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Nguyen, Daniel Xuyen

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Daniel X. Nguyen

Øster Farimagsgade 5, Building 26, DK-1353 Copenhagen K., Denmark
Tel.: +45 35 32 30 01 – Fax: +45 35 32 30 00
http://www.econ.ku.dk

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The Desire for (Danish) Quality in High and Low Income Countries*

Daniel X. Nguyen†
University of Copenhagen

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Abstract

We estimate the correlation between firm prices and sales within a CN8 product-country-year market. We do this for every market to which at least 16 different Danish firms exported between 1999 and 2006. Approximately 60% of Danish exports are to markets in which the price is negatively correlated with sales. These correlations are significantly different across destination countries within product categories, but across years for a given product-destination pair. While some existing theories perform better than others at predicting these patterns, none can reconcile the variation across countries. To fully explain the patterns, We introduce a model in which the price-sales correlation can be interpreted as the market's desire for high quality goods over low cost substitutes. We discover an inverted U shaped relation between a country's desire for quality and its per capita GDP, which we term a Quality Kuznets Curve. This curve has a turning point around 10 000 Euros for Danish exports. The Quality Kuznets Curve appears both when looking across products and within products.

Keywords: exports, firm heterogeneity, quality, productivity, Kuznets

JEL Codes: F12

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†Address: Department of Economics, University of Copenhagen, Øster Farimagsgade 5, bygning 26, 1353 København K , Denmark, daniel.x.nguyen@econ.ku.dk.

1 Introduction

Do firms that supply high-quality high-cost products in a market garner higher sales than firms that supply low-quality low-cost substitutes? Recent theoretical work has suggested that differences in firm-specific technologies drive the variation of sales within a market[1]. While these works have interpreted firm-idiosyncratic technologies as differences in production costs, other studies have interpreted them as differences in production quality[2]. These two interpretations have disparate predictions on the correlation between firm prices and sales. If the price of a firm's product increases with both quality[3] and costs[4], then we can test these two predictions against one another. If firms are primarily differentiated via costs, then firms posting lower prices should garner higher sales. If instead firms are differentiated via quality, then firms posting higher prices should garner high sales.

Baldwin and Harrigan (2009) introduces a model in which quality and costs are linked: high quality production requires high costs. Although other studies have endogenized the choice of quality[5], Baldwin and Harrigan (2009) skip that step and simply assume a loglinear relationship between quality and costs. If quality increases slower than costs, then low-quality/low-cost firms will garner higher sales. If quality increases faster than costs, then high-quality/high-cost firms will garner higher sales. Baldwin and Harrigan (2009) find industry-level, cross-country evidence that quality increases faster than costs. Their results are also supported by two recent papers that run pooled regressions on firm prices and sales. Kugler and Verhoogen (2008) find a positive correlation between Colombian firms' output prices and size within industries and regions. Manova and Zhang (2009) find a positive correlation between prices and sales within a destination for Chinese firms.

This study estimates the prices-sales correlation, or elasticity, for each of 5899 product-destination-year categories supplied by Danish exporters between 1999 and 2006, instead of estimating a single number for all of an exporting country's firms. Not surprisingly, we find the elasticities vary greatly among different CN8 product categories. We show how Baldwin and Harrigan's (2009) model might reconcile this variation across products.

What is more surprising is our finding that the price-sales elasticities are not constant

[1] See Melitz (2003), Eaton and Kortum (2002), and Bernard, Eaton, Jensen, and Kortum (2003) for seminal works.

[2] e.g. see Baldwin and Harrigan (2009), Kugler and Verhoogen (2009), Hallak and Sivadasan (2009), Johnson (2009)

[3] Crozet, Head, and Mayer (2009) find firm level evidence for this for French wines.

[4] This is a cornerstone of Krugman (1980) and most of the international trade literature.

[5] See Baldwin and Harrigan (2007) for a more detailed discussion.

across destinations even within the same product category. Over 70% of Danish exports are sold in product-destination-year markets which have price-sales elasticities that are significantly different than other destinations. This variation across destinations cannot be reconciled by any known model, although Baldwin and Harrigan (2009) come close. In their model, firm-specific-quality is preferred by all destinations equally. Therefore, two firms, each with publicly known prices and qualities, should garner the same relative sales in all destinations.

To reconcile this cross-country variation, this study introduces a model that allows destinations to differ in whether they prefer high-quality varieties or low-cost substitutes. We call this preference the "desire for quality." Suppose the US has a (very) high desire for quality for Danish eyeglasses while India has a (very) low desire. Then a higher quality Danish eyeglasses firm would have higher sales in the US, but lower sales in India. We show that, within our sample period, the desires for quality are stable across years.

Finally, this study looks at the relationship between a country's income and its desire for quality. That is, we estimate the correlation between a country's population/income and its desire for quality within a product category. Curiously, we discover an inverted U relationship between a country's income and its desire for quality. Countries with higher incomes increase their desire for high quality manufacturing goods until it surpasses a per capita GDP around 10 000 EUR. To the author's knowledge, this relationship has not been discovered before. In keeping with the Kuznets (1995) literature, we term it a Quality Kuznet Curve.

The following section presents a general model of international trade with heterogeneous firms. We show how this general model can be simplified to that of Krugman (1979), Melitz (2003), Baldwin and Harrigan's (2009), and finally our model. Each model has a different prediction concerning the sign of price-sales correlations within product-destination-year markets. We then show evidence from Danish firm level export data to refute or collaborate these models. Finally, we show how the desire for quality correlates with per capita income, controlling for other country and product characteristics.

2 Theories relating price and revenue

This section summarizes the current literature's predictions on the relationship between price and sales by embedding several known models into a generalized model. In this generalized model, prices are affected by two sources of firm heterogeneity: quality and cost. Depending on the functional form relating quality and cost, this model collapses into that of Krugman (1980), Melitz (2003), Baldwin and Harrigan (2009), or this study's model.

We assume a small open economy such as Denmark. Denmark supplies many CN8 products indexed by n to foreign destination countries indexed by c in years $t \in [1990, 2006]$. We refer to a market by its product-country-year nct index. Each nct market is supplied by a set of firms Ω_{nct}. Each firm $f \in \Omega_{nct}$ produces a unique variety of CN8 product n. For a given market, demand[6] for those varieties is represented by U_{nct} :

$$U_{nct} = \sum_{f \in \Omega_{nct}} \left(\lambda_{nctf} q_{nctf}\right)^{\frac{\sigma_n - 1}{\sigma_n}} \tag{1}$$

where q_{nctf} is the quantity of product n sold by firm f in country c in time t. The quality shifter λ_{nctf} affects the firm's sales in market nct and will be discussed in detail momentarily. The elasticity of substitution term $\sigma_n > 1$ denotes a love of variety specific to that product. Given this utility function, a firm f pricing its variety at p_{nctf} garners the following sales:

$$sales_{nctf} = p_{nctf} q_{nctf} = \left(\frac{\lambda_{nctf}}{p_{nctf}}\right)^{\sigma_n - 1} \Pi_{nct} \tag{2}$$

where $(\Pi_{nct})^{-1} = \sum_{f \in \Omega_{nct}} \left[\left(\frac{p_{nctf}}{Y_{nct}\lambda_{nctf}}\right)^{(1-\sigma_n)}\right]$ is a market competitiveness term encompassing Y_{nct}, the total expenditure by country c on product n, and the prices of all other varieties of p in nct. Since Denmark is a small country, the mass of Danish firms exporting to c does not affect Π_{nct}[7].

Given a constant marginal cost production function, the firm will set its profit maximizing price as a constant markup over that marginal cost. Therefore, if p_{nctf} differs between firms in a market, this reflects differences between firms' marginal supply costs.

The firm specific variable λ_{nctf} is often referred to as a quality shifter (See Hummels and Klenow 2003) that is known to the consumer but unobserved by the econometrician. When choosing among varieties, consumers compare the quality adjusted prices $\frac{p_{nctf}}{\lambda_{nctf}}$.

The relationship between p_{nctf} and λ_{nctf} ultimately determines how firm level prices and sales are correlated within a market. We examine the simplifications this model that match those predictions of Krugman (1980), Melitz (2003), and Baldwin and Harrigan (2009) below:

[6]This paper focuses on prediction of models using CES demand, a mainstay of the current international trade literature. The author considers the predictions of linear demand models in an upcoming study.

[7]In the data, Denmark does not constitute more than 20% of any country's total imports for any CN8 product.

2.1 Model 1: All firms are the same

The seminal Krugman (1980) model does not address price/revenue variation among firms within a market. Algebraically, it assumes that $p_{nctf} = p_{nct}, \lambda_{nctf} = 1 \forall f \in \Omega_{nct}$, or posted market prices are the same for all firms within a market. If we interpret Krugman (1980) seriously, Equation 2 simplifies to

$$sales_{nctf} = p_{nct}^{-(\sigma_n - 1)} \Pi_{nct} \tag{3}$$

See that there is no f term on the right hand side: Krugman (1980) does not account for any variation in sales across firms. Since all firms post the same prices in market nct, taking Krugman (1980) seriously implies that there is no correlation between the prices and sales of firms within a market. Any variation in prices or revenues can be viewed as measurement errors.

2.2 Model 2: Firms differ by costs.

Melitz (2003) was one of the first trade models to incorporate firm heterogeneity into a Dixit-Stiglitz setting. Algebraically, it assumes that firms differ in prices p_{nctf} but share the same quality $(\lambda_{nctf} = 1)$. In a Melitz (2003) world, equation 2 simplifies to

$$sales_{nctf} = p_{nctf}^{-(\sigma_n - 1)} \Pi_{nct} \tag{4}$$

Here we see the firm-level price-sales elasticity $(= -(\sigma_n - 1))$ is negative. High cost firms have higher prices and consequentially lower sales. Melitz suggests that, within a product-destination-year market, prices and sales are negatively correlated.

2.3 Model 3: Firms differ by quality.

A footnote in Melitz (2003) suggests that the model can be easily viewed as a quality heterogeneity model instead of price heterogeneity model. To match that in our model, we can simplify $p_{nctf} = p_{nct}$ but maintain heterogeneous quality λ_{nctf} across firms[8]. In a Melitz (2003) quality heterogeneous world, equation 2 simplifies to

$$sales_{nctf} = p_{nct}^{-(\sigma_n - 1)} \lambda_{nctf}^{\sigma_n - 1} \Pi_{nct} \tag{5}$$

[8] Kugler and Verhooven (2008) show a Pareto distribution version of the Quality Melitz Model, but assume that quality increases marginal costs, as in Baldwin and Harrigan (2009). We do not make that assumption here.

This model has the same predictions regarding price and sales that of Krugman (2003). Since all firms post the same price p_{nct}, there should be no correlation between price and sales. In this model, we interpret variations in sales as due to quality differences among firms, instead of measurement error.

2.4 Model 4: Quality comes at a cost

Baldwin and Harrigan (2009) assumes that quality is monotonically increasing with the firm's price. This assumption comes out of a literature existing before the advent of firm-level datasets (See Hummels and Klenow, 2003; Hummels and Skiba, 2003). Other papers (e.g. Kugler and Verhooven 2008) endogenizes the choice of quality given an exogenous marginal cost draw, which leads to a one-to-one mapping between costs and quality. Baldwin and Harrigan (2009) abstracts from this quality choice problem because the relationship is one-to-one. In their words, models of quality "invariably deliver a mapping between an exogenous parameter... and the possibly endogenous supply of quality." Therefore, if a firm's quality is optimally chosen after a firm is endowed with an exogenous cost parameter, the resultant choice function could simplify to a monotonic relationship between exogenous costs and endogenous quality.

Specifically, Baldwin and Harrigan (2008) uses the quality production function $\lambda_{nctf} = \lambda_f = p_f^{\theta+1}$, $\theta > -1$, to model the relationship between the firm price and quality. Baldwin and Harrigan term θ as the "quality elasticity", and it denotes how expensive it is to upgrade product quality. The market price p_{nctf} then reflects both the quality of the good and its supply cost. With these relationships, equation 2 simplifies to

$$sales_{nctf} = p_{nctf}^{\theta(\sigma_n - 1)} \Pi_{nct} \tag{6}$$

This model is more flexible than the ones discussed prior. The sign of the price-sales elasticity ($= \theta(\sigma_n - 1)$) depends on θ. If $\theta < 0$, then prices are negatively correlated with sales. If $\theta > 0$, then prices are positively correlated with sales. Baldwin and Harrigan (2009) estimate $\theta(\sigma_n - 1)$ using industry level price and sales variation across countries to provide evidence that $\theta > 0$, on average.

As discussed earlier, empirical price-sales correlations supporting $\theta > 0$ is also provided by Kugler and Verhoogen (2008) and Manova and Zhang (2009).

2.5 Model 5: Markets desire quality differently

The brilliance of Baldwin & Harrigan (2009) is in their flexible form connecting quality and price. It would be quite straightforward to place an n subscript on θ and suggest that some products have $\theta_n < 0$ and others have $\theta_n > 0$. We then can use price-sales correlations for each product that Denmark exports to measure the quality elasticity of that product.

Using Baldwin and Harrigan's setup restricts us to the same product-specific θ across destinations, however. As we will see in the empirics section, price-sales correlations are not constant across destinations. And the magnitude and direction of the correlation depends on destination specific characteristics as well as product category. In Baldwin and Harrigan's (2009) framework, we would need to add a c subscript to θ to account for this variation. But a quality production function $\lambda_{nctf} = p_f^{\theta_{nc}+1}$ suggests that the firm's quality is not constant across destination. The firm needs to have a different production line for each destination. Would a Danish pencil maker build a line to make high quality pencils for export to Norway and then build another line to make low-quality pencils for export to India? The literature to date assumes that a firm's production coming off a single line, with a firm-specific quality.

If all of a firm's output comes off a single production line with identical qualities regardless of their export destinations, then we need a market-specific factor to reproduce the variation of price-sales correlation across markets. We accomplish this by assuming markets desire quality differently. We interpret λ_{nctf} as market $nct's$ added utility from consuming a unit of firm $f's$ output. Then, we model the relationship between λ_{nctf} and p_{nctf} as

$$\lambda_{nctf} = \lambda_f^{d_{nc}+1}, \tag{7a}$$

$$p_{nctf} = b_{nct} p_f, \tag{7b}$$

$$\lambda_f = p_f. \tag{7c}$$

In the first equation, d_{nc} denotes market $nct's$ desire for quality. The λ_{nctf} term increases if the firm-specific quality λ_f increases, or if market $nct's$ desire for quality d_{nc} increases. The second equation says that firms prices can be separated into an average market price b_{nct} and the firm's market-differenced price p_f, or its price compared to its competitors in nct. The last equation embodies the assumption that market-differenced prices p_f increases with production quality λ_f. We could embed Baldwin and Harrigan's θ into equation 7c, but then θ would not be identifiable separately from d_{nc}.

Given this setup, equation 2 simplifies to

$$sales_{nctf} = p_f^{d_{nc}(\sigma_n - 1)} b_{nct}^{1-\sigma_n} \Pi_{nct} \tag{8}$$

This model is even more flexible than Baldwin and Harrigan's (2009). Price-sales correlations can now vary across products and destinations. In markets where $d_{nc} > 0$, consumers desire high quality goods and are willing to pay for them. In those markets, higher-quality, higher-price varieties would enjoy high revenues. In markets where $d_{nc} < 0$, consumers desire low-price, low-quality goods over high price, high quality goods. In those markets, lower priced varieties would enjoy higher revenues.

To be clear, if $d_{nc} = d \forall n, c$, then this new model is isomorphic to Baldwin and Harrigan's (2009) except for causal interpretation. The algebra is essentially identical. The difference between the two models is the channel by which price and sales are correlated. Baldwin and Harrigan (2009) suggests that the price-sales elasticity arises primarily from a costly production of quality. It is difficult to imagine these quality production costs to also vary across destinations. Our desire-for-quality channel allows price-sales correlations to vary across destinations within a given product by allowing countries to differ in their desires to have high quality varieties. Like Baldwin and Harrigan (2009) this model can be closed by assuming a steady-state equilibrium with sunk costs of entry.

Although we could place a t subscript on the desire d term, we assume that the desire for quality does not change within a country over the time period examined. We test this assumption below.

3 Data

The Danish External Trade Statistics provides product-level destination-specific export data for all Danish firms for the years 1999-2006. The initial dataset consisted of over 1.6 million observations of annual firm sales by 43924 manufacturing[9] firms to 210 countries at the 8 digit Combined Nomenclature (CN8) totalling 2 trillion Danish kroner (DKK). In addition to firm sales, the dataset reports shipment weights in kilograms. CN8 product-firm-destination-year specific prices are calculated as the ratio of sales to weight. See Statistics Denmark (2003) for data details.

First, to minimize possible measurement error, we drop the bottom and top one percentiles of sales. These restrictions corresponded to sales below 30 and above 2.2e7 DKK.

[9]Manufacturing firms are ones that self-report a 2 digit NACE industry code between 15 and 39, inclusive.

We repeat for weights (below 1 and above 931356 kilograms) and prices (below 1.46 and above 14704 DKK/kg).

Since we are estimating price-sales elasticities within CN8 product-country-year markets, we consider only those markets with greater than 15 Danish firms. There are 5899 such markets, comprising 168615 observations totalling 84 billion DKK across 423 CN8 products, 6526 firms, and 52 countries. This is only five percent of total Danish exports in the time frame, but we are constrained by our regressions, which require within market variation of prices and sales. The vast majority of Danish exports are to markets comprising few Danish firms, and we cannot look at within-market firm competition in those markets.

Table 1 summarizes price, weight, and sales in our final dataset, separating the variation into that across firm within a CN8 product-country-year market and that within a firm and across markets. Most of the variation is across firms: that variation is 2-3 times that of the variation across markets.

For population and per capita GDP, we obtain values from the Penn World Tables (Heston, Summers and Aten 2006). Since our regressions using these values are cross-sectional, we use the average 1999-2006 population and per capita GDP for each country. Distances are recorded as log kilometers between the national capital and Copenhagen.

4 Testing the Models

Econometricians do not observe quality[10] or marginal cost. However, we do observe firm-level prices and sales for each of 5899 product-destination-year markets. By estimating the price-sales elasticities, we can test the validity of each of Equations 3, 4, 5, 6, and 8 corresponding to the models discussed above. All of these equations, when in log form and adding an error term ε_{nctf}, can be characterized by:

$$\ln sales_{nctf} = A_{nct} + \beta_{nct} \ln p_{nctf} + \varepsilon_{nctf} \tag{9}$$

where A_{nct} is a constant and β_{nct} is the firm-level price-sales elasticity in a market. In equations 3 5, $\beta_{nct} = 0$. In equation 4, $\beta_{nct} = -(\sigma_n - 1)$. In equation 6, $\beta_{nct} = \theta(\sigma_n - 1)$. Finally, in equation 8, $\beta_{nct} = d_{nc}(\sigma_n - 1)$.

To discern which of these models best describes the variation of Danish firm exports, we need to compare our estimates of β_{nct} with the predictions of the models. We can summarize the predictions of the models described above as such:

[10] The notable exception being Crozet, Head and Mayer (2009) discussed in the introduction.

1. Models 1 (Krugman, 1980) and 3 (Quality Melitz, 2003): $\beta_{nct} = 0 \forall n, c, t$.

2. Model 2 (Melitz, 2003, Costs): $\beta_{nct} = \beta_n < 0 \forall c, t$.

3. Model 4 (Baldwin and Harrigan 2009): $\beta_{nct} = \beta_n > 0 \forall c, t$.

4. Model 5: $\beta_{nct} = \beta_{nc} \forall t$.

Predictions 1-4 can be tested by estimating β_{nct} for a specific CN8 product-country-year market. If $\beta_{nct} < 0$ for a particular market, we refer to that market as a cost-driven market, since that market is consistent with a Melitz (2003) type cost heterogeneity story. If $\beta_{nct} > 0$, then we refer to that market as a quality-driven market.

4.1 Price-sales elasticities within markets vary greatly

We estimate the price-sales elasticity β_{nct} in equation 9 for each of the 5899 CN8 product-country-year markets in our final dataset. Summary statistics for the prices, weights, and values are presented in Table 1. The histograms in Figure 1 illustrates the distribution of the results of the regressions. As the histograms show, price-sales elasticities vary greatly across markets: the mean elasticity across all of the markets is -0.024, with a standard deviation of .66. Slightly more than half are negative. This result suggests that firms compete in both cost-driven markets and quality-driven markets. Even as we rule out small sample errors by including only markets with more than 25 (in gray), or more than 50, firms (in white), the spread of the distribution does not change significantly.

When we weigh the results by the total Danish sales to that market, the distributions of β_{nct} shift to the left, as seen by the histograms in Figure 2. Approximately 60% of Danish exports in the sample are to markets with a negative price-sales elasticity. The elasticities are still centered close to zero, with a mean of -0.20, -0.16 and -0.6 for markets with greater than 15, greater than 25, and greater than 50 firms, respectively.

Out of the 5899 markets examined, 1501 exhibit price-sales elasticities that were significantly different from zero[11]. These markets accounted for just over 26% of total sales. Figure 3 shows that most of the insignificant markets were from the middle of the distribution. Removing the insignificant β_{nct} splits the distribution into two: of the significant markets, 45% of markets exhibited a negative price-sales elasticity, a decrease from the 60% we found in the overall sample of all β_{nct}. Restricting the sample to only markets with greater than 25 (50) firms further reduces that fraction to 40%(32%). Markets with

[11] at a 90% confidence level using a two-sided T-test.

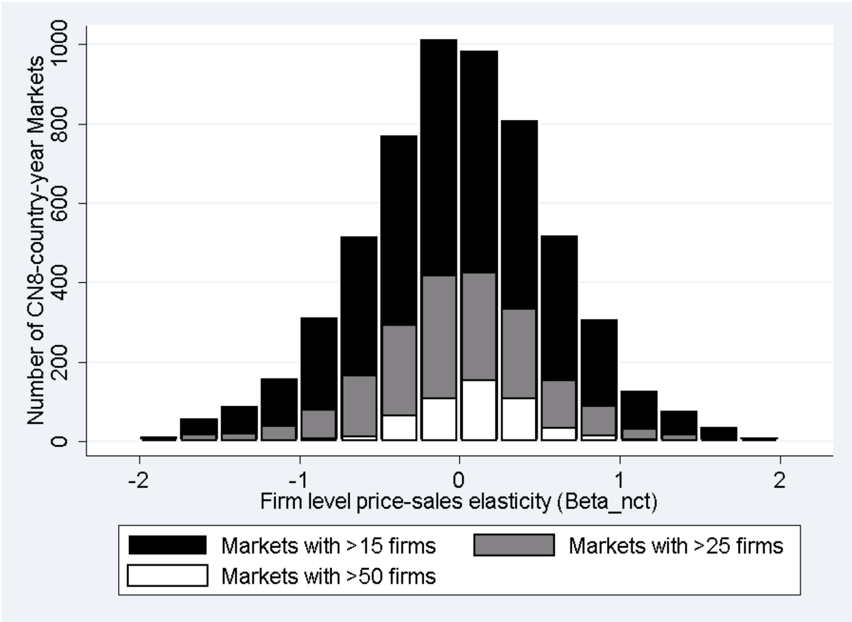

Figure 1: Price-Sales Elasticities β_{nct} for 5899 CN8-country-year markets. The gray (white) distribution comprises only markets with greater than 25 (50) firms.

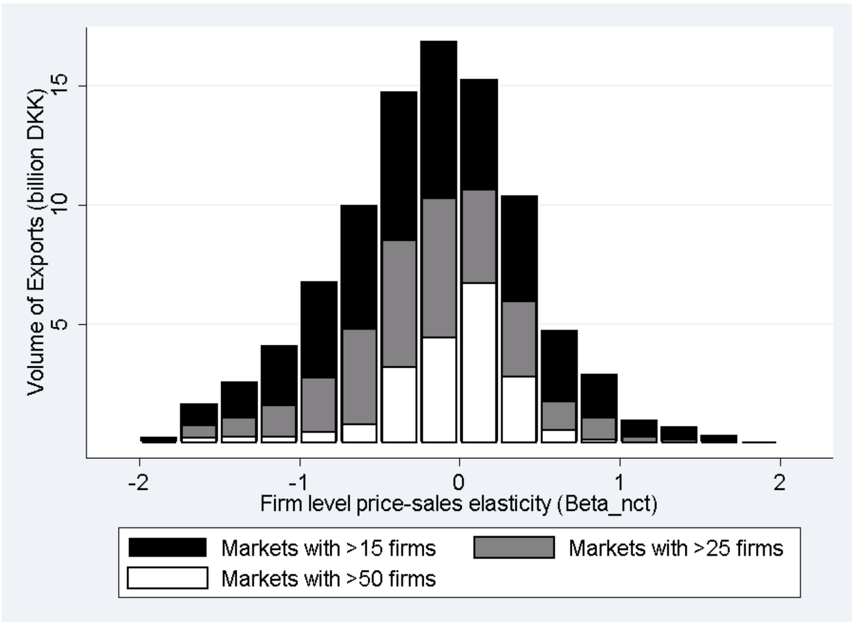

Figure 2: Price-Sales Elasticities β_{nct} for Danish exports to 5899 CN8-country-year markets, weighted by the value of the export to that market. The gray (white) distribution comprises only markets with greater than 25 (50) firms.

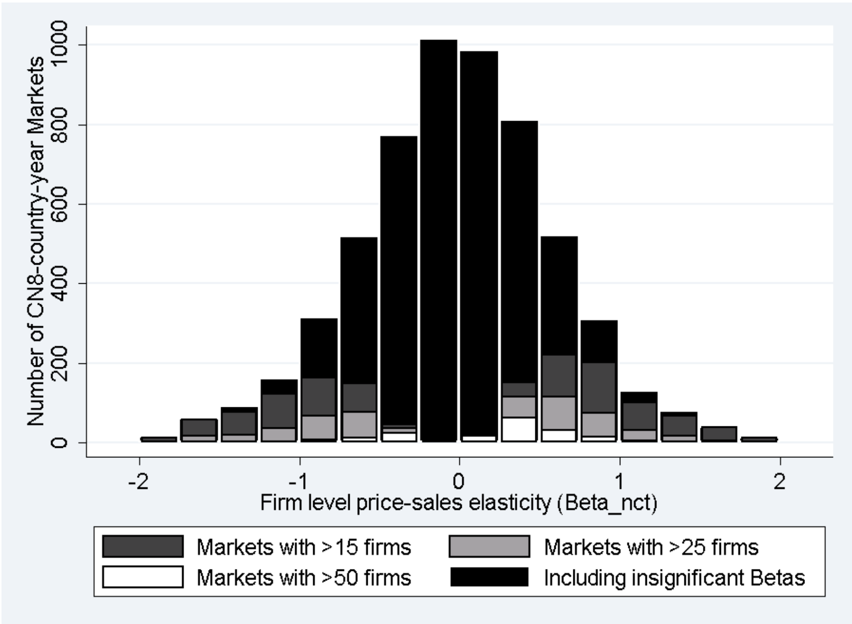

Figure 3: Price-Sales Elasticities β_{nct} for Danish exports to 1501 CN8-country-year markets where β_{nct} was significant different from 0. The light gray (white) distribution comprises only markets with greater than 25 (50) firms. The black histogram includes the insignificant β_{nct} and is provided for reference.

more firms have a higher probability exhibiting positive β_{nct}. We discuss in the next section that this may be due to differences between imports of rich and poor countries.

The distribution of significant price-sales elasticities changes dramatically when weighted by the sales in each market, as seen in Figure 4. The distribution to the left of zero increases at the expense of the distribution to the right. While 45% of markets exhibit a negative price-sales elasticity, these markets make up 71% of the value of Danish exports in our sample. Most Danish exports in our sample are to markets that support a Melitz (2003) style model where lower prices lead to higher sales.

Since three out of four estimates of β_{nct} were insignificant from zero, these results may support Krugman's (1980) and Quality Melitz's (2003) prediction that price is not correlated with sales. However, a meta-analysis[12] of the 5899 estimates of β_{nct} produces a predicted value of $\beta_{nct} = -0.05 \pm 9.7 \times 10^{-8}$, which is significantly different from zero. Krugman (1980) and Quality Melitz (2003) predict $\beta_{nct} = 0$ for all markets, which can be rejected using this metric. The insignificant estimates could be a result of a low θ_{nct} in Baldwin and Harrigan (2009), a low d_{nct} in Model 5, or a low elasticity of substitution

[12] Using Danish sales in market nct divided by the square of the standard error of β_{nct} as the weight for each β_{nct} estimate. For methodology, see Hartung, Knapp, Sinha (2007).

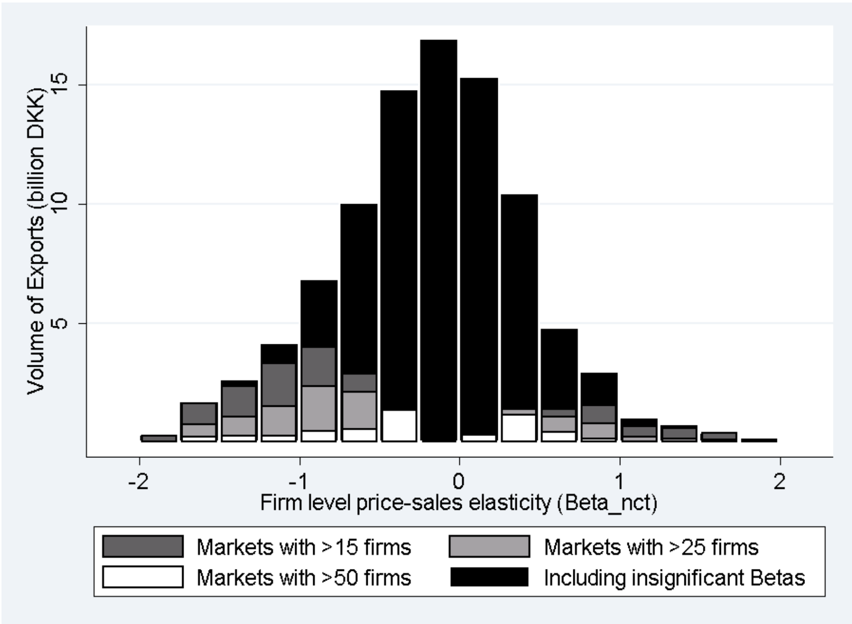

Figure 4: Price-Sales Elasticities β_{nct} for Danish exports to 1501 CN8-country-year markets where β_{nct} was significant different from 0, weighted by the value of exports to that market. The light gray (white) distribution comprises only markets with greater than 25 (50) firms. The black histogram is the same as in Figure 1 and is provided for reference.

σ_n for those particular products.

In summary, we find a large variation in price-sales elasticities across Danish export destinations. Most markets exhibit β_{nct} that provide support for Models 1-3, although Models 4 and 5 are flexible enough to reconcile these patterns. In our next exercise, we use the within product variation of β_{nct} to discern the models.

4.2 The elasticities are (mostly) not constant within products

We find positive, negative, and insignificant price-sales elasticities for the 5899 markets. These differences could very well be due to differences across products. Table 2 summarizes the estimates of β_{nct} separated by broad Harmonized System (HS) sectors. The table shows that the distributions of β_{nct} vary across products. For example, the mean β_{nct} in the Chemical and Plastics sector is significantly different from and the opposite sign of the mean β_{nct} in the Textiles and Footwear sector. Within our generalized model, we can account for this variation as product-specific elasticities of substitutions σ_n. However, only model 5 accounts for differences in β_{nct} across countries *within* a product category. This section tests Models 1-4's prediction that $\beta_{nct} = \beta_n$ for all products n in our sample.

We test whether the price-sales elasticities are constant across countries within a CN8 product category. To put it another way, are the within-market price-sales elasticities for Danish wooden chairs the same for all countries importing Danish wooden chairs? Our test is a standard Wald test for the null hypothesis $H_{0n} : \beta_{nc} = \beta_n$ against $H_{1n} : \beta_{nc} \neq \beta_n$. To do so, we pool together the observations for markets within each product n and regress the following:

$$\ln sales_{nctf} = A_{nct} + \beta_n \ln p_{nctf} + \boldsymbol{\eta}_{nc} \left(\mathbf{Dummy}_{nc} \ln p_{nctf} \right) + \varepsilon_{nctf}. \tag{10}$$

where $\mathbf{Dummy}_{nc}$ is the vector of product-country specific dummies with corresponding specific slope vector $\boldsymbol{\eta}_{nc}$. If H_{0n} is correct, $\boldsymbol{\eta}_{nc} = 0$. For each product n, we test the joint hypothesis that $\boldsymbol{\eta}_{nc} = 0$ and capture the two-sided p-value. That is, we find the probability that at least one $\beta_{nc} \neq \beta_n$ for that product n. We can do this for 139 of the CN8 products in our sample, comprising 1572 CN8 product-destination pairs .[13]

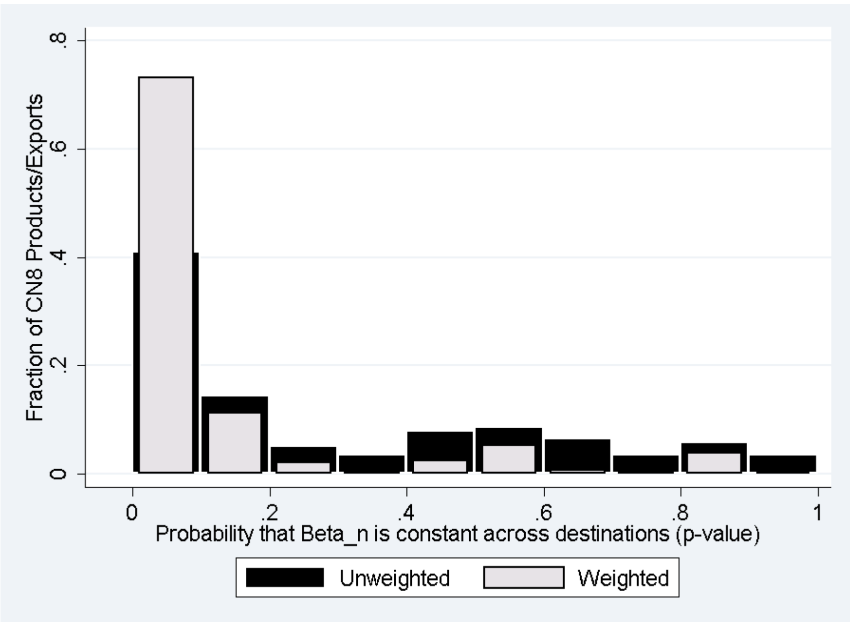

Figure 5: Probabilities of Type I error when rejecting the hypothesis that $\beta_{nc} = \beta_n$; unweighed and weighed by total Danish sales to that product.

Figure 5 presents the Wald tests p-values from the regressions of Equation 10. For about 40% of the products, we estimated less than a 10% probability that $\beta_{nc} = \beta_n$. That is, for 40% of products exported by Denmark in our sample, we reject the hypothesis

[13] The distribution of the estimated β_n is presented as Figure 9 in the Appendix, and is similar to the distributions of β_{nct} presented in the preceding section.

that the price-sales elasticities are identical within-product, across destinations. Those products accounted for over 70% of total sales in the sample, as illustrated by the leftmost grey bar in Figure 5.[14] In summary, a large plurality of products comprising a large majority of Danish exports have price-sales elasticities that vary across countries. This cross-country variation cannot be reconciled by models 1-3 (Krugman, 1980 & Melitz, 2003) nor a strict interpretation of Model 4 (Baldwin and Harrigan, 2009).

We can construct a more lenient test of Baldwin and Harrigan (2009) by applying a looser interpretation of the model. Suppose Baldwin and Harrigan (2009) is right, but the elasticity of substitution σ_n differs across countries. Then there would be cross country variation in β from σ_n. However, since $\sigma_n > 1$, the product $\theta(\sigma_n - 1)$ should always have the same sign for all product-destination pairs within each product. Instead of testing whether $\beta_{nc} = \beta_n$, we can test whether $sign(\beta_{nc}) = sign(\beta_n)$, as in Bowen, Leamer, Sveikauskas (1987). If the null hypothesis is correct, then the sign test should pass 100% of the time. If instead β_{nc} and β_n are independent, then $sign(\beta_{nc}) = sign(\beta_n)$ only 50% of the time. Table 3 presents the results of this more lenient test.

Table 3 shows the probability that $sign(\beta_{nc}) = sign(\beta_n)$ is not much better than a coin flip. Across the 1572 product-country pairs in our sample, only 59% have price-sales elasticities that were the same sign as the average price-sales elasticity for the corresponding product. Although the positive β_{nc} match up better, this is partially due to 55% of the β_n being positive. When weighted by sales, the sign test results are even less in favor of the null hypothesis. Only 41% (38% of significant) β_{nc} by Danish exports have the same sign as the average β_n in that product. The low percent of β_{nc} passing the sign test suggests that there is cross-country variation in Baldwin and Harrigan's θ, which is at odds with the cost of quality channel proposed in Baldwin and Harrigan (2009). However, this variation can be explained by Model 5's d_{nc} desire for quality parameter.

4.3 The elasticities are (mostly) constant across time

We showed that the price-sales elasticities vary across countries within CN8 product categories. This variation violates the predictions of Models 1-4. Model 5 is flexible enough to reconcile this variation, but assumes that β_{nct} does not vary over time within a given nc pair. That is, if tastes do not change significantly over our sample years, then Model 5 predicts that the price elasticities should not differ from year to year. We can test this prediction with the null hypothesis $H_{0nc} : \beta_{nct} = \beta_{nc}$ against the alternative

[14] We repeat this exercise for only those β_n that are significantly different from 0 and find similar results. A distribution of these results is presented in Figure 10 in the Appendix.

$H_{1nc} : \beta_{nct} \neq \beta_{nc}$. To do so, we pool together the observations for all markets within each nc product-destination category and estimate the following equation for each nc product category:

$$\ln sales_{nctf} = A_{nct} + \beta_{nc} \ln p_{nctf} + \boldsymbol{\zeta}_{nct} \left(\mathbf{Dummy}_{nct} \ln p_{nctf} \right) + \varepsilon_{nctf}. \tag{11}$$

This regression equation is similar to equation 10, and we again use the standard Wald test to test the null. The resultant p-values from those tests are summarized in Figure 6

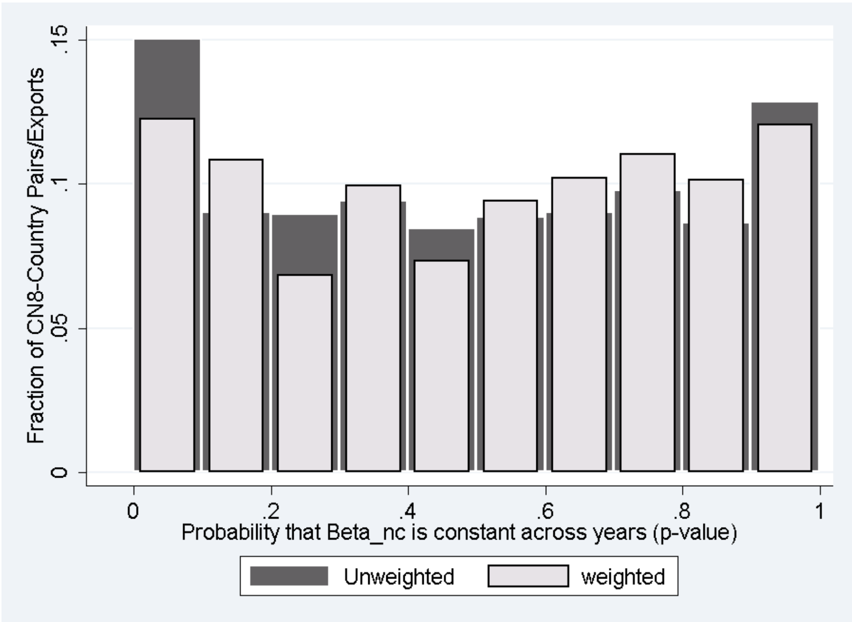

Figure 6: Probabilities of Type I error when rejecting the hypothesis that $\beta_{nct} = \beta_{nc}$; unweighed and weighed by total Danish sales to that product-country.

Price-sales elasticities are much more stable across time then across countries. Only 15% of product-country pairs have price-sales elasticities that vary over the years, as seen in Figure 6.When weighted by total exports, this number drops to 12%. Over 85% of Danish sales are to markets which have stable price-sales elasticities. This graph contrasts highly with that in Figure 5, where most of the probabilities are close to zero. This result supports Model 5's assumption of constant elasticity of substitution across time. We argue that that is support for our modelling of desire for quality as d_{nc} and not d_{nct}.

5 A Quality Kuznets Curve

We have discovered variation patterns in the firm level price-sales elasticities across CN8-country-year markets. Within a CN8 product, they vary over destination countries but not over year. These patterns are consistent with Model 5's desire for quality interpretation of the price-sales elasticity and inconsistent with the other four models'. Therefore, we now interpret β_{nc} as country $c's$ desire for quality for Danish product n. In this final exercise, we investigate the differences between countries that lead to variation for their desires for Danish quality. Table 4 summarizes the desires β_{nc} obtained from Equation 11 for different destinations. From the table, we can see that rich (per capita GDPs above 10,000 EUR (74,500 DKK)), OECD, and Western European countries import many more products than poor, non-OECD, and non-Western European countries. Those average β_{nc} in the rich, OECD, and Western European countries are also much lower than their poor, non-OECD, and non-Western European counterparts.

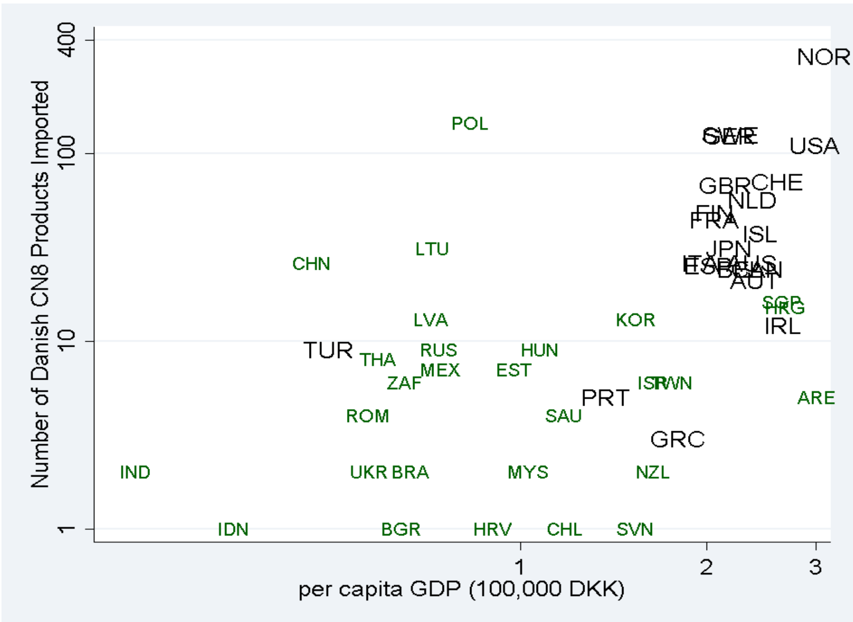

Figure 7: The number of Danish CN8 products imported by various countries, compared to per capita GDP. Big (and black) three-digit country codes correspond to OECD countries. Small (and green) codes correspond to non-OECD countries.

The relationship between income and number of Danish products imported is more apparent when seen in Figure 7. Richer countries import more products. Poorer countries import much less. Western European and OECD countries import more, but most of them are richer than the Eastern European and nonOECD countries, so there are possible collinearities. To examine this more seriously, we use probit estimations to see whether income affects the country's willingness to import products with a high average desire for quality. We generate a product's mean desire for quality $\overline{(\beta_{nc})_n}$ by averaging the corresponding β_{nc} estimated in Equation 11. Then, we run a probit regression of having positive sales $sales_{nc}$ of Danish product n in country c on country characteristics and $\overline{(\beta_{nc})_n}$. The results are found in Table 5. Across all specifications, countries farther from Denmark have a lower probablity of importing a product. Countries with higher populations and higher per capita GDPs have a higher probability of importing a product. These results are consistent with the gravity model of trade. Our variable of interest, $\overline{(\beta_{nc})_n}$, has a slightly negative effect. A one unit increase of the desire for quality decreases the likelihood of importing that product by less than 1%. Since the standard deviation of $\overline{(\beta_{nc})_n}$ is only .635, we conclude that a product's desire for quality does not have much effect on its importation into a given country. As a robustness check, the second specification interacts $\overline{(\beta_{nc})_n}$ with log per capita GDP. The coefficient on $\overline{(\beta_{nc})_n}$ turns positive, but the interaction coefficient is negative. Between the sample range of countries' per capita GDP (9.95-12.7), the marginal effect of $\overline{(\beta_{nc})_n}$ on the probability of import is not much different from zero.

The relationship between a country's per capita income and the average desire for quality for products that it imports is much more interesting. We generate a country's mean desire for quality $\overline{(\beta_{nc})_c}$ and plot it against per capita GDP in Figure 8. The desire for quality clearly rises with income for poorer countries but declines with income for richer countries. There is an inverted U shape with a turning point is between 70 and 105 thousand DKK. This curve resembles a Kuznets (1955) curve, which relates a country's income and its desire for equality. In our study, it is for the desire for quality instead of equality. We thus term this inverted U the *Quality Kuznets Curve*. As poor countries get richer, they desire more quality differentiable goods. After a turning point of approximately 10 000 Euros (74500 DKK), countries' desires for quality decrease with income. For comparison, Grossman and Krueger (1995) estimate a Kuznets Curve turning point for environmental standards at around \$7 500-10 000 in 1985 US dollars.

The Quality Kuznets Curve is also present at disaggregrated sectoral levels. Figures 11 and 12 in the Appendix show the Desire-for-Quality / income relationship at the sectoral level defined in Table 2. The sectors with over 400 observations (Chemicals and Plastics, Wood Products, Metals, Machinery and Electrical Equipment) all exhibit Quality Kuznet Curves, except the Textiles and Footwear sector. The other sectors (in Figure 12) could have Quality Kuznets Curves but for lack of observations. To complete our examination, we regress β_{nc} on country characteristics, with CN8 product dummies to control for cross-

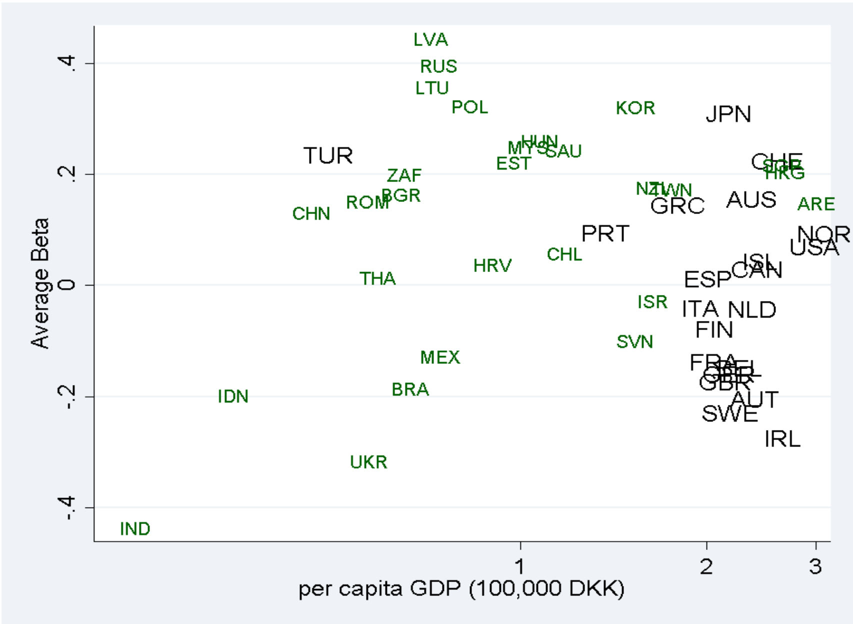

Figure 8: Average β_{nc} for each country c, compared to per capita GDP.

product variation. Table 6 summarizes the results. The base result in column 1 shows a negative relationship between per capita income and the desire for quality, although this is due to having more observations for rich countries than for poor countries. When a square per capita GDP term is introduced (column 2), the estimates for per capita GDP become insignificant. A quadratic model may be inappropriate for modelling the relationship between per capita income and the desire for quality. Instead, we investigate whether rich countries have different per capita income - desire for quality elasticities than poor countries[15]. Column 3 shows a significant negative (positive) relationship between rich (poor) countries' per capita incomes and their desires for quality. This relationship holds when we add a control for the number of CN8 products a country imports (in column 4). Our estimations are within-product; holding the imported product fixed, countries are more likely to desire quality over costs as they increase their incomes, up until their per capita incomes are over 10 000 EUR. Then, they decrease their desires for quality. This pattern has not been recorded previously (to the author's knowledge).

[15] This is tantamount to running a spline regression with a knot at 10 000 EUR (74500 DKK).

6 Discussion and Conclusion

In the heterogeneous firms trade literature, firm-specific costs and quality are often thought of as isomorphic. An increase in both results in an increase in revenue. However, decreasing costs results in a decrease in price, while increasing quality results in an increase in price. We take advantage of this dichotomy to test whether it is quality or costs that differentiates firms.

Baldwin and Harrigan (2008) provides a straightforward and simple relationship between costs and quality. This paper adds a model similar to Baldwin and Harrigan's in order to reconcile the variation of price-sales elasticities across destinations within a product category. Using firm level Danish exports, we find that price-sales elasticities vary immensely across products and destinations. A little over half of Danish products, comprising 60% of Danish exports, are to markets exhibiting negative price-sales elasticities. The fraction of negative estimations increase when we look only at elasticities significant different from zero.

At first glance, our results appear different from those of Manova and Zhang (2009). They find a positive price-sales elasticity (=0.08) within a product-destination pair when they examine Chinese firm level exports. To check our results against theirs, we repeat their exercise, running a pooled OLS of price on sales, using product-destination-year fixed effects. We estimate a significantly positive overall price-sales elasticity $\beta = 0.05$(t-stat = 11.3), in line with Manova and Zhang (2009). However, a pooled regression gives us a point estimate that does not show the rich variation across products and destinations. This study shows that we should not assume that export destination markets are either all cost or all quality differentiated.

Whether a market is cost or quality differentiated is not constant within products. Baldwin and Harrigan's (2009) channel of costly quality production alone cannot reconcile this variation. Instead, we find that the price-sales elasticity is unique to each product-country pair, and (mostly) constant over time. The price-sales elasticities are significantly related to per capita income, rising at low incomes and falling at high incomes. This is consistent with our interpretation of the price-sales elasticity as a market's *Desire for Quality.* A new discovery in this study is the existence of an inverted U relationship between a market's Desire for Quality and its per capita income. Following the Kuznets (1955) literature, we term it a Quality Kuznets Curve.

The title of this study includes the parenthetical (Danish) in the Desire for $(\cdot)$ Quality since the data comprises only Danish firms. Perhaps Denmark makes high quality goods, which low income countries see as luxury goods. As the low income countries increase their wealth, they start importing Danish goods. For countries with incomes above 74500 DKK/10,000 EUR, Danish exports are not seen as "high"quality anymore, but now compete with other goods from high income countries; therefore, relative costs are more important. This exporter-specific channel may explain the inverted U shape. A comparison between our estimates and ones from an emerging economy may shed more light on whether price-sales elasticities are caused by exporter characteristics.

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A Tables

	Mean	Std Dev	Min	Max
Price (DKK/KG)				
Overall	640	1552	1.46	14704
Between Markets		772	4.1	5583
Within Market		1341	-4465	14907
Weight (KG)				
Overall	12228	56264	1	9.3e5
Between Markets		20674	9.35	2.2e5
Within Market		54874	-2.1e5	9.1e5
Value (DKK)				
Overall	5.6e5	1.8e6	30	2.2e7
Between Markets		6.4e5	3292	5.7e6
Within Market		1.7e6	-5.0e6	2.1e7

Table 1: Descriptive statistics on the price, revenue, and weights of Danish Exports, 1999-2006 for markets with at least 16 firms. Author calculated.

		All β_{nct}			Only significant β_{nct}		
Sector Name	HS2 Range	Observations	Mean	Std Dev	Observations	Mean	Std Dev
Animal and Vegetable Products	01-24,41-44	97	-.07	1.44	20	.27	2.42
Chemicals and Plastics	28-40	839	-.11	.63	168	-.27	1.13
Wood	44-49	825	.08	.55	197	.32	.84
Textiles and Footwear	50-67	649	.36	.77	191	.92	.89
Stone and Glass	68-71	11	-.23	.53	2	-.62	.11
Metals	72-83	401	-.19	.54	78	-.53	.84
Machinery and Electrical	84-85	2044	-.03	.52	526	-.05	.82
Transportation	86-89	84	-.43	.74	29	-.67	1.11
Misc	90-97	949	-.18	.76	290	-.41	1.12
All	01-97	5899	-.02	.66	1501	-.003	1.07

Table 2: Average estimated β_{nct} by sector. Rich countries are those with greater than 10000 EUR (74500 DKK) per capita GDP. Asian Tigers are Thailand, Singapore, South Korea and Taiwan

	All		Significant	
	Observations	Same sign β_n	Observations	Same sign β_n
Unweighted				
Positive β_{nc}	770	75%	320	84%
Negative β_{nc}	802	44%	343	43%
Total	1572	59%	663	63%
	Sales (B DKK)	Same sign β_n	Sales (B DKK)	Same sign β_n
Weighted				
Positive β_{nc}	33.1	56%	15.2	59%
Negative β_{nc}	61.2	33%	38.4	29%
Total	94.3	41%	53.6	38%

Table 3: Results of the sign test. The All columns include all calculated β_{nc}, while the Significant columns include only for those that are significantly different from 0. The bottom weighted section are sign results weighted by total Danish export sales to that product-country pair. Author calculated.

	Mean β_{nc}	Median β_{nc}	Number of CN8 Products	Number of Countries	Products/ Country
All Countries	0.047	0.04	1569	50	31
OECD	-0.01	-0.01	1212	21	58
nonOECD	0.24	0.26	357	29	12
Rich Countries	0.01	0.00	1367	39	35
Poor Countries	0.27	0.28	202	15	13
East Asia	0.21	0.19	118	9	13
China	0.15	0.24	41	2	21
Asian Tigers	0.20	0.17	43	4	11
West Europe	-0.03	-0.05	954	14	68
East Europe	0.26	0.28	265	14	19

Table 4: Average estimated price-sales elasticities across countries. Rich countries are those with greater than 10000 EUR (74500 DKK) per capita GDP. Asian Tigers are Thailand, Singapore, South Korea and Taiwan

	Mean	Std Dev	Min	Max	Base (1)	Interaction (2)
Distance (log)	7.86	1.1	5.86	9.80	-.037	-.037
					(.001)***	(.001)***
Population (log)	9.89	1.67	5.62	14.1	.015	.015
					(.001)***	(.001)***
per Capita GDP (log)	11.66	.608	9.95	12.7	.075	0.77
					(.003)***	(.003)***
Average $\overline{(\beta_{nc})}_n$	.126	.635	-6.02	2.95	-.009	.294
					(.002)***	(.058)***
$\overline{(\beta_{nc})}_n$ x per Capita GDP	1.46	7.41	-75.2	36.7		-.025
						(.004)***
Observed Probability of Positive Exports:					.075	.075
Predicted Probability of Positive Exports (at x-means):					.044	.043
Obs.					20678	20678
Pseudo R^2					.171	.173

Table 5: Probit Results, Dependent Variable: Indicator of positive $Sales_{nc}$. Reported values are marginal effects.

	Specification			
	(1)	(2)	(3)	(4)
Population (log)	-.020	-.020	-.018	-.019
	(.008)***	(.008)***	(.008)**	(.008)**
Distance (log)	.042	.041	.046	.073
	(.013)***	(.013)***	(.013)***	(.015)***
per Capita GDP (log)	-.064	-.893		
	(.026)**	(1.038)		
pc GDP $(\log)^2$		.036		
		(.044)		
Rich * pcGDP (log)			-.085	-.161
			(.043)**	(.047)***
Poor * pcGDP (log)			.258	.252
			(.135)*	(.134)*
Number of CN8 products				.0006
				(.0002)***
Rich Indicator			.931	1.601
			(.532)*	(.556)***
Poor Indicator			-3.769	-4.612
			(1.549)**	(1.555)***
Product Indicators	CN8	CN8	CN8	CN8
Obs.	1557	1557	1557	1557
R^2	.668	.669	.67	.675
F statistic	5.52	4.298	4.53	6.302

Table 6: Cross Country Regression Results, Dependent Variable: β_{bc}. Rich countries have per capita incomes over 10 000 Eur (74 500 DKK)

B Additional Figures

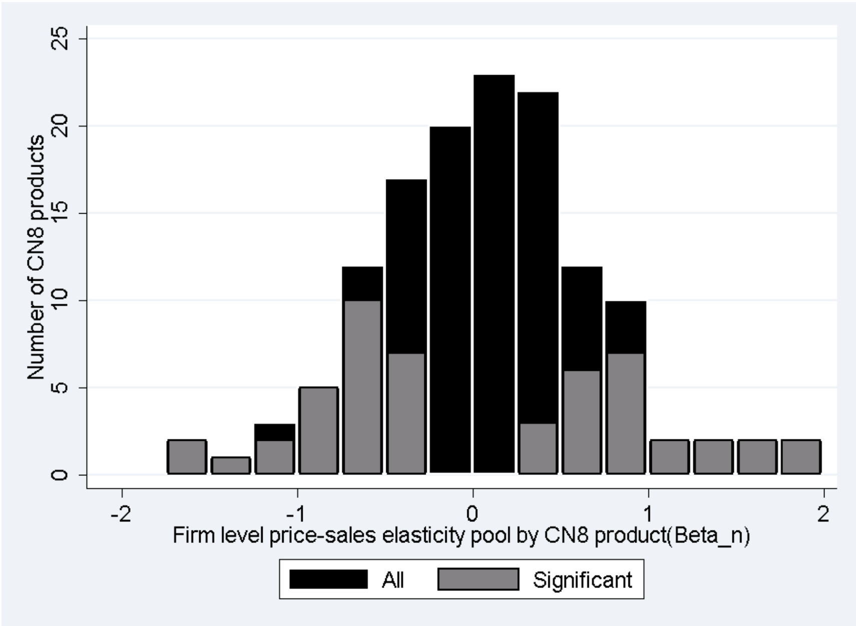

Figure 9: Price-Sales Elasticities β_n for 131 CN8 products. The gray distribution comprises only products that had a β_n significantly different from 0. The black (gray) distribution has a mean of .003 (-.03).

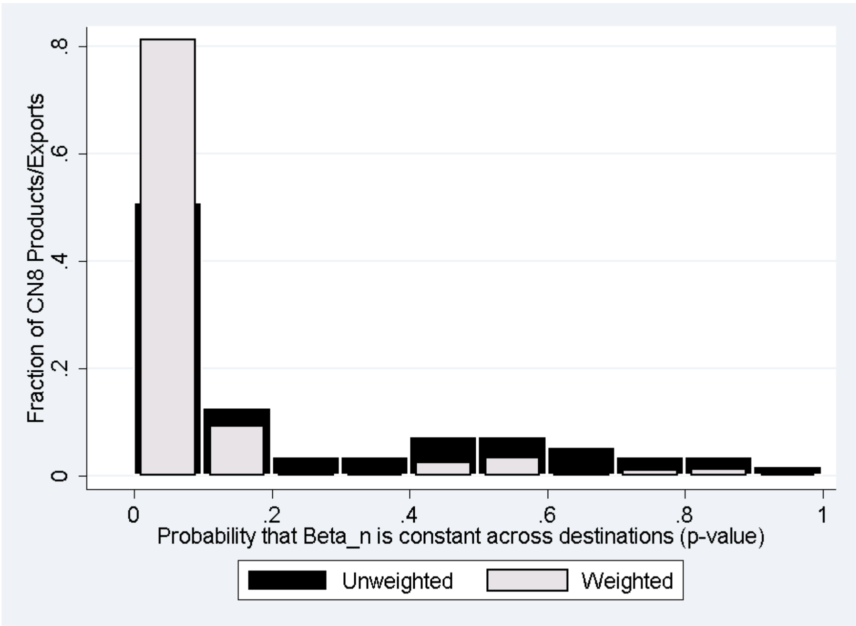

Figure 10: Probabilities of Type I error when rejecting the hypothesis that $\beta_{nc} = \beta_n$; unweighed and weighed by total Danish exports of that product. This table uses only the 55 products where the β_n is significantly different from 0.

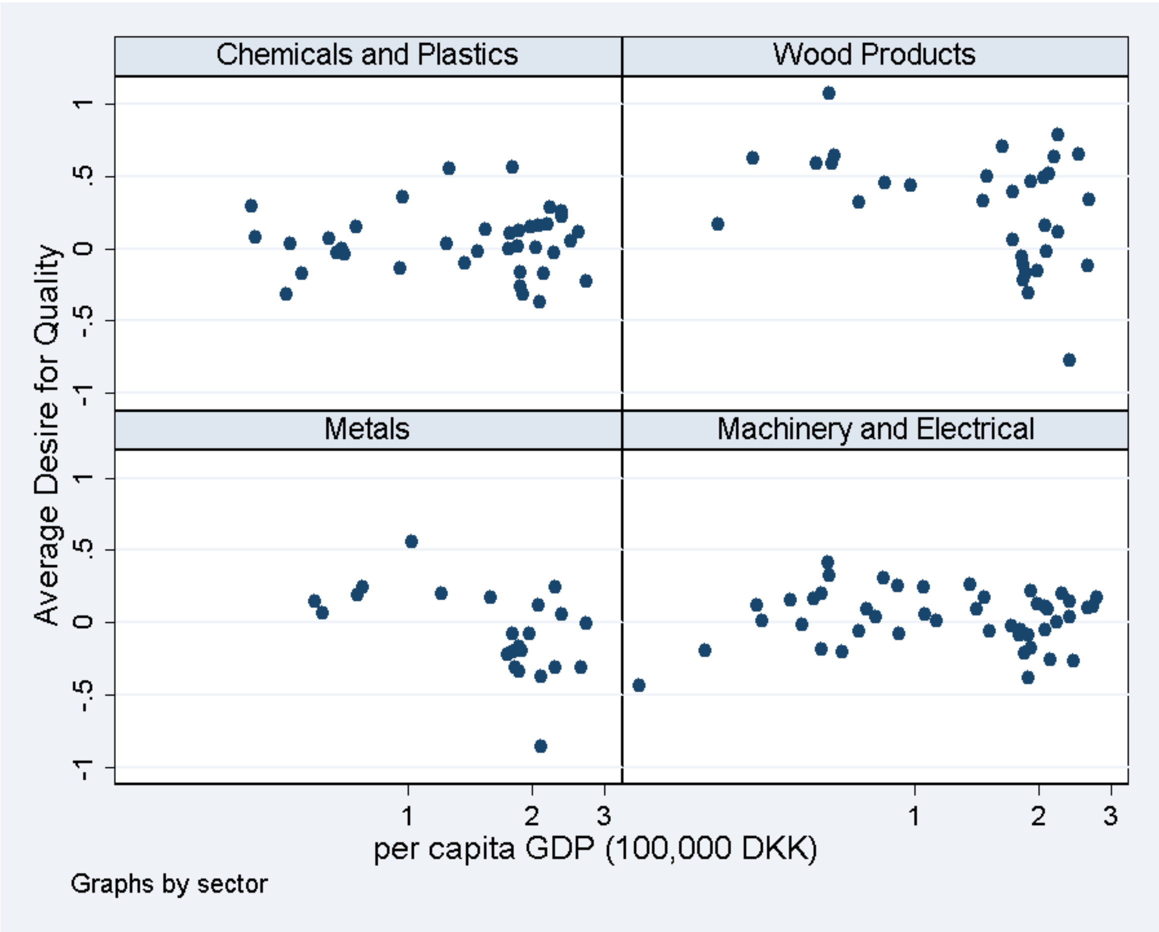

Figure 11: Average destination countries' β_{nc} compared to per capita GDP, by HS2 sector.

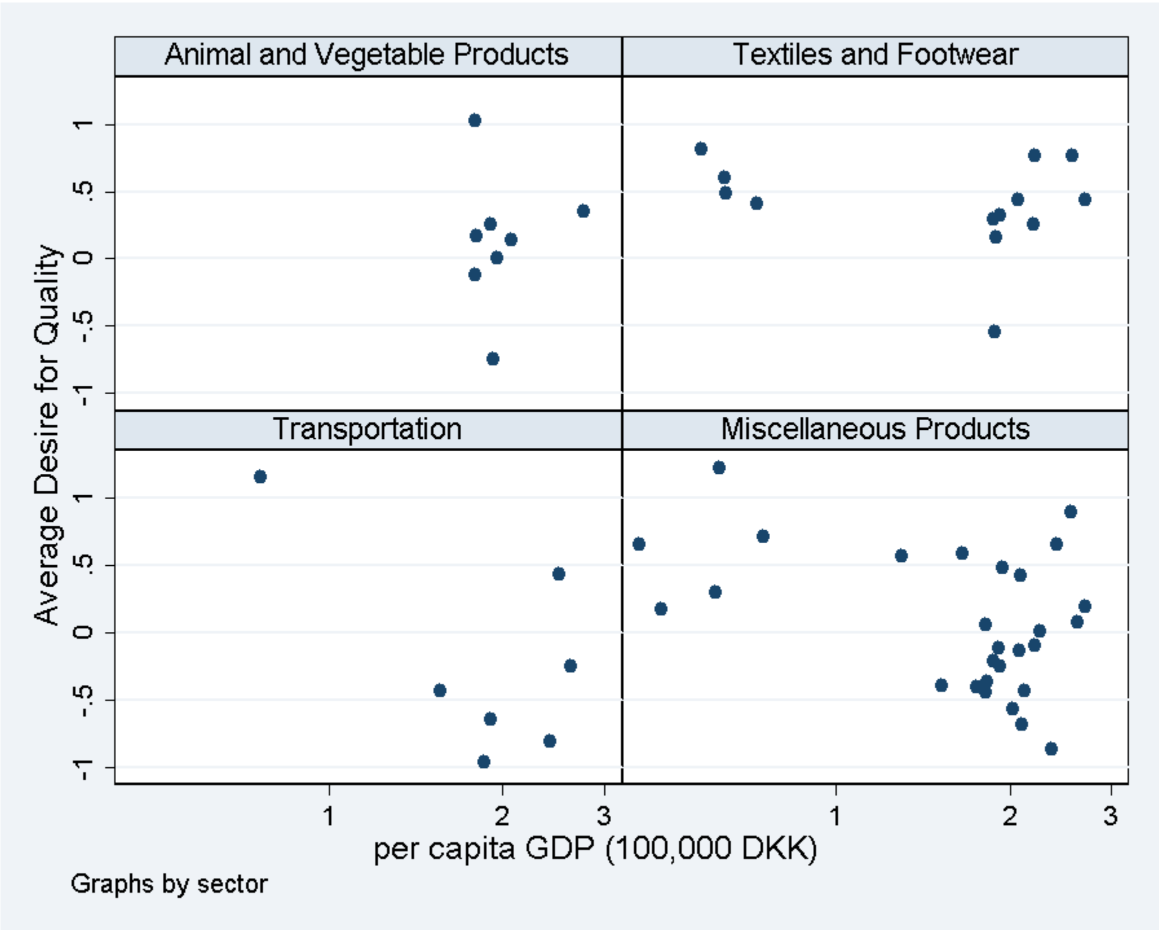

Figure 12: Average destination countries' β_{nc} compared to per capita GDP, by HS2 sector.