

# Does quality or cost matter more for exporting?\*

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## Abstract

There is a debate over whether quality differences or cost differences drive firm-level export revenues. We estimate the net effect of cost and quality on firm revenues, taking advantage of the contrasting price-quality and price-cost relationships. For 60% of Danish exported products, quality differences drive export revenue differences. For those products, firms with higher prices usually enjoy higher sales. Cost differences among firms drive revenues in the other 40% of Danish exports. Competition among Danish exporters plays a role in determining whether quality or cost drives revenues. In markets where the top four firms share less than 50% of total Danish exports, firms with lower prices usually enjoy higher sales. However, over 80% of product-destination markets are dominated by four or fewer Danish firms, so the overall result points towards quality as the driver of exports.

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

**JEL Codes:** F12

## 1 Introduction

Does quality or cost matter more for exporting? This is an important question for firms facing increasing pressures in a globalized market. As trade costs fall, developing countries such as China and India increase their exporting activities to the world. Existing exporters located in Europe and America now face much greater competition. Should these firms

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cut production costs to lower prices or concentrate on producing high cost, high quality goods? This will depend on whether costs or quality has a higher impact on the firms' revenues and profits.

This study tries to answer whether cost or quality differences among firms are responsible for the revenues differences within a destination. It does so by exploiting the contrasting effects of quality and cost on firm-level prices. The empirical strategy is based on recent work in trade theory.

Recent theory has shown how variation in firm-specific effects can lead to variation in prices and revenues. Melitz (2003) focuses on costs as the source of this variation. More productive firms incur lower marginal costs and are able to charge lower prices to garner higher revenues. Other models have suggested that differences in firm-specific quality can lead to price and revenue differences. Baldwin and Harrigan (2007) show how higher quality firms can charge higher prices and achieve the same quantities demanded.

Since firm-specific cost and quality are hard to measure and disentangle, prior studies have been unable to separate their effects. This study can disentangle the two using disaggregated firm-product-destination level export sales and weight data. It estimates the within-product-destination price elasticity of revenues. The cost elasticity of quality can then be calculated using the model presented by Baldwin and Harrigan (2007).

A major contribution of Baldwin and Harrigan (2007) is their simplification of the relationship between quality and cost. Unlike other studies that endogenize the choice of quality<sup>1</sup>, Baldwin and Harrigan (2007) skip the optimization step and directly assume a loglinear relationship between costs and quality. If quality increases slower than costs, then the "better" firms are the low cost firms. If quality increases faster than costs, then the "better" firms are the high quality ones.

Baldwin and Harrigan (2007) then make the assertion that quality increases faster than the corresponding cost. That is, a 100% increase in a firms' quality is marked by less than a 100% increase in marginal cost. A goal of this paper is to measure that relationship between cost and quality. Since an increase in quality increases both price and revenue, while a decrease in cost decreases price but increases revenue, our empirical strategy involves determining the relationship between prices and revenues.

While there are many important export quality studies at the product or sector level<sup>2</sup>, these studies focus on product unit values across destination countries. The lack of firm-level data has prevented previous studies from looking at the differences between firms

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<sup>1</sup>See Baldwin and Harrigan (2007) for a more detailed discussion.

<sup>2</sup>See Schott (2004), Hummels and Klenow (2005), Hallak (2006), Kneller and Yu (2008), Hallak and Schott (2009), Baldwin and Ito (2009).

selling a narrow product category within a destination. Baldwin and Ito (2009) is particularly close to the current study as it also uses Baldwin and Harrigan (2007) as a benchmark model. Baldwin and Ito (2009) classifies goods into quality oriented versus cost oriented based on the distance elasticity of price, instead of the price elasticity of revenue in the current study. Much like the current study, Baldwin and Ito (2009) find that a majority of European exports are quality oriented. The current study benefits from a firm-level dataset not available in Baldwin and Ito (2009).

Crozet, Head, and Mayer (2009) also uses Baldwin and Harrigan (2007) as a benchmark model and has the benefit of firm-level exports for French champagne exporters. The authors ask a similar question to this paper: "Do firms sort via quality or productivity?" One advantage of Crozet, Head, and Mayer (2009) is the availability of quality data; they observe the book ratings of champagnes. The study maps those ratings to a 1-5 scale of firm quality. Crozet, Head, and Mayer (2009) can then estimate the cost elasticity of quality. Their findings support Baldwin and Harrigan (2007) assertion that costs increases slowly with quality, at least for one product. In the current study, we answer this question for 2517 Danish exports at the eight-digit product classification. In order to measure it without observing quality, we turn to the relationship between quality, costs, and prices. We use those theoretical predictions to interpret the relationship between firm-level prices and revenues.

Two other papers look at the relationship between prices and revenues at the firm level. Both find a positive relationship between price and revenues. Kugler and Verhoogen (2008) examine the hypothesis that productivity and quality inputs are complements in production. Their study looks at the universe of Colombian firms between 1982 and 2005 and performs several reduced form estimations. Another reduced form study by Manova and Zhang (2009) examines export prices of Chinese exporters in 2005 within and across destinations. They use their results to qualitatively judge predictions of recent theoretical works. Both Kugler and Verhoogen (2008) and Manova and Zhang (2009) find support for quality sorting across all firms.

This study differs from these other two in several respects. First, this study regresses revenues on price, not the other way around. Trade theory (Krugman 1980, Melitz 2003, Baldwin and Harrigan 2007) suggests that prices are determined by an exogenous quality or productivity parameter. Firms charge a constant markup, and revenues are then determined by prices. More recent papers (Melitz and Ottaviano 2008) have endogenized the choice of price and revenues, but in general, prices are determined first. In no current model of trade are firm prices determined by an exogenously given revenue. Prices are determined by destination specific characteristics such as distance and income.

Since Kugler and Verhoogen (2008) and Manova and Zhang (2009) also regress price on destination-specific characteristics, their used revenue as an explanatory variable to stay consistent. However, current trade models suggest the direction of the causal arrow as productivity/quality  $\rightarrow$  price  $\rightarrow$  revenue.

Second, this study measures the price elasticities of revenue at a more disaggregated level than before. It finds a positive elasticity in over 60% of eight-digit Combined Nomenclature (CN8) product categories that Denmark exports. For those products, firms are sorted more by quality than cost. This result is robust across years and across destination market sizes and incomes. However, that means that cost is the driver for almost 40% of Danish products - a substantial portion of exports.

Finally, this study examines the relationship between market concentration and the price elasticity of revenue. Markets served by 25 or more Danish firms are more likely to exhibit a negative price-revenue relationship. In those markets, the "better" firms are the lost cost ones. Markets where a few firms dominate Danish exports exhibit a positive price-revenue relationship. A contribution of this study is to show that export markets with a few dominating firms are differentiated by quality, while export markets with many small firms are differentiated by costs. In the case of Denmark, 80% of products are exported to markets driven by quality differences. For Danish exports, quality matters more than costs.

The following section gives a brief overview of the data. The section after presents an extension of Baldwin and Harrigan's (2007) with Nguyen (2009) type firm-destination specific effects. This model structurally motivates our empirical strategy. That strategy and the results are then presented. We then relate our results to the concentration of Danish firms within a market. Concluding remarks discuss the theory and policy implications of our results.

## 2 Data

The Danish External Trade Statistics provides product-level destination-specific export data for all Danish firms for the years 1999-2003. Exports are recorded according to the eight-digit Combined Nomenclature product code which encompasses approximately 10,000 different product categories. We have firm-product-destination observations of the total value of exports and total quantity shipped, in kilograms. In the following analysis we restrict the sample to exports by manufacturing firms employing at least one employee. To minimize possible measurement error, we drop export values below 10,000 Danish Kroner and 100 quantity units. With these restrictions, our dataset comprises 399977

firm-product-destination-year shipments of 6142 products to 238 countries by 5789 firms totaling 840 billion Danish Kroner (DKK). See Statistics Denmark (2003) or Munch and Nguyen (2009) for further details.

We divide firm-destination-year export values by generate our firm-product-destination specific prices. Table 1 summarizes some descriptive statistics. Across our data, our prices range from 0.007 to 1263555.DKK/kg. Over 90% of the prices were between 8 and 1133 DKK/kg. The average price was 425 DKK/kg, while the median price was only 95 DKK/kg. This divide between the mean and median also exists in the revenue and weight data. The low median compared to the mean suggests that there are many firms selling low quantities of low priced goods. However, since the data is pooled over destinations, products, and years, we may be comparing difference in prices between markets and not within markets.

Insert Table 1

Even within a product-destination-year market, we see a left-skewed distribution of prices, revenues, and weights. Figure 1 plots histograms of product-destination-year mean-differenced export log revenues, log quantities, and log prices. Prices, weights and revenues all vary immensely, and most of the observations are below the mean. We also present a scatter of relative prices and revenues in Figure 1. The scatter shows that the relationship between price and revenue is not immediately clear. as we show later, this muddle is due to the large variation of the price elasticity of revenue across products.

Insert Figure 1

For total imports to a destination, we use trade flows from World Integrated Trade Solution (WITS). For details, see <http://wits.worldbank.org>. For GDP and per capita GDP, we obtain values from the Penn World Table (Heston, Summers and Aten 2006).

### 3 Theory

This model is the Quality, Heterogeneous Firms, and Trade model presented in Baldwin and Harrigan (2007) with the addition of firm-destination specific appeal introduced by Nguyen (2009). We focus only on the equations relevant to our empirical exercise. See the two papers for theoretical general equilibrium closures.

The utility gained in country  $j$  by consuming product varieties sold by Danish firms  $w \in \Omega$  exporting to  $j$  at time  $t$  is

$$u_{jt} = \left( \sum_{w \in \Omega_{jt}} \exp\left(\frac{\varepsilon_{jw}}{\sigma}\right) (\lambda_{wt} c_{jw})^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \quad (1)$$

where  $c_{wt}$ ,  $\lambda_{wt}$ , and  $\varepsilon_{jw}$  are the quantities consumed, quality, and appeal of  $w$  in  $j$ .  $\Omega$  can either represent the set of all firm-product varieties exported by Denmark or can refer to the set of varieties in a narrowly defined product category. The quality and appeal of  $w$  are drawn from independent distributions. The utility function generates the following demand function for firm  $w$ :

$$c_{jw} = \frac{1}{p_{jw}} \left( \frac{p_{jw}}{\lambda_{wt}} \right)^{(1-\sigma)} \frac{Y_{jt}}{\Pi_{jt}} \exp(\varepsilon_{jw}) \quad (2)$$

where  $Y_{jt}$  and  $\Pi_{jt} = \sum_{w \in \Omega_{jt}} \left( \frac{p_{jw}}{\lambda_{wt}} \right)^{(1-\sigma)} \exp(\varepsilon_{jw})$  are the expenditures and price index in  $j$  for  $\Omega$  which are exogenous to the firm. Firm  $w$ 's cost of supplying  $c_w$  goods to  $j$  is

$$f + \tau_{jt} a_{wt} c_{wt} \quad (3)$$

where  $f$  and  $\tau_{jt} > 1$  are fixed and transportation costs. The marginal cost  $a_{wt}$  represents the firm's productivity: more productive firms enjoy a lower marginal cost. Given its demand and cost, firm  $w$  sets its price  $p_{jw}$  at

$$p_{jw} = \frac{\sigma}{\sigma-1} \tau_{jt} a_{wt} \quad (4)$$

and garners revenues  $r_{jw}$  and profits  $\pi_{jw}$  of

$$r_{jw} = \left( \frac{p_{jw}}{\lambda_{wt}} \right)^{(1-\sigma)} \frac{Y_{jt}}{\Pi_{jt}} \exp(\varepsilon_{jw}) \quad (5)$$

$$\pi_{jw} = \frac{1}{\sigma} r_{jw} \quad (6)$$

Equation (5) shows the relationship between costs, quality, and revenues. Firms with low costs and high qualities both enjoy higher revenues<sup>3</sup>. A cetera paribus decrease in the firm's marginal cost  $a_w$  results in a decrease of the mill price. Since demand is elastic ( $\sigma > 1$ ), this lower price garners higher revenues for the firm. A cetera paribus increase in  $\lambda_{wt}$  decreases the quality adjusted price  $\left( \frac{p_{jw}}{\lambda_{wt}} \right)$  that consumers observe, which also

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<sup>3</sup>and higher profits, since profits are a constant fraction of revenue in this model.

results in higher quantities demanded. Finally, an increase in the firm's appeal  $\varepsilon_{jw}$  in the country does not affect the prices but increases the quantity demanded. This in turn increases the firm's revenue in  $j$ .

Baldwin and Harrigan (2007) suggests a relationship between quality and marginal cost. In particular,

$$a_{wt}^{\theta+1} = \lambda_{wt}, \theta > -1 \quad (7)$$

where  $\theta + 1$  is the cost elasticity of quality. For  $\theta \in (-1, 0)$ , quality increases slowly with costs. For  $\theta > 0$ , quality increases rapidly with cost. Note that this is not a model of endogenously determined quality. Baldwin and Harrigan (2007) abstracts from this problem because, in their words, "Models of... quality... invariably deliver a mapping between an exogenous parameter... and the possibly endogenous supply of quality." Therefore, if  $\lambda$  were optimally chosen by the firm's draw of  $a$ , the resultant choice function could simplify to equation (7). Whether or not firms prefer high or low  $a$  and  $\lambda$  depends on the elasticity parameter  $\theta$ . Examining equations (4), (5), (7) shows us the role that  $\theta$  plays in determining the firm's revenue in destination  $j$ .

Combining equations (4) and (7) shows that an increase in the quality  $\lambda_{wt}$  forces the firm to charge a higher price. The higher price lowers demands, but this is offset by its higher quality, which is observed by the consumer. The net effect on revenues can be determined by combining (4), (5) and (7):

$$r_{jw} = \left( \frac{\sigma}{\sigma - 1} \tau_{jt} \lambda_{wt}^{\frac{1}{1+\theta}} \right)^{\theta(\sigma-1)} \left( \frac{\sigma}{\sigma - 1} \tau_{jt} \right)^{\theta(\sigma-1)} \frac{Y_{jt}}{\Pi_{jt}} \exp(\varepsilon_{jw}) \quad (8)$$

If  $\theta \in (-1, 0)$ , an increase in  $\lambda_{wt}$  will decrease revenues. The higher costs outweigh the higher quality and firms prefer to have low cost output. If  $\theta > 0$ , quality is inelastic to cost; a good that has twice the quality costs less than twice as much to produce. In that case, firms prefer high quality output. Our goal is to determine whether high revenue firms are those with high quality  $\lambda$ 's or those with low cost  $a$ 's. The next section shows how we can do that without observing  $\lambda$  nor  $a$ .

## 4 Empirics

The econometrician does not observe quality<sup>4</sup> or marginal cost. The model shows that an increase in quality increases price, while a decrease in costs lowers price. Since we observe prices, we can use the contrasting price-quality and price-cost relationships to construct

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<sup>4</sup>The notable exception being Crozet, Head and Mayer (2009) discussed in the introduction.

our empirical tests. First we rewrite equation (8) by noting that the term in the first bracket equals price:

$$r_{j\omega t} = p_{j\omega t}^{\theta(\sigma-1)} \left( \frac{\sigma}{\sigma-1} \tau_{jt} \right)^{\theta(\sigma-1)} \frac{Y_{jt}}{\bar{\Pi}_{jt}} \exp(\varepsilon_{j\omega t}) \quad (9)$$

and take the natural log of the result to obtain:

$$\ln r_{j\omega t} = \theta(\sigma-1) \ln p_{j\omega t} + \Lambda_{jt} + \varepsilon_{j\omega t} \quad (10)$$

where  $\Lambda_{jt} = \left( \frac{\sigma}{\sigma-1} \tau_{jt} \right)^{\theta(\sigma-1)} \frac{Y_{jt}}{\bar{\Pi}_{jt}}$  is a destination-year-specific effect. Equation 10 gives us a simple relationship between firm-destination specific revenues and the corresponding prices. We can regress firm-destination-year revenues on prices and fixed effects to estimate the value of  $\theta(\sigma-1)$ . Since  $\sigma > 1$ , the sign of our estimate of  $\theta(\sigma-1)$  is also the sign of  $\theta$ . If  $\sigma$  is known,  $\theta$  can be calculated. In practice, we use prior estimates of  $\sigma$  to impute  $\theta$  for each exported CN8 Danish product<sup>5</sup>.

## 4.1 Pooled Regressions

First, we assume that the set of varieties  $\Omega$  represents the set of all firm-product varieties exported by Denmark. That is, we pool all of our observations across 6093 CN8 products and 5 years together and estimate a statistically significant (at the 1% level) price elasticity of revenue  $\left( \frac{d \ln(\text{revenue})}{d \ln(\text{price})} \right)$  of 0.10. We also run pooled CN8 products together for each of the 5 years in the sample and find remarkably stable estimates across the years. Table 2 summarizes the results. For these pooled samples, the results support Baldwin and Harrigan's (2007) claim that  $\theta > 0$ ; that marginal costs are inelastic to quality.

Insert Table 2

Our pooled results are not directly comparable to those of Manova and Zhang (2009) and Kugler and Verhoogen (2008). We regress revenue on price while the two other studies regress price on revenue. The presence of fixed effects precludes the ability to simply invert the point estimate. However, we can repeat their exercise to compare results. We aggregate a firm's exports across all products to a destination. We then regress this aggregated export value on an aggregated export price, with destination-year fixed effects. We obtain a statistically significant point estimates for revenue elasticity of price  $\left( \frac{d \ln(\text{price})}{d \ln(\text{revenue})} \right)$  of 0.085. In their estimations that most closely resemble this study's,

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<sup>5</sup>Estimates for  $\sigma$  are for US SITC5 exports from Broda and Weinstein (2006).

Manova and Zhang (2009) and Kugler and Verhoogen (2008) estimate a revenue elasticity of price of 0.081 and 0.021 when using similar fixed effects. Our findings are similar to theirs.

The variation in prices explain a low percentage of the variation in firm-product-destination specific revenues in our pooled regressions. While we get  $R^2$  values of above 60%, our adjusted  $R^2$  is only approximately 15%. Within a product-destination-year, price variation only explains about 15% of revenue variation. Much of the revenue variation must be explained by something orthogonal to prices, such as the appeal in Nguyen (2009).

The trade theories using monopolistic competition with increasing returns to scale (Krugman 1980, Melitz 2003, Baldwin and Harrigan 2007) are motivated by trade patterns between big, rich countries. We also want to look at whether quality or productivity is important when taking the size of the destination country into account. Perhaps quality is more of a factor when exporting to big countries than to small countries. We find that this is not the case. We divide our sample into small middle and big countries by GDP, using the 25th percentile and the 75th percentiles as our cutoffs<sup>6</sup>. As Table 3 shows, the results do not significantly vary between small, middle, and big countries. Countries of all sizes demand more high quality Danish goods than they do low cost goods.

Insert Table 3

Instead of small and big, we consider rich and poor countries. Following Schott (2004), we partition our sample into poor, middle income, and rich countries by per capita GDP, using the 30th and 70th percentiles as cutoffs. Table 4 summarizes the results. Quality matters more for poor countries and rich countries than for middle income countries. All of the results are positive, so again, quality beats out costs as the driver of revenues across countries of all sizes.

Insert Table 4

## 4.2 By individual product

Next we assume  $\Omega$  refers to the set of varieties in a CN8 product category. That is, we estimate the price elasticity of revenue for each of the 2517 CN8 product categories having positive degrees of freedom. We obtain mean and median values of 0.16 and 0.21 for the price elasticity of revenue. Over 60% of the estimates were positive. When we restrict our calculations to only the 978 elasticities that were statistically different from

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<sup>6</sup>We also use the 20th and 80th, and 30th and 70th percentiles, with similar results.

zero, we obtain mean and median values of 0.23 and 0.57. Over 66% of these estimates were positive. A majority of estimates support Baldwin and Harrigan's (2007) assertion that quality increases faster than costs. Figure 2 presents the histogram of our results.

Insert Figure 2

Figure 2 shows the substantial variation of elasticities across Danish exported products. While most products exhibit positive price elasticities of revenue, a third of products exhibit negative elasticities.

Our model allows us to calculate  $\theta$  for each of our CN8 products given known values of  $\sigma$ . Broda and Weinstein (2006) estimate  $\sigma$  for SITC5 categories for US exports. We use these values to calculate our CN8 specific  $\theta$ 's. We concord SITC5 categories to CN8 and calculate  $\theta$  by dividing our estimate of the price elasticity of revenue by  $\sigma - 1$ . There are 2304 CN8 products for which we had estimates of both price elasticity of revenue and  $\sigma$ .

We find the cost elasticity of quality to be generally positive. The mean and median  $\theta$  for our 2304 CN8 products are 0.29 and 0.10. That is, firms in the median exported product have production functions in which quality increases 10% faster than costs. The variation of  $\theta$  is large: the standard deviation of our estimates is 2.8, with 10% of the estimates over 2.8 or below -1.6. When only considering the 864 price elasticities of revenue that are statistically different from zero, we obtain a mean and median  $\theta$  of 0.48 and 0.32 and a standard deviation of 3.0. Figure 3 presents a histogram of the calculated  $\theta$ 's. We find no correlation between  $\theta$  and  $\sigma$  (correlation coefficient = -0.03 for all, -0.06 for only significant estimates).

Insert Figure 3

As Figures 2 and 3 shows, estimates of the price elasticity of revenue and  $\theta$  vary greatly over Danish exported products. We calculate a mean  $\bar{\theta}$  and  $\frac{d\ln(\text{revenue})}{d\ln(\text{price})}$  for each HS2 sector and report those results in Table 5. Many of the negative  $\bar{\theta}$ 's are within HS2 categories between 31 and 35: fertilizers, tanning products, essential oils, soaps, and glue. These sectors are generally thought of as having simple productions. Many of the positive  $\bar{\theta}$ 's are in sectors 82-92: tools, machinery, vehicles, and optical instruments. These sectors should have complex productions. While we do not classify goods as quality oriented or price oriented as does Baldwin and Ito (2009), Table 5 suggests that goods with more complicated productions compete more on quality.

Insert Table 5

We aggregate exports to the HS6 level and repeat our exercise. We find similar results at this aggregation level. For the pooled sample of 3612 HS categories across all five years, we estimate a price elasticity of revenue of 0.10. We estimated the individual price elasticities for 1883 HS6 categories that had sufficient degrees of freedom. Of those, 763 regressions results in estimates statistically different from zero. The mean and median  $\theta$  of those significant estimates were 0.38 and 0.28. Over 60% of the estimates (62% of the significant estimates) were positive. Table 6 summarizes the results.

Insert Table 6

### 4.3 Firm Concentrations

Since Denmark is a small country, its exporters must compete in larger markets against both Danish firms and foreign firms. Danish firms should have little or no market power. We define a market as a HS4 industry-destination-country category. Our sample comprises 93668 markets. According to WITS, the Danish share of import demand in a destination is less than 20% in over 95% of the markets in our sample. Using world import demand as the total market size, we find four Danish-firm concentration ratios of less than 25% in over 98% of the markets. Therefore, a monopolistic competition assumption seems plausible.

If within each market, Danish firms compete more against themselves than against non-Danish firms, market power may have some play. We look at firm market shares just within the set of Danish firms serving a market. The firm's Danish-served market share is simply the firm's share of export revenue among all Danish firms exporting in the same HS4 industry to the same destination that year. Using our Danish-served market shares, we construct Danish four-firm concentration ratios (4FCR) for each HS4 industry-destination-year market. Approximately 37% of our observations were in markets with four or fewer Danish exporting firms; those were assigned  $4FCR = 1$ .

We then examine our results for four subsamples of our original dataset. Each subsample contains a different 4FCR quartile. For example, the first subsample contains only markets exhibiting 4FCR greater than 75%. The second subsample contains markets with 4FCR between 50% and 75%, etc.... The results are summarized in Table 7.

The results are startling when compared to the pooled results in Table 2. For HS4-destination-year markets in which the top four firms are responsible for over 75% of the

total Danish exports, the price elasticity of revenue of 0.14 is comparable to that of the pooled sample. The estimate drops slightly to 0.12 when we only consider markets served by more than four Danish firms. However, as 4FCR drops, so does the price elasticity of revenues. We estimate a negative elasticity for those industries where the exports of the top four firms are less than half of the total Danish exports. This is shown in columns 4 and 5.

Insert Table 7

Why did we get significantly positive estimates in our pooled results? A look at the number of observations in Table 7 provides the answer. Most Danish exporting industries are dominated by a handful of firms. More than 37% of the observations belonged in markets comprising four or fewer firms. More than 80% were in markets exhibiting 4FCR greater than 75%. That is, for the overwhelming majority of Danish markets, four or fewer firms share more than 75% of total Danish exports to that destination. Only two markets exhibited 4FCR less than 25%. These markets comprised "furniture and furniture parts made of metal, wooden, and plastic" exported by 296 firms to Norway in 1999 and 2000.

The number of firms serving a market is another good indicator of the competitiveness of a market. We also partition our sample by the number of Danish firms exporting to each market. We look at markets with greater than 4 firms, greater than 10 firms, etc... Results are summarized in Table 8.

Insert Table 8

The results in Table 8 support those in Table 7. As we restrict the sample by the number of Danish firms serving each market, we find that the price elasticity of revenue decreases. It become significantly negative when we look at HS4-destination-year markets with greater than 25 firms.

Since less than 20% of the observations are in 25+ firm markets, the pooled average is driven by the positive estimates of the markets with few firms, as reported in Table 2. Less than 16% of markets are served by more than 4 firms. This strengthens the result that most Danish exporting industries are dominated by a handful of firms.

In summary, we find that degree of competition among Danish competitors is a major factor in determining the sign of  $\theta$ . In markets where a few firms constitute a large share of total Danish exports, firms with higher prices usually have higher revenues. The reverse is true for markets with more than 25 firms or markets in which the top four firms share less than 50% of total exports. In the framework of Baldwin and Harrigan's (2007) model,

these results imply that markets with many exporters are differentiated via productivity, while markets with few exporters are differentiated via quality. In the case of Denmark, most exported markets are quality driven, not productivity driven.

## 5 Conclusion

In the heterogeneous firms trade literature, firm-specific productivity and quality are often thought of as isomorphic. An increase in both results in an increase in revenue. However, increasing productivity 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 productivity that differentiates firms.

We find for Danish manufacturing exports that it is usually quality differences that drive sales differences. Over 60% of products are quality oriented. However, in markets with more than 25 firms or markets where the top four firms share less than 50% of total exports, productivity differences drives sales differences.

Baldwin and Harrigan (2008) provides a straightforward and simple relationship between costs and quality. We use their model to estimate the cost elasticity of quality. It is elastic for most Danish exported products, but there is a lot of variation in this elasticity across products. The overall positive result is driven by the high elasticities in industries where the top four firms dominate most or all of the exports. Most Danish exports are in markets served by four or fewer Danish firms, implying that quality is what matters for Danish exports.

No current model of trade has encompassed both quality driven and productivity driven sectors. Our results suggest that a model encompassing both should show that there are more firms in the productivity driven sectors than in the quality driven sectors. In addition, we find that price variation explain little of revenue variation, suggesting that much of firm heterogeneity may be orthogonal to firm prices, as in Nguyen (2009).

From a policy standpoint, we find that the markets served by Danish firms compete more on quality than costs. This may be because Denmark is a highly industrialized, high wage country making and destinations view Danish products as "high quality" goods. Our results suggest that Danish exporters should worry less about lowering their production costs, and more about raising the quality of their output.

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## A Tables and Figures

	<b>Price (DKK/kg)</b>	<b>Revenue (1000 DKK)</b>	<b>Weight (1000 KG)</b>
Mean	425	2,100	83
Std. Dev.	6320	21,000	19000
Median	95	185	1.7
5%tile	8.66	16	0.14
95%tile	1133.8	7000	140

Table 1: Descriptive statistics on the price, revenue, and weights of Danish Exports, 1999-2003

	<b>Years in Sample</b>					
	<b>1999-2003</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>
$\frac{d \ln(revenue)}{d \ln(price)}$	0.10	0.08	0.08	0.11	0.10	0.10
t-stat	22.0	7.6	8.5	11.2	10.9	11.0
# FE	213083	41942	43335	43105	42519	42178
R-squared	62%	62%	62%	62%	61%	62%
adjusted R-squared	15%	15%	15%	16%	15%	16%
# obs	387234	75434	78550	78481	77793	76976

Table 2: pooled estimations of Equation 10 at the CN8 level, using CN8-destination-year fixed effects (FE), by year. All values are statistically significant at the 1 percent level.

	<b>GDP (billions of \$<sub>yr2000</sub>)</b>		
	<b>&lt;140</b>	<b>140-800</b>	<b>&gt;800</b>
$\frac{d \ln(revenue)}{d \ln(price)}$	0.12	0.10	0.12
t-stat	11.7	17.6	12.4
# FE	58336	88713	46001
R-squared	73%	57%	61%
adjusted R-squared	15%	14%	15%
# obs	26145	178458	85650

Table 3: pooled estimations of Equation 10 at the CN8 level, using CN8-destination-year fixed effects (FE), by year 2000 adjusted USD GDP, using the 25th and 75th percentiles as cutoffs. All values are statistically significant at the 1 percent level.

	<b>pcGDP (thousands of \$<sub>yr2000</sub>)</b>		
	<b>low</b>	<b>middle</b>	<b>high</b>
	<b>&lt;14.1</b>	<b>14.1–26.1</b>	<b>&gt;26.1</b>
$\frac{d \ln(revenue)}{d \ln(price)}$	0.32	0.04	0.13
t-stat	24.3	4.8	17.5
# FE	69980	75081	47989
R-squared	73%	62%	52%
adjusted R-squared	18%	15%	14%
# obs	104489	136907	107195

Table 4: pooled estimations of Equation 10 at the CN8 level, using CN8-destination-year fixed effects (FE), by per capita incomes in the destination country, using the 30th and 70th percentiles as the splits between low-middle and middle-high. All values are statistically significant at the 1 percent level.

<b>HS2</b>	$\bar{\theta}$	$\frac{d\ln(revenue)}{d\ln(price)}$	<b>HS2</b>	$\bar{\theta}$	$\frac{d\ln(revenue)}{d\ln(price)}$
28	0.03	-0.94	63	-5.54	-0.46
29	3.86	1.60	64	0.65	1.02
30	0.86	1.25	65	2.97	0.95
31	-1.74	-4.00	66	-9.53	-2.63
32	-0.27	-0.39	68	0.47	0.02
33	-0.20	-0.18	69	0.00	0.08
34	-0.26	-0.66	70	-1.03	-1.66
35	-1.03	-0.64	71		1.20
37	1.36	0.75	72	-0.86	-2.06
38	0.34	0.26	73	-0.18	-0.48
39	-0.04	-0.32	74	-0.19	-0.15
40	-0.65	-0.79	76	0.02	-0.47
41	2.15	1.86	79	-0.36	-0.41
42	1.14	0.83	80	-0.60	-4.03
43		1.56	82	2.16	0.71
44	0.26	2.15	83	0.31	-0.06
48	-0.38	-0.44	84	0.72	0.41
49	-0.33	-0.81	85	1.48	0.69
51	0.41	1.39	86	0.47	2.40
52	0.20	0.24	87	0.25	0.24
53	0.33	0.69	88	0.53	1.45
54	-0.20	-0.25	89	0.35	1.22
55	0.41	0.88	90	1.85	0.88
56	0.03	0.03	91	0.54	0.12
57	-1.02	-2.05	92	3.91	1.02
58	0.60	0.89	93	-5.88	-2.81
59	3.30	1.47	94	0.78	-0.14
60	0.29	1.05	95	-5.93	0.85
61	0.43	0.87	96	1.17	0.73
62	0.70	1.15			

Table 5: Average estimations of the price elasticity of revenue and theta by HS2 sector.

	Years in Sample					
	1999-2003	1999	2000	2001	2002	2003
$\frac{d\ln(\text{revenue})}{d\ln(\text{price})}$	0.10	0.09	0.09	0.10	0.10	0.10
t-stat	23.3	8.9	9.5	11.2	11.7	10.8
# FE	172608	33845	34968	34946	34488	34357
R-squared	55%	55%	55%	56%	55%	55%
adjusted R-squared	14%	14%	13%	16%	14%	15%
# obs	364002	70642	73614	73901	73293	72552

Table 6: pooled estimations of Equation 10 at the HS6 level using HS6-destination-year Fixed Effects, by year. All values are statistically significant at the 1 percent level.

	4-Firm Concentration Ratio				
	75-100%	75%-100%*	50-75%	25-50%	0-25%
$\frac{d\ln(\text{revenue})}{d\ln(\text{price})}$	0.14	0.12	0.05	-0.04	-0.50
t-stat	25.0	19.3	6.4	-2.8	-5.9
# FE	201239	73703	16523	2740	44
R-squared	70%	55%	39%	31%	14%
adjusted R-squared	14%	16%	17%	14%	8%
# obs	311904	161623	68036	16571	724
#markets	91582	13076	1837	247	2

Table 7: Pooled estimations of Equation 10 at the CN8 level using CN8-destination-year fixed effects (FE), by 4-Firm Concentration Ratios Quartiles in the HS4-destination-year market. All values are statistically significant at the 1 percent level. \*: column 2 contains only HS4-destination-year markets with greater than 4 firms. There are a total of 93668 markets

	Number of firms in the market					
	All	>4	>10	>25	>50	>100
$\frac{d\ln(\text{revenue})}{d\ln(\text{price})}$	0.10	0.08	0.04	-0.02	-0.15	-0.34
t-stat	23.3	17.2	7.9	-3.1	-12.3	-15.9
#FE	172608	93013	45833	13122	3592	799
R-squared	55%	50%	41%	32%	25%	25%
# obs	364002	249696	162016	73004	31170	10080
#markets	93668	15162	5224	1174	294	54

Table 8: pooled estimations of Equation 10 at the CN8 level using CN8-destination-year fixed effects (FE), by number of firms in the corresponding HS4-destination-year market. All values are statistically significant at the 1 percent level. There are a total of 93668 markets

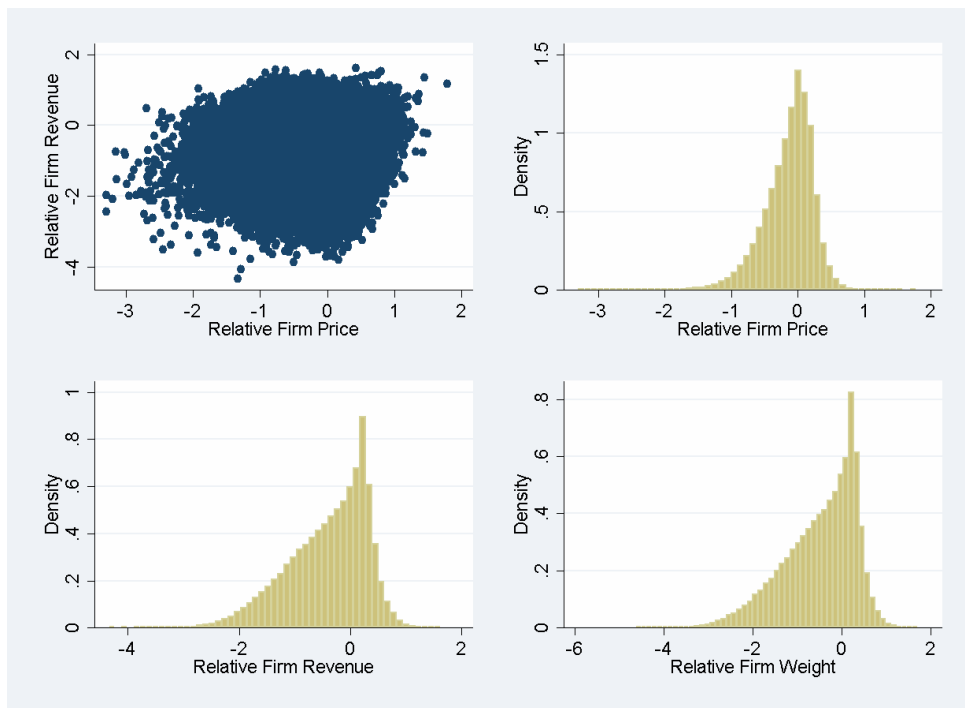


Figure 1: The top left panel presents a scatter of firm-level prices and revenues. The other panels present histograms of firm-level prices, weights, and revenues. The values are in log base 10 relative to the mean values in the product-destination-year market. Thus, a relative firm price of 1 is 10 times greater than average, a relative firm price of 2 is 100 times greater than average, etc.

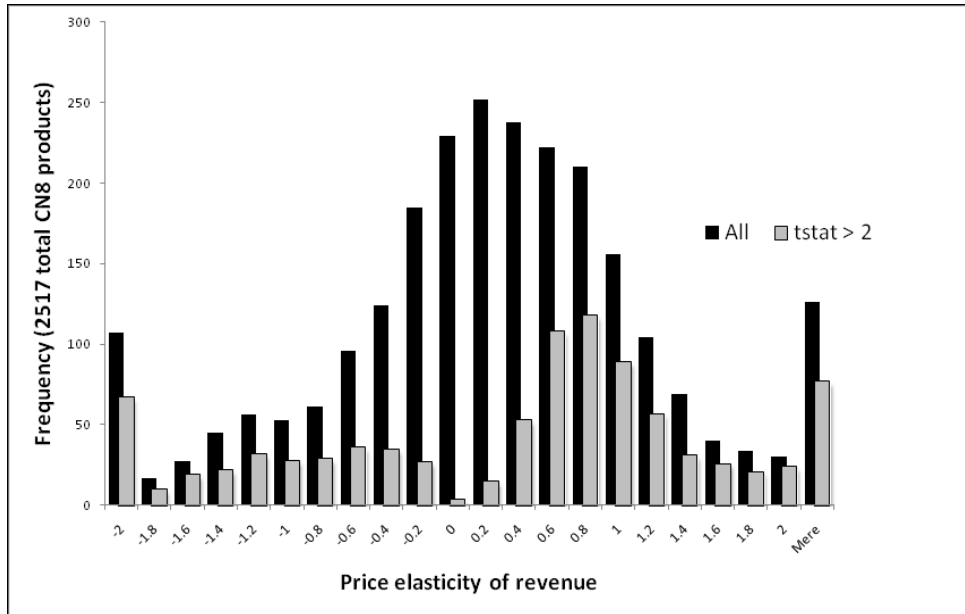


Figure 2: Estimated Price elasticity of Revenue for each CN8 category.

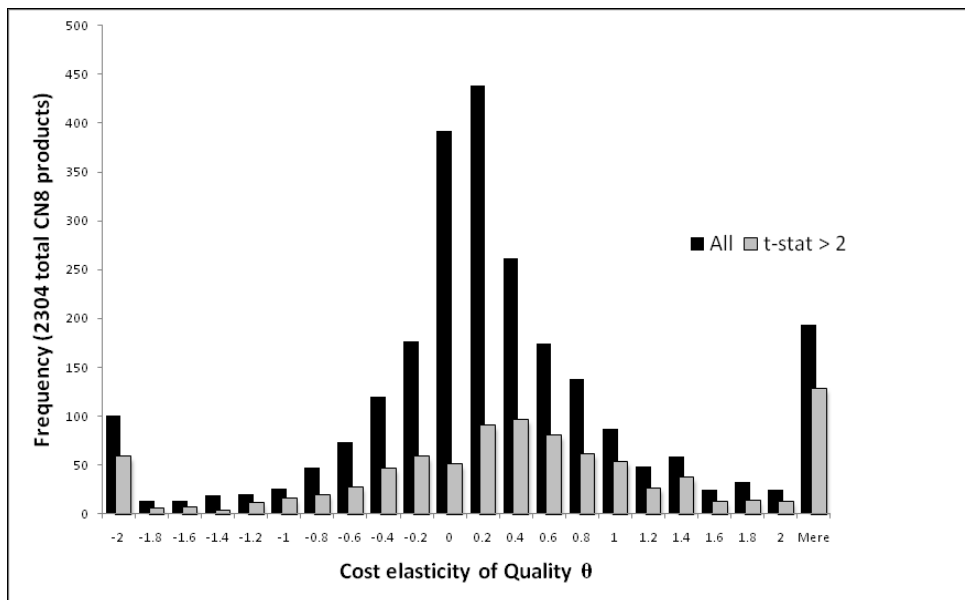


Figure 3: Estimated Cost elasticity of Quality parameter  $\theta$  for each CN8 category.