would be worthwhile to investigate such claims in the context of European data with the now better quality measure at hand. Better quality measures now opens up possibilities for investigating the role of product quality in trade patterns or in import competition.

([55]) If $\overline{lnladder} < \frac{0.43}{0.3} = 1.433$, the price elasticity would turn negative. However, the range of quality ladders in the sample is always above this threshold.

IX. CONCLUSIONS AND POLICY ISSUES

The measurement of quality is a difficult task. Given that quality is typically an unobserved product characteristic and unobserved in the data, this requires a structural model with an identifiable quality parameter.

In this paper we follow the methodology by di Comité, Thisse and Vandenbussche (2014) developed for this purpose. This allows us to construct product-level quality ranks of products, of which we can study the distribution for each European member state's exports to a common destination market.

Based on our analysis of quality as a determinant of competitiveness, one of the most striking findings is that there is a lot of quality dynamics going on in the European market. However there are only a few countries with a clear specialization in top quality products. Countries like Japan and to a lesser extent also the US, systematically offer high quality products on the EU market and their quality distribution is highly skewed to the right. China is the opposite with a quality distribution characterised by a large mass of low quality products, resulting in distribution that is heavily skewed to the left.

Amongst the EU competitors whose quality distribution is geared most towards high quality products and display a "right-hand side peak" are the "Nordic countries", like Finland, Sweden and Denmark.

Most other EU countries display a more "hump shaped" quality distribution with many more products belonging to a middle quality category. France, Italy, Austria and the UK tend to have "humps" that incline to the right-hand side of the quality distribution where the average quality of their products is higher than countries where the "hump" of the quality distribution is more centred in the middle or to the left-hand side such as Germany, Belgium and Netherlands.

Many of the former Central European countries and the Iberian countries display a "left-hand side peak" quality distribution, similar to China, with many low quality goods on offer. This is the case for Spain, Portugal and also for Poland Czech Republic, Slovakia, Bulgaria, Romania and Lithuania.

Finally, some countries like the Baltic states, Slovenia, Hungary display a "bimodal" quality distribution with two peaks in the distribution, one peak around low quality goods and one peak around high quality goods, with very few goods in the middle quality category.

In terms of quality offered, substantial country heterogeneity in the EU can be observed.

The good news is that several of the "new" European countries are moving out of the low-quality goods and into the higher quality goods relatively quickly and display strong dynamics over time despite the recent economic crisis. This is especially apparent in the Baltic states, but also for Bulgaria and Romania. Quality dynamics are also going in the direction of more high quality goods in Poland, Hungary, Czech Republik, Slovenia and Slovakia but with much weaker (slower) dynamics and much smaller distribution shifts during the same time period 2007-2011, in these countries.

For countries like Spain and Portugal, the quality dynamics are not so favourable. These countries have quality shifts that go in the opposite direction with a larger mass of products residing under the left-hand side peaks of the distribution in 2011 as compared to the year before the crisis 2007, i.e. a longer mass of lower quality products.

Denmark and Austria are countries with quality dynamics going in the "right" direction. A similar positive quality distribution shift but less strong can be observed for France and Italy.

In contrast, countries like Sweden, UK, Belgium, Netherlands have quality rank distributions that are characterized by less favourable shifts with a decreasing number of top quality products.

The analytical results presented in this study, bring us to the important policy question of whether specializing in low quality products can be a sustainable strategy for EU member states in the future.

From our analysis it is clear that quality upgrading offers opportunities to escape cost competition. The estimated price elasticity of quality that we find lies around 0.5, depending on the specification. This implies that quality upgrading is typically associated with a higher willingness to pay by consumers which may result in higher profits and higher market shares.

Also, we find that in product-markets where quality ladders are longer i.e. product-markets characterized by more product differentiation, it appears to be easier to escape the cost competition. The longer the quality ladder in a market, the more quality improvements can raise price. In a market with more homogeneous products, cost competition will be stronger. Put differently, when the quality distance between high-to-low quality varieties is small, this implies that all varieties in a product market are close substitutes and there is not much possibility for product differentiation. But in markets with long quality ladders, where consumers value quality differentiation, costs competition is less important and firms can charge higher markups.

Of course, quality upgrading is not the only strategy available to countries. Another way to gain competitiveness and to raise market share is to cut costs and produce cheaper than rivals. China is a good example of that. Chinese export products typically have very high market shares in the EU, despite the fact that China specializes in low quality products.

The danger for EU member states that continue to export low quality products is that they face tough competition from other low-quality providers such as Chinese products. In order to compete with China for market share in these products, EU member states would be subject to strong cost competitiveness. Therefore, an EU member that competes with its products in the low quality segment will be forced to rely heavily on cost controls and wage moderation.

A potential avenue to escape the cost competition is to move to higher quality segments. Future efforts should be geared towards more product innovation to push the European product-level quality distributions more in the direction of top quality products.

Quality upgrading corresponds to moving into products with higher markup per unit sold, which in turn generates additional profits to better compensate workers and to invest in innovation.

Of course a justified concern is that higher quality products often appeal only to a richer and smaller segment of consumers but may also require higher skilled workers in the production process. As such, one cannot exclude that when moving towards the production of higher quality products, this may imply lower employment levels for low skilled workers. But as long as the value-added generated at country-level allows for the compensation of this group of workers, a strategy of quality upgrading could potentially offer a good way to deal with global competition.

Appendix A - Products(CN8) exported by year and country

Table A1.1: **Products (CN8) Exported by year and by Country**

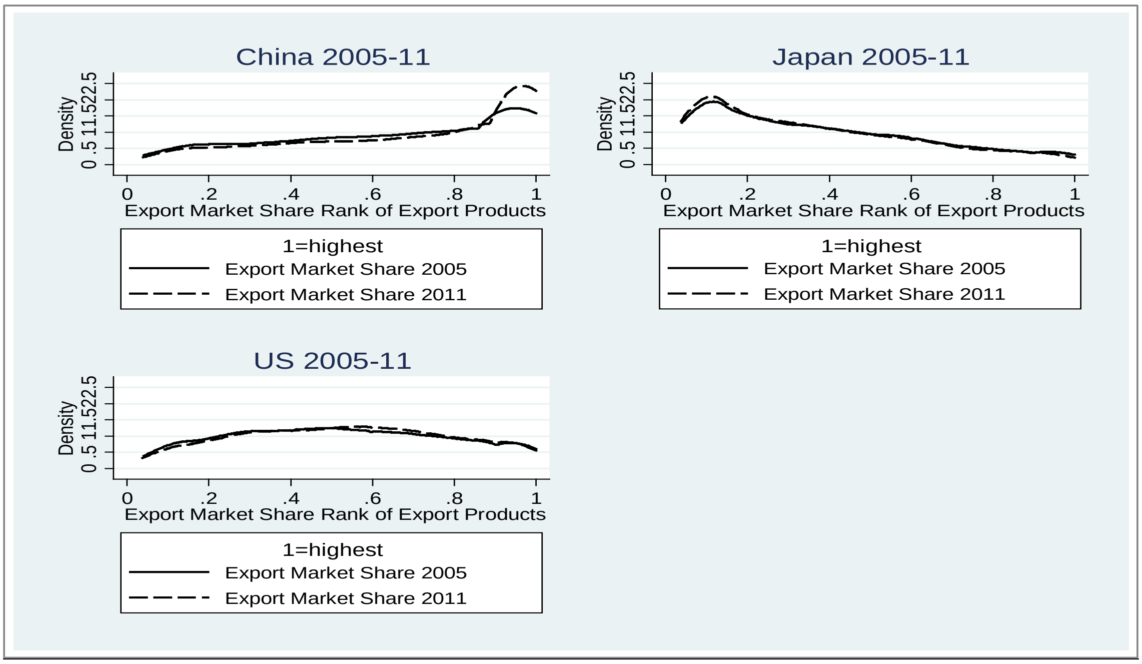
The combination of ORBIS data (for cost data) and COMEXT data (for price) resulted in the following data on the number of products exported by country on which we base our analysis in subsequent sections:

Country	2005	2006	2007	2008	2009	2010	2011
AT	4630	4352	4646	4515	4673	4515	4438
BE	6037	5903	5791	5831	5873	6036	5974
BG	2437	2702	2684	2653	2725	3199	3341
CN	1269	4035	4076	4068	4098	4077	3691
CY	44	102	164	275	286	198	156
CZ	4226	4159	4243	4307	4252	4525	4532
DE	6576	6502	6537	6555	6522	6578	6550
DK	61	38	3206	3443	3149	3349	3463
EE	1746	1728	1760	1761	1700	1948	1992
ES	6193	6126	6178	6193	6140	6244	6235
FI	3246	3224	3275	3268	3182	3355	3313
FR	6423	6354	6325	6355	6313	6408	6391
GB	6296	6213	6173	6243	6205	6298	6296
GR	2772	2515	2599	2600	2519	2858	2818
HU	3385	3231	3295	3303	3370	3700	3586
IE	2594	2730	2744	2808	2602	2619	2398
IT	6280	6215	6209	6241	6173	6298	6264
JP	3755	3769	3829	3792	3680	3692	3654
LT	1601	1664	1886	1892	1861	2191	2173
LU	1132	1089	1244	1165	1266	1419	986
LV	980	1029	1143	1134	1016	1522	1617
MT	101	108	122	120	117	112	125
NL	3475	3424	3348	2942	3084	3221	2642
PL	4459	4520	4618	4757	4774	5011	4997
PT	4519	4144	4162	4506	4482	4683	4655
RO	3262	3312	3012	3131	3087	3614	3770
SE	5115	5022	5023	5065	5005	5166	5142
SI	2652	2606	2685	2691	2632	2894	2972
SK	2622	2598	2790	2645	2654	3063	2869
US	5032	5026	4953	4927	4749	4663	4141

(1) Legend of included countries: Austria (AT), Belgium (BE), Bulgaria (BG), Czech Rep (CZ), Germany (DE), Denmark (DK), Estonia (EE), Spain (ES), Finland (FI), France (FR), UK (GB), Hungary (HU), Italy (IT), Lithuania (LT), Luxemburg (LU) , Latvia (LV), Netherland (NL), Poland (PL), Portugal (PT), Romania (RO), Sweden (SE), Slovenia (SI), Slovakia (SK), Japan (JP), United States (US), China (CN)
Source: COMEXT, EUROSTAT

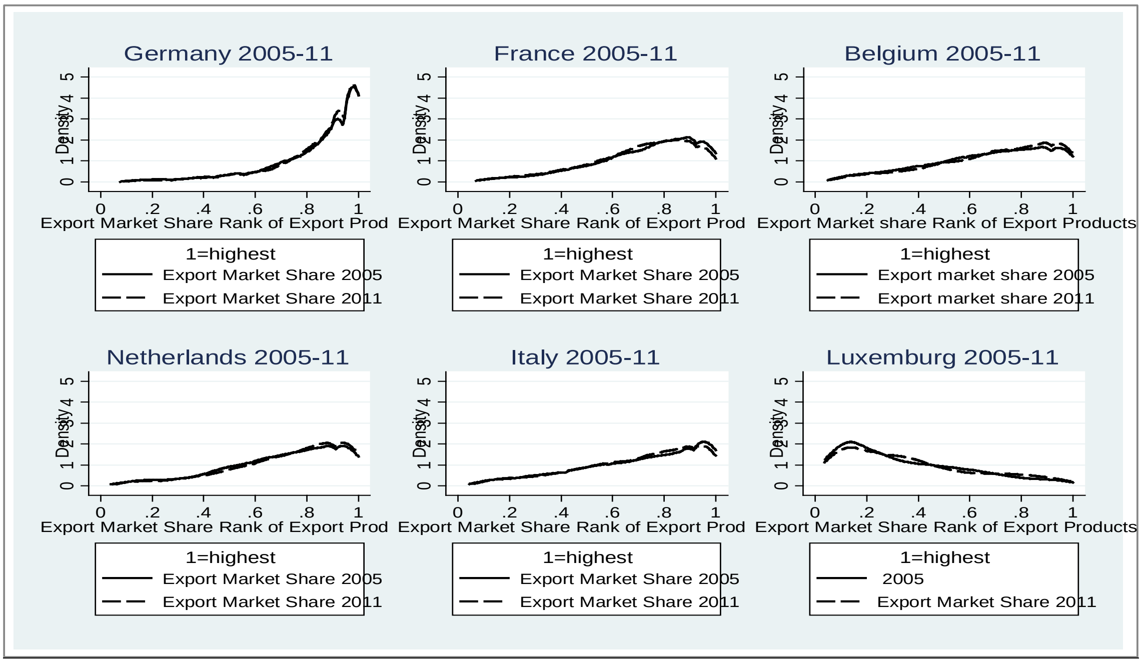
Appendix B - Market shares distributions (CN8) by country

Graph A1.1: **Market share rank distributions for China, Japan and US**



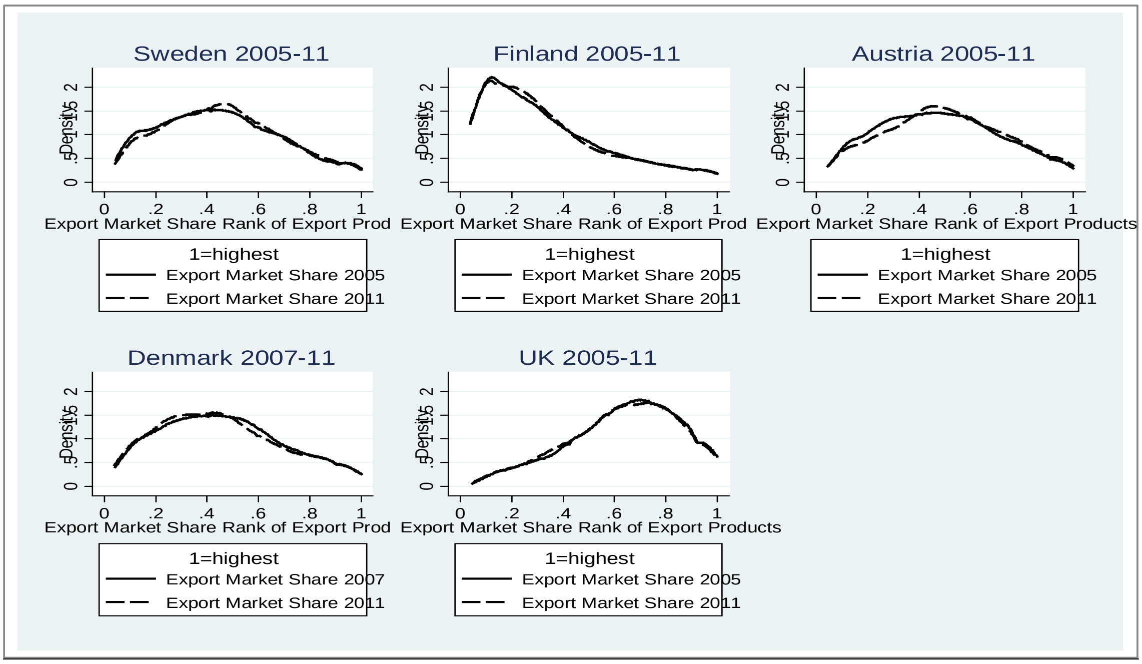
Source: Author's calculations

Graph A1.2: **Market share rank distributions for Germany, France, Belgium, Netherlands, Italy and Luxembourg**



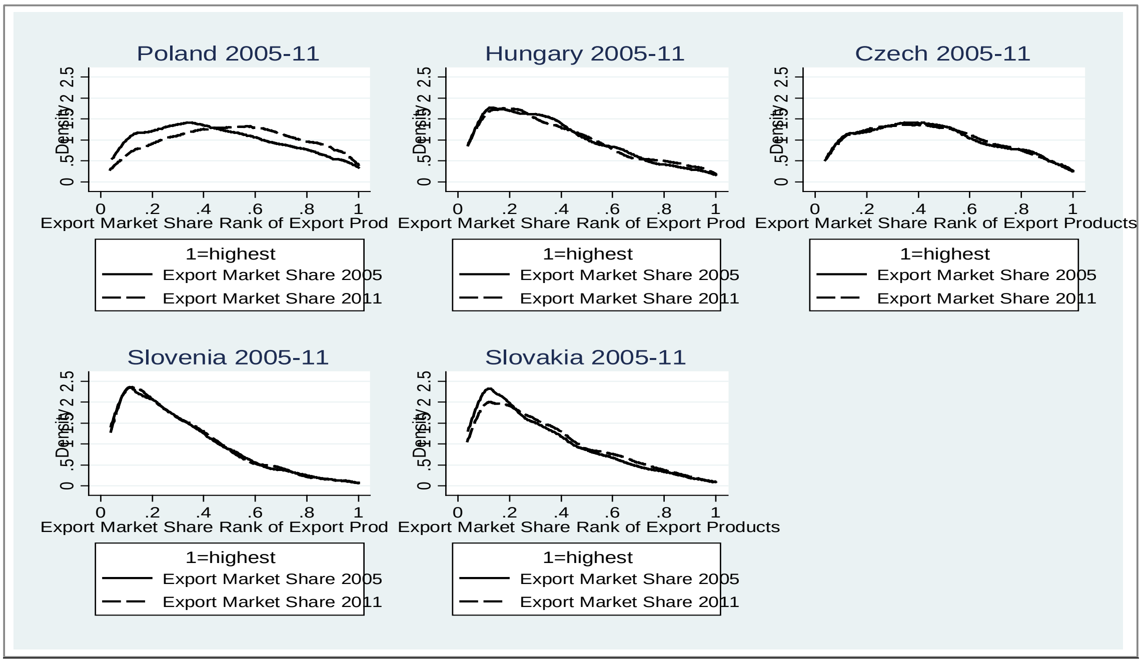
Source: Author's calculations

Graph A1.3: **Market share rank distributions for Sweden, Finland, Austria, Denmark and UK**



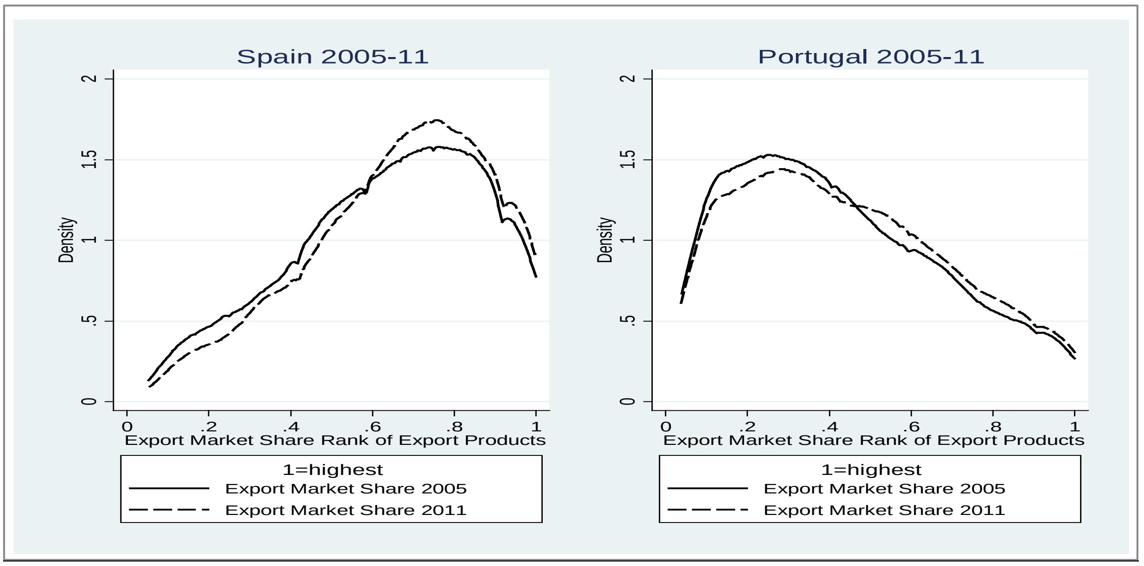
Source: Author's calculations

Graph A1.4: **Market share rank distributions for Poland, Hungary, Czech Republic, Slovenia and Slovakia**



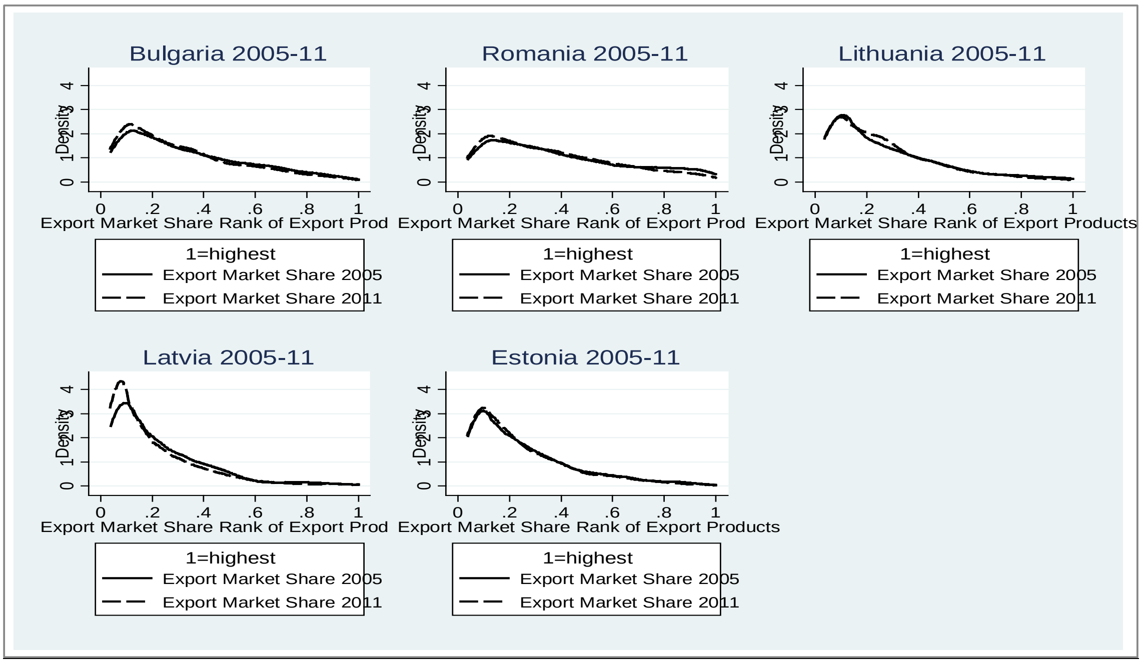
Source: Author's calculations

Graph A1.5: **Market share rank distributions for Spain and Portugal**



Source: Author's calculations

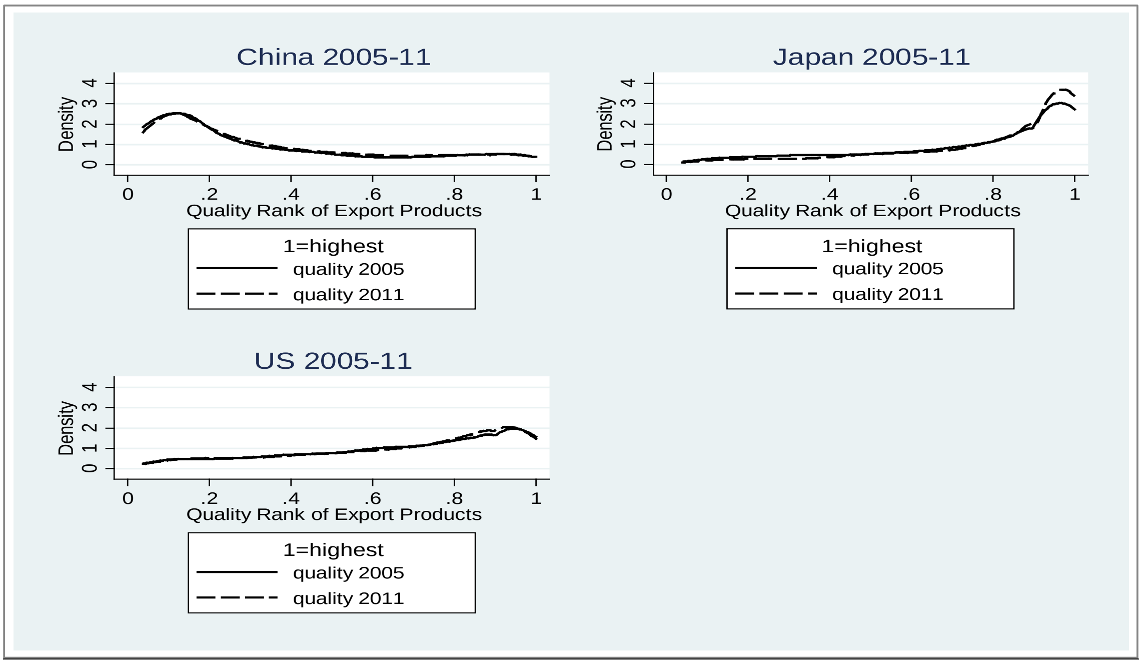
Graph A1.6: **Market share rank distributions for Bulgaria, Romania, Lithuania, Latvia and Estonia**



Source: Author's calculations

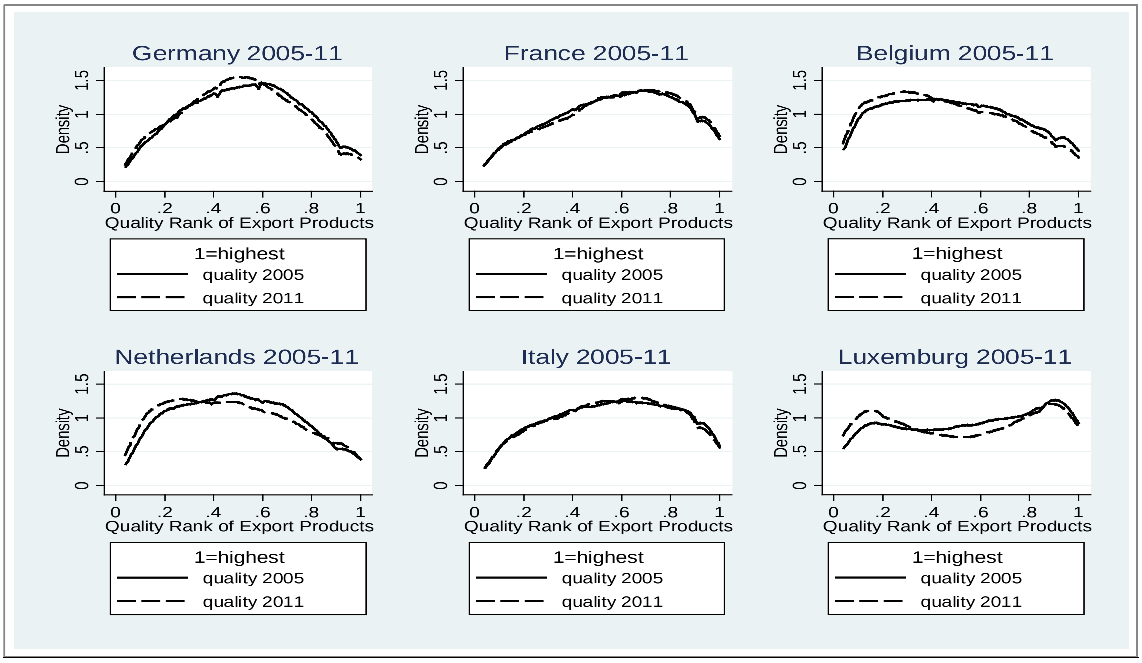
Appendix C - Quality rank distributions (CN8) by country

Graph A1.1: **Quality rank distributions for China, Japan and US**



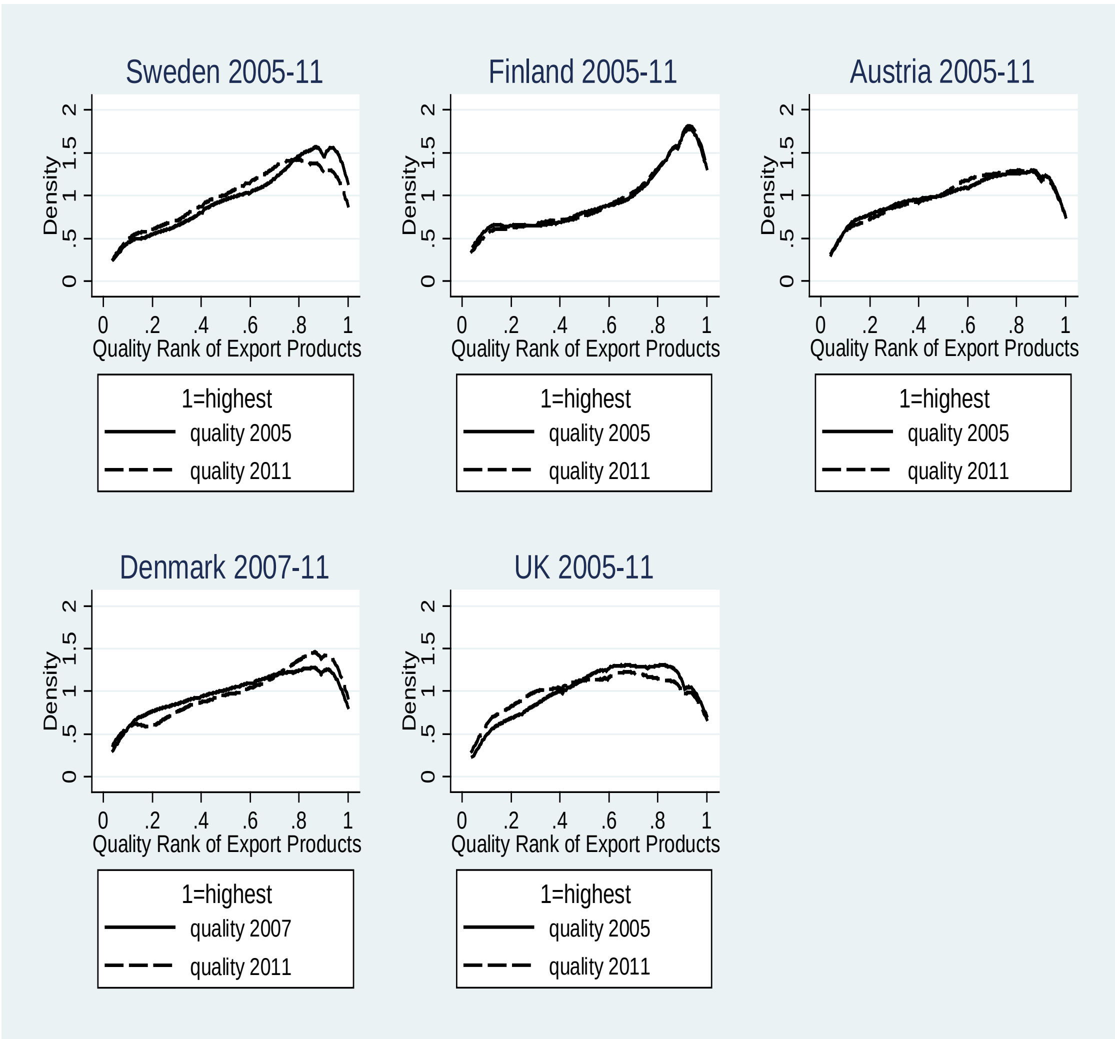
Source: Author's calculations

Graph A1.2: **Quality rank distributions for Germany, France, Belgium, Netherlands, Italy and Luxembourg**



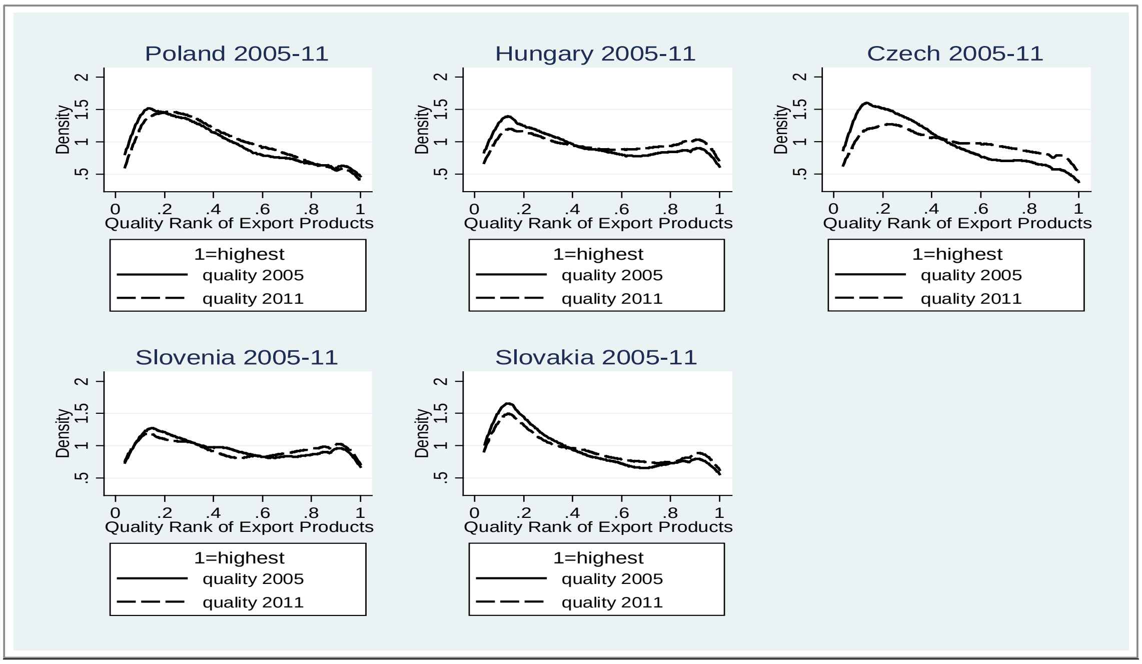
Source: Author's calculations

Graph A1.3: **Quality rank distributions for Sweden, Finland, Austria, Denmark and UK**



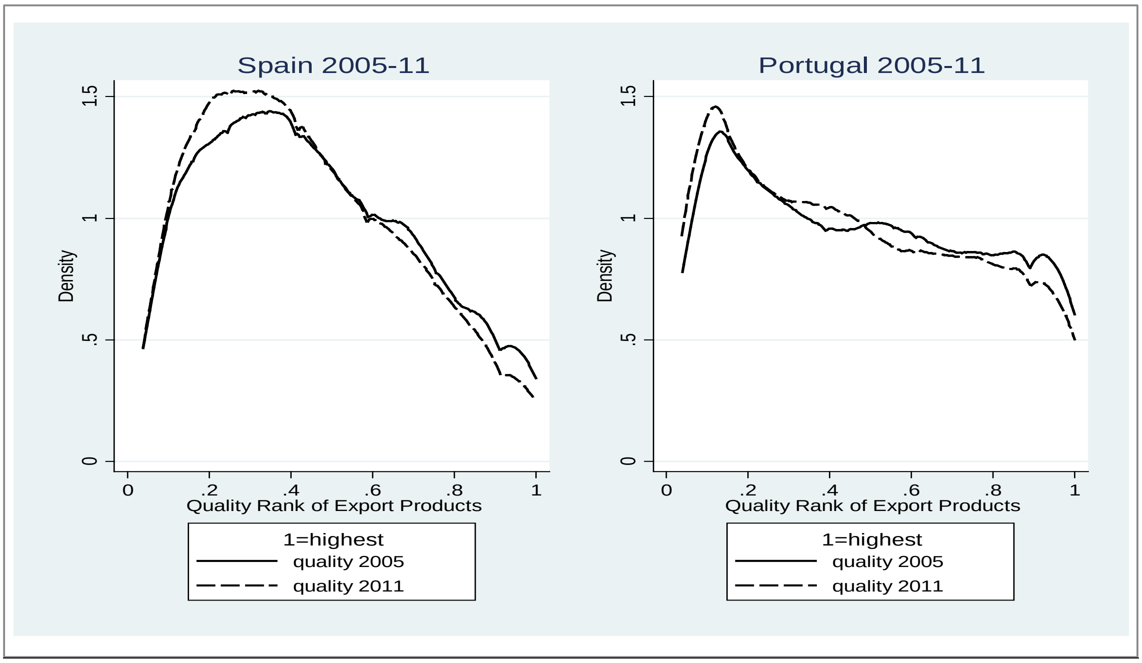
Source: Author's calculations

Graph A1.4: **Quality rank distributions for Poland, Hungary, Czech Republic, Slovenia and Slovakia**



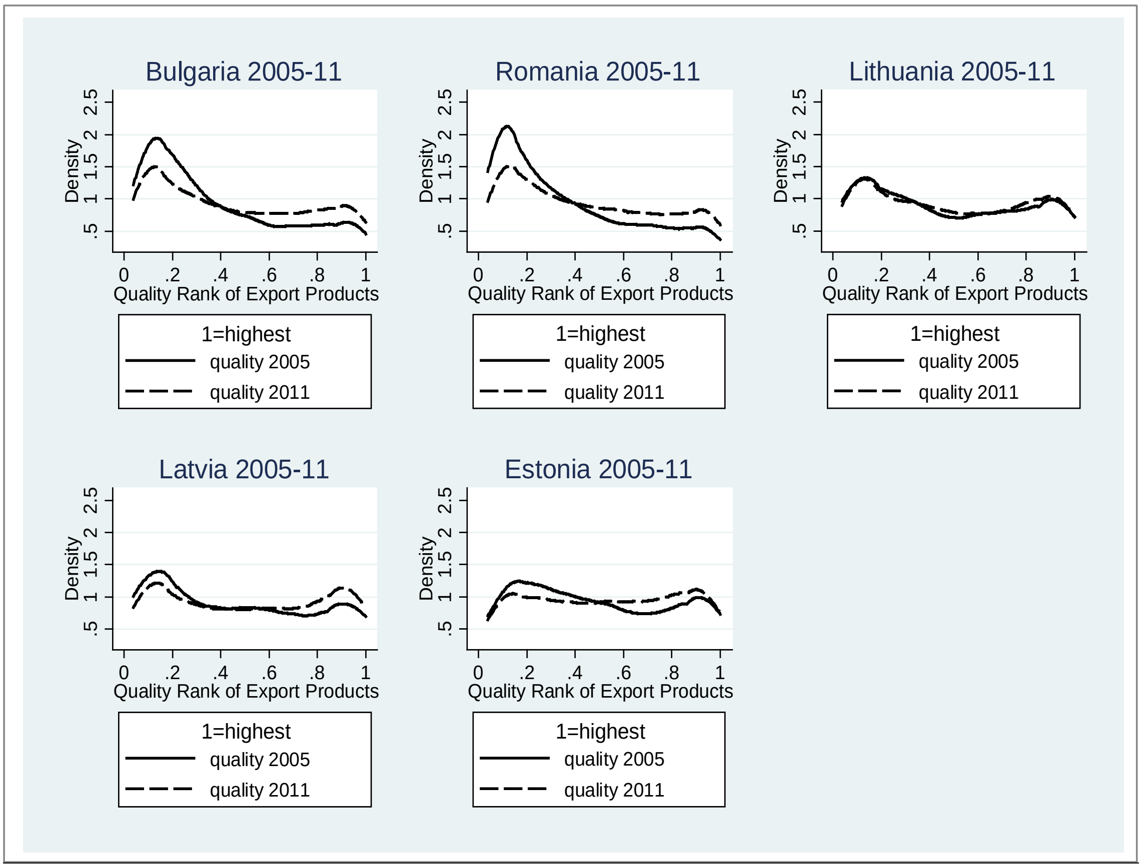
Source: Author's calculations

Graph A1.5: **Quality rank distributions for Spain and Portugal**



Source: Author's calculations

Graph A1.6: **Quality rank distributions for Bulgaria, Romania, Lithuania, Latvia and Estonia**



Source: Author's calculations

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