Markups and export prices♣

Joakim Gullstrand
AgriFood Center and Department of Economics, Lund University

Karin Olofsdotter
Department of Economics, Lund University

Susanna Thede
Department of Economics, Lund University

Abstract: We analyze empirically product-price variation across export destinations using detailed firm-product data. Recent studies using firm-level data emphasize variations in product quality as an explanation as to why firms charge different prices for the same product on different export markets. In this paper, we take an alternative approach and assume that variations in firms' export prices reflect market segmentation and investigate the relationship between price variation and average firm markup. We study an entire supply chain in order to see how price discrimination varies across sectors with different distribution networks. Specifically, we make use of firm-level data for exporting firms in the Swedish food supply chain. The results offer additional information about the behavior of exporting firms. Hence, for the food processing industry, firms with greater ability to discriminate between markets are associated with a higher markup. However, the results also reveal that markups are a complex function of firm characteristics and that the price-setting behavior of firms in the manufacturing sector is not necessarily observed in other sectors of the supply chain.

JEL: D40, F12, F14

♣ We would like to thank seminar participants at IFN in Stockholm, March 2011, and Department of economics in Lund, May 2011. We are also grateful to the conference participants at ETSG in Lausanne, September 2010, CAED Conference in London, September 2010, SNEE Conference in Mölle, May 2011 and the National Conference in Uppsala, 2011. Financial support from Jan Wallander and Tom Hedelius Foundation is gratefully acknowledged.

1. Introduction

Recent empirical research has recognized large variations in firms' f.o.b. export prices even at very narrowly defined product classifications. These variations are not only observed across firms but also within a single firm exporting to different destinations (Görg et al., 2010). In international trade studies using detailed product- and/or firm-level data, variations in product quality are proposed as an important explanation to different prices for the same product on different export markets. Much of this work builds on heterogeneous-firms models where quality differences and, hence, price variations are seen as additional important heterogeneity variables across firms.

While product quality may provide a plausible explanation to variation in prices *across* firms, the relevance of quality differences for variations in export prices *within* a single firm appears much more uncertain. One reason is that, in the presence of scale economies, quality differentiation will be costly for the firm. Moreover, as emphasized in the trade mark literature, firms are believed to care about their brand and reputation making quality-to-market less likely (Economides, 1988). In fact, in the industrial-organization literature, price dispersion within single-product lines is primarily explained by price discrimination across market segments.[1] Under market segmentation, which may result from transaction costs or purchasing search costs, firms can charge different prices, net of trade costs, for the same product in different locations.

While other recent studies have focused mainly on the quality-difference explanation, this paper instead argues in favor of segmented markets and price discrimination. In particular, we explore the relationship between export-price variation and overall firm markup (defined as price over marginal cost) by studying individual firm's variations in export prices for products going to different locations and examine whether larger price variations are associated with higher markups. Hence, the paper focuses on the price setting behavior of exporting firms and acknowledges firm ability to set prices. This approach is supported by firm surveys providing empirical evidence for the importance of price-discriminating behavior. For instance, Fabiani et al. (2005) reveal that more than 80 percent of firms within the Euro area apply price-discriminating strategies.[2]

To thoroughly investigate firms' ability to set prices and to see how the ability to price-discriminate varies across sectors and different distribution networks, we study an entire supply

[1] See, e.g., Tirole (1988).
[2] See also Goldberg and Knetter (1999).

chain. Specifically, we make use of detailed firm-level data for exporting firms in the Swedish food supply chain, consisting of four sectors; agriculture sector, food processing, wholesale and retail. This supply chain is of particular interest as it is one of the largest supply chains and is highly vertically integrated.

The paper contributes to the existing literature in several ways. First, while previous empirical research on export-price variation across countries has focused on quality differences we use an approach where imperfect competition and market segmentation become meaningful. Second, by considering a whole supply chain, we are able to compare differences in competitive pressures and price-setting behavior across sectors. Finally, as the empirical analysis shows that food-processing firms with greater price dispersion across export markets have on average higher markups, we offer additional information about the behavior of exporting firms in the manufacturing sector.

The paper is organized as follows. Section 2 reviews previous work in international trade on variations in export prices and outlines the approach of the present paper. Section 3 describes the method to estimate markups, presents the data and gives the econometric specification. The results are reported in Section 4. Section 5 offers an extension investigating the determinants of export prices and Section 6 concludes.

2. Theoretical outline and related studies

2.1 Price discrimination and market power

Observed variations in prices across export destinations may be attributed to international price discrimination and geographically segmented markets. Price discrimination across markets requires, besides the existence of arbitrage costs, that firms exert some kind of market power. It is important to notice, though, that the relationship between price dispersion and market power is not straightforward, which becomes clear if we define the export price as a markup over marginal cost. The price may vary with both the markup (determined by the elasticity of demand and the firm's market share) and the costs of production. At the moment, let us disregard cost-based differentials and focus on pure discriminatory behavior. Consider a profit-maximizing firm that is selling its product on two different markets and charges different prices. If the marginal cost of the good is independent of its destination (in f.o.b. prices), then price discrimination implies that at least one export price is greater than the marginal cost and there is a positive markup. Thus, price discrimination or a price dispersion across export markets has to be associated with firm market power. However, consider another firm also selling its product on two different markets but charging the same price. Clearly, as prices can be above marginal costs on both markets, this does not imply that the firm does not exert market power as prices can be above marginal costs on both markets. Thus, while price discrimination cannot occur without market power, market power may be present without price discrimination.[3] Consequently, it remains an empirical question whether more price discrimination (i.e., more variations in export prices) implies higher markups or not.

2.2 Markups and export prices in the international trade literature

Until recently, price discrimination and segmented markets have received fairly little attention in the international-trade literature. This can be explained partly by the extensive use of monopolistic competition models with CES preferences and iceberg trade costs in which price discrimination does not occur.[4] Early exceptions can be found in the reciprocal dumping models by Brander (1981) and Brander and Krugman (1983) explaining intra-industry trade in homogenous goods. In these models, firms are able to segment international markets which results in lower markups on exports compared to the domestic market.[5] Lately, variations in markups have been introduced in a heterogeneous-firm framework. Melitz and Ottaviano (2008) propose a monopolistic competition model in which markets are segmented. Particularly, they demonstrate how, with firms facing linear demand as opposed to CES demand, markups will vary across firms and export destinations. In their setting, firms with lower costs (i.e. more productive firms) will charge lower prices and have higher markups. Moreover, the ability to price-discriminate across markets will lead to lower markups and prices on markets characterized by higher competition. Bernard et al. (2003) also model variations in markups across firms using a Ricardian framework with Bertrand competition. Although more efficient firms will have higher markups on average, the markup is not linked to the cost efficiency of the firm. Hence, in their model, a firm's markup and price will be higher on markets where it can exert more market power. The explanation of factors that determine market power is however outside the scope of their study.

The relationship between markups and export status is investigated in De Loecker and Warzynski (2009). Similar to our work, they estimate firms' overall markups across markets

[3] This is analyzed theoretically in McAfee et al. (2006).
[4] See the discussion in Martin (2010).
[5] Also related are papers following the tradition on spatial price discrimination developed by Hoover (1937). See, e.g., Greenhut et al. (1985) on reverse dumping.

from firm-level data. In particular, using data on the Slovenian manufacturing sector, they find that exporters have on average higher markups than non-exporters.[6] This result is consistent with a productivity premium for exporters as suggested in heterogeneous-firm settings. At the same time, De Loecker (2007) using similar data finds that about a third of the higher markup for exporters is not due to costs or productivity.

Some recent empirical studies use detailed firm-level data to investigate within-firm price variations across export destinations.[7] Common for these studies is that they focus on the spatial pattern of export prices, taking both quality and markup explanations into account.[8] For instance, Martin (2010) focuses on how within-firm export prices of French exporting firms vary with distance and finds that firms set higher prices at more distant markets. However, this positive relationship, he argues, cannot be explained by existing international-trade models, whether due to quality upgrading or higher markups.[9] Manova and Zhang (2009) use data on Chinese exporting firms in 2005 and examine how export prices vary with distance and market size in different heterogeneous-firm settings where they, in addition to quality, also consider differences in markups across markets. They find that firms that export more and to a larger number of markets have higher export prices on average and also display higher export price variation. A similar approach is taken by Görg et al. (2010) who use Hungarian export data for the year 2003. Besides quality-to-market they suggest a markup explanation where exporting firms add transport costs to f.o.b. prices implying a higher export price to more distant markets.[10]

Although these papers suggest price discrimination and differences in markups as a possible explanation to variations in export prices, they do not elaborate on this proposition. In this

---

[6] This result is also found in Görg and Warzynski (2003).

[7] An early paper on price discrimination and markups in export markets is provided by Aw (1993). See also Aw et al. (2001) that investigates price variations across domestic and export markets.

[8] Several empirical studies have identified a positive correlation between average export prices and distance. In international-trade models with heterogeneous producers, this observation is consistent with product quality differences across export destinations. In particular, Baldwin and Harrigan (2007) explain this in a model where higher-quality products are more costly to produce but also more profitable and therefore better at penetrating distant markets. Similarly, Johnson (2009) shows that prices increase with distance and the difficulty of entering a market. In addition, he finds that more productive firms produce higher-quality goods and consequently can charge higher prices.

[9] In order to explain the positive correlation between export prices and distance, he proposes additive trade costs instead of iceberg trade costs, which also makes it possible to maintain the monopolistic-competition setting with CES preferences. Additive trade costs are also considered in Hummels and Skiba (2004).

[10] The argument in Görg et al. (2010) is that when the firm has found an export destination, it buys transport services and adds these to export prices. Thus, in reality f.o.b. prices may contain transport costs.

paper, we focus on the segmented-market explanation as to why within-firm-product prices vary, and, in particular, perform a markup estimation where we investigate how markups correlate with a firm's ability to price-discriminate across markets.

3. Markups and the empirical model

Our empirical procedure consists in estimating average markups using firm-level data for four sectors constituting the Swedish food supply chain.

In order to calculate markups, we consider a general model consistent with an imperfectly competitive market structure. This approach has been adopted *inter alia* by Hall (1988), Levinsohn (1993) and Harrison (1994), who all used the primal Solow residual to measure the markup. We apply an extension of the work of Hall (1988) developed by Roeger (1995), implying the use of both the primal and the dual Solow residual. [11] Hall showed how the markup can be obtained from the primal Solow residual (calculated from the production function) when there is market power. This residual, however, contains a productivity term that may cause endogeneity problems when the markup is estimated. Roeger demonstrated how this problem can be taken care of by subtracting the dual Solow residual (calculated from the cost functions) from the primal residual.[12]

More formally, firm output at time *t* is determined by a linear homogenous production function with three factors of production; capital (K), labor (L) and material inputs (M)[13]

$$Q_t = \theta_t \mathrm{F}(K_t, L_t, M_t) \tag{1}$$

where θ_t is a Hicks-neutral productivity term. With imperfect competition in product markets, Hall (1988) showed that the primal Solow residual will be

$$(\Delta\ln Q_t - \Delta\ln K_t) - \alpha_{Lt}(\Delta\ln L_t - \Delta\ln K_t) - \alpha_{Mt}(\Delta\ln M_t - \Delta\ln K_t) = \beta[(\Delta\ln Q_t - \Delta\ln K_t)$$

[11] International trade studies using the Roeger method are, e.g., Konings and Vandenbussche (2005) and Badinger (2007). See Tybout (2003) for a discussion of alternative ways to estimate markups

[12] The drawback with Roeger's method is that it relies on the assumption of constant returns to scale. With increasing returns to scale, the estimated markup will be biased downward. See, e.g., Levinsohn (1993).

[13] The inclusion of materials inputs is suggested by Domowitz et al. (1988) and is an extension of the original Hall approach that only incorporated capital and labor.

$$+ (1 - \beta)\Delta\ln\theta_t \tag{2}$$

where $\alpha = P_{It}\, I_{It} / P_t\, Q_t$, $I = L, M$, are factor shares of sales with P_{It} denoting factor prices and P_t the product price. Thus, the residual can be decomposed into a market power term and a productivity term with β being directly related to the markup, μ, of price over marginal cost by $\mu = 1/(1-\beta)$.[14]

As the two terms on the right-hand side of equation (2) are positively correlated, the estimation of β is problematic. Roeger (1995) solves this by deriving the dual Solow residual:

$$\alpha_{Lt}\,\Delta\ln P_{Lt} + \alpha_{Mt}\,\Delta\ln P_{Mt} + (1 - \alpha_{Lt} - \alpha_{Mt})\,\Delta\ln R_t - \Delta\ln P_t = -\beta\,[(\Delta\ln P_t - \Delta\ln R_t)$$
$$+ (1 - \beta)\Delta\ln\theta_t \tag{3}$$

with R_t denoting the price of capital, and then subtracting equation (3) from equation (2) to obtain the net Solow residual

$$(\Delta\ln Q_t + \Delta\ln P_t) - \alpha_{Lt}\,(\Delta\ln L_t + \Delta\ln P_t) - \alpha_{Mt}\,(\Delta\ln M_t + \Delta\ln P_t)$$
$$- (1 - \alpha_{Lt} - \alpha_{Mt})(\Delta\ln K_t + \Delta\ln R_t) = \beta\,[(\Delta\ln Q_t + \Delta\ln P_{Lt}) - (\Delta\ln K_t + \Delta\ln R_t)] \tag{4}$$

Notice that in equation (4) the productivity term that causes the endogeneity problem cancels out.

To obtain a direct estimate of the markup μ, equation (4) can be rewritten

$$(\Delta\ln Q_t + \Delta\ln P_t) - (\Delta\ln K_t + \Delta\ln R_t) = \mu_t\,\{\alpha_{Lt}\,[(\Delta\ln L_t + \Delta\ln P_{Lt}) - (\Delta\ln K_t + \Delta\ln R_t)$$
$$+ (\alpha_{Mt}\,[(\Delta\ln M_t + \Delta\ln P_{Mt}) - (\Delta\ln K_t + \Delta\ln R_t)]\} \tag{5}$$

In order to estimate (5), only nominal data on firm sales and values of input factors are required. To simplify notation, let ΔY_t denote the left-hand side and ΔX_t the term within the bracket on the right hand side of equation (5)

---

[14] Notice that under perfect competition when price equals marginal cost the Solow residual is given by $\Delta\ln\theta_t = (\Delta\ln Q_t - \Delta\ln K_t) - \alpha_{Lt}\,(\Delta\ln L_t - \Delta\ln K_t) - \alpha_{Mt}\,(\Delta\ln M_t - \Delta\ln K_t)$. If price exceeds marginal costs, however, factor share in costs increases to $(P / mc)\ \alpha_{It}$. The Solow residual should therefore be modified to $\Delta\ln\theta_t = (\Delta\ln Q_t - \Delta\ln K_t) - (1 - \beta)^{-1}\alpha_{Lt}\,(\Delta\ln L_t - \Delta\ln K_t) - (1 - \beta)^{-1}\alpha_{Mt}\,(\Delta\ln M_t - \Delta\ln K_t)$ where β is the Lerner index $(P - mc)/P$.

$$\Delta Y_t = \mu \Delta X_t \tag{6}$$

where, thus, ΔY_t is the growth rate of sales per value of capital, ΔX_t reflects growth rates of the input factors weighted by their shares in sales and μ is the markup to be estimated.[15]

3.1 Data

We make use of detailed firm-level data provided by Statistics Sweden for exporting firms in the Swedish food chain, covering the period 1997-2006 for the food processing firms and the period 2003-2006 for firms in the agricultural, wholesale a retail part of the food chain. [16] The focus on the food chain is an interesting case study for several reasons. First, food products constitute still a large and stable share of consumers' expenditures and has accounted for around 15 per cent of total expenditures the last decade..[17] Hence the pricing behavior of firms in this chain has a major impact on consumers' welfare. Second, the food chain is an important part of the Swedish economy since it employs around 6 per cent of all employees in Sweden (the dataset used in this study covers around 220 000 employees) and the food processing industry is the fourth largest manufacturing industry. Third, the different parts of the food chain are highly integrated but at the same time they face very different market situations.[18] The production chain may be described as a chain of imperfect markets where the agricultural sector has least market power while the wholesale and retailing sectors are the least competitive ones. Hence we have a unique possibility to compare pricing behavior of exporters when we follow products downstream.

The export behavior of firms in the Swedish food chain has been found to resemble the behavior of firms in other countries and sectors (Greenaway et al., 2010; Gullstrand, 2011). Thus, the number of exporting firms is quite small when all firms are considered. In agriculture and

---

[15] Exact definitions of ΔY_t and ΔX_t are given in the Appendix.
[16] We only consider firms that exist for at least three consecutive years.
[17] These figures stem from LivsmedelsSverige (a joint platform between the industry, consumer groups and academia) and can be found on the following web page (downloaded 28th June 2011) http://www.livsmedelssverige.se/hem/statistik/livsmedelskedjan.html.
[18] McCorriston (2002) argues that the European food chain market consists of a multi-stage oligopoly where one "*oligopolistic sector sells its output to another oligopolistic sector*" but at the same time the structure of the food chain varies across countries. In the EU15, the concentration ratio of the five largest firms in the retail sector in the mid 90's varies from around 96 per cent in Finland to 30 per cent in Italy, and a similar variation is found in the manufacturing sector. Thus, if the structure of the food chain differs widely across countries, then the bargaining power and the pricing behavior of a Swedish firm selling on different markets differs widely as well.

retailing only around 1 per cent of the firms are exporters while the same figure is around 14 per cent in the food processing industry and 16 per cent in wholesale (figures from 2003). In addition, a comparison between exporters and non-exporters within sub-sectors at a three digit level support the findings of other studies, i.e. that exporters are more productive.[19]

In this study, however, we will focus on exporters and their ability to reach out to many markets as well as to price-discriminate between these markets. Hence, we will investigate whether the pricing behavior of firms exporting to at least two markets with very different f.o.b. prices differs from those exporting to only one market or from those exporting to several markets but without price discrimination across markets.

The data set reports export values and quantities by product and trading partners at the 8-digit level of the Combined Nomenclature. The information on values and quantities is used to calculate export unit prices (values divided by quantities) for each product and export destination. The reason for using very detailed products classification is that we want to compare the export price of a narrowly defined product from one specific firm to several export destinations. As products are defined at a highly disaggregated level, we thus minimize the problem of comparing prices of products with different quality.[20]

Table 1 displays some descriptive figures for our sample divided between single and multi-destination exporters (i.e. exporting the same product to several destinations) and the different parts of the food chain. Note that a single-destination exporter may be active in more than one destination if they export more than one product when these products are sold on different markets. The figures reveal a common pattern throughout the food chain. Multi-destination exporters are bigger, both in terms of sales and number of employees, more productive, and they export a greater number of products than single-destination exporters. The only exception to this pattern is that single-destination firms seem to be more productive in retailing. The figures resemble those in recent studies focusing on differences between exporting manufacturing firms and intermediary exporters in wholesale and retail. That is, intermediary exporters are in general found to be smaller, have higher industry diversification but are less geographically diversified (Bernard et al., 2010)

[19] Exceptions are found in the agricultural sector when it comes to mixed farming, pig farming and cereal production.

[20] For instance, in our data material products with the CN-code 09102090 and 04031039 are described as *crushed or ground saffron* and *yogurt (excl. flavored or with added fruit, nuts or cocoa), with added sugar or other sweetening matter, of a fat content, by weight, of > 6,0%*, respectively. These categories are also examples of products that display high export-price variation at the firm level.

[Table 1 about here]

Figure 1 shows how prices vary across destinations in the food chain with the help of the coefficient of variation of firm-product prices across markets. The results are based on the period 2003-2006 in order to allow the sample period to be the same for all sectors. The figures indicate a higher variation in agriculture and wholesale compared to food processing and retailing, and the results show that exporters use very different prices across markets. Besides using the coefficient of variations, we also construct a dummy variable defining a firm-product export price to be local when it deviates from the mean with more than 40 per cent (this threshold is somewhat arbitrary but different thresholds are used in the analysis as a robustness check). Otherwise we define the price to be global (i.e. more or less the same on all markets). Figure 2 shows the share of local prices not only for the different parts of the chain but also for whether the exported product is defined as a differentiated product or not (according the classification of Rauch, 1999). In addition, the pattern of local versus global price setting is compared between only multi-destination exports and all exports where single-destination exports are included and defined as global price setter. The pattern, however, is similar. Local pricing is more common in the upstream part of the food chain compared to exporters downstream. Also, price discrimination across markets is more common when the exported product is defined as differentiated compared to more homogeneous products.

[Figure 1 about here]

[Figure 2 about here]

3.2 Empirical specification

To analyze how variations in firms' export prices are associated with market power, we study how the markup given by (6) changes with price variations at the firm-product level for each sector in the food supply chain separately. In particular, we focus on the interaction between price variations and the input growth composite term, ΔX_t. The full model to be estimated by Roeger's (1995) method is given by

$$\Delta Y_{ijt} = \mu_1 \Delta X_{ijt} + \mu_2 [\Delta X_{ijt} \times PriceVar_{ijt}] + \boldsymbol{\mu} [\Delta X_{ijt} \times \mathbf{Z}_{i,k,t}] + \beta\, PriceVar_{ijt} + \boldsymbol{\gamma}\, \mathbf{Z}_{i,k,t} + \alpha_{ij} + \tau_t + \varepsilon_{ijt} \qquad (7)$$

In (7), μ_1 is the average markup (for the whole sector) while μ_2 reflects how the markup *changes* with variations in firm *i*'s export price of product *j* at time *t*, with $PriceVar_{ijt}$ denoting the price variation variable. Additional changes in the markup linked to various control variables (firm and country specific variables of the destination market (*k*), reflected by the vector $\mathbf{Z}_{i,k,t}$) are captured by $\boldsymbol{\mu}$. β and $\boldsymbol{\gamma}$ denote the direct effects of the price variable and the control variables, respectively. In addition, α_{ij} are firm-product fixed effects to control for heterogeneity of products, τ_t a year dummy, and ε_{ijt} is a white noise error term.

We thus use the two different measures to capture firms' price discrimination at the product level across markets, both based on the unit export values, the coefficient of variation and the local market dummy. Descriptive statistics for the price variation variables and information about the additional control variables are presented in Table 2.

[Table 2 about here]

4. Results

We estimate markups using firm-level data on sales and total expenditures on inputs for the different parts of the food chain. As a benchmark, we estimate the average markup for each part in the food chain (not presented) when no interactions or other control variables are introduced in equation (7). These estimations suggest a rather expected pattern since we found a positive markup downstream but not upstream. That is, no markup is found in the agricultural sector while the food processing industry and wholesale has a markup of 1.27 and 1.14 respectively. This is consistent with the findings in other studies.[21] Notice that this markup is determined by the market structure on both the Swedish and international markets as we do not differentiate between domestic and foreign sales. On the other hand, the average markup of retailers is below one, which suggests a negative profit for these firms. This may be a result of a small sample since very few retailers export. Also, these firms may have very different export behavior compared to other parts of the food chain as suggested by the observation in Table 1 that single-destination exporters display much higher productivity level compared to multi-destination exporters in this particular sector.[22]

[21] See for example De Loecker and Warzynski (2009) and Wilhelmsson (2006).
[22] One reason for this is that wholesalers' act as a distribution channel for retailers who are more concerned about the local market (see Gullstrand and Jörgensen, 2011).

In Table 3 the interaction terms between the price-variation variables and the markup are added into the regressions. While the results are upheld for the estimated overall markups, the markup seems only to vary with price discrimination possibilities in the food processing industry. This result is robust for our two different types of price discrimination variables. That is, the markup is higher for firms with a more diversified pricing behavior on the export market. For the other parts of the food chain, the results are inconclusive. While price-discriminating firms in the agricultural sector have a higher markup as long as we categorize firms into local versus global price setters with the help of a dummy variable, no such effect is found when we use the coefficient of variation. Further, the results indicate that price-discriminating firms may even have a lower markup in the wholesale sector while no effect is found in retailing. The results are all robust for a change in the threshold of the local market dummy.[23]

[Table 3 about here]

Nevertheless, the results in Table 3 might be explained by the ability of reaching out to several markets as well as the ability to price-discriminate between markets being correlated with other characteristics influencing the markup pattern across firms. More productive firms and/or more international firms (higher export intensity or a greater number of export destinations) may both be associated with a higher ability to price-discriminate and a higher markup. Table 4 reports the results from including additional firm- and average-market characteristics of the export destinations. In particular, we add firm productivity, measured as total factor productivity, export intensity, number of destinations and the weighted distance (using export shares as weight). All regressions also include the direct effects of the variables interacted with the markup μ but these are excluded for brevity.

The results in Table 4 suggest not only that the markup is indeed a complex function of firm characteristics but also that the impact of the ability to price-discriminate becomes more conclusive. That is, it is only in the food-processing industry that firms with a greater ability to discriminate between markets are associated with a higher markup. In all other cases the markup does not vary with a variation in export prices. The lack of price discriminating behavior among exporters in the agricultural sector is likely to reflect the standard use of reference pricing on agricultural products. In addition, the contrasting price-setting behavior between exporters in the

[23] We have used 0.5 and 0.3 as alternative thresholds and although the results are not published here, for brevity, they are available upon request.

food-processing sector and exporters in the wholesale and retail sector is in line with reported discrepancies in the use of price discrimination between firms in the manufacturing and trade sector (see Fabiani et al., 2005).

When it comes to the other results in Table 4, productivity seems to be positively correlated with markups in the food processing and trade sectors, but not for agriculture. Notably, firm productivity has a strong impact on markups in the retail sector, where the average markup now is significantly above 1. Our estimations also provide evidence of a positive correlation between the firm's markup and export intensity in the agricultural, food processing and wholesale sector. Again, the results point to a different export behavior amongst retailers. The different role of trade within intermediaries is also displayed by the negative correlation between the markup and the number of destinations to which the product is exported in the wholesale and retail sector. As revealed by our results, the positive impact of price discrimination between export markets on the markup is not just a reflection of these firms having a starker international focus and/or reaching out to more markets. Finally, the markup seems to be independent of whether the firm exports to more distant markets or not.

[Table 4 about here]

5. Extension: The determinants of export prices

While the primary focus of this paper is placed on price discrimination, as measured by export price variation, and markups, the firm decision to charge a particular export price in a market merits its own study. Previous empirical work studying firm pricing behavior in foreign markets has focused on the relationship between export prices and various gravity variables (see Görg et al., 2010, Manova and Zhang, 2009, and Martin, (2010). We replicate this research by looking at the determinants of unit value export prices for our data set, using the firm-product-destination export price for every observation as our independent variable. Figure 3 displays how export prices change with distance in the different parts of the food chain, revealing quite different patterns across sectors. Notably, while export prices increase with distance in food processing and wholesale, they decrease in retail. In the agricultural sector, the relationship is nonlinear.

[Figure 3 about here]

In Table 5, we present the results for all exporting firms in each of the investigated sectors. Our findings resemble those identified by other researchers. In particular, the bilateral factors are empirically validated for the food processing, wholesale and retail sectors. The different results for agriculture may again reflect the standard use of reference pricing in the sector. This explanation is in line with the estimation results in Görg et al. (2010), which show that gravity variables do not affect the export prices on homogenous products.

For the sectors where gravity variables affect firms' export price behavior, GDP per capita, expected to capture the income level of a country, influences prices positively.[24] In addition, distance has a positive effect on a firm's export prices in the food processing and retail sector, suggesting that firms in these sectors charge higher prices on more distant markets. The positive effect of distance has acquired a lot of attention in prior research, not least because it contradicts expectations on basis of the Mayer and Ottaviano (2008) model. In most previous studies, this has been interpreted as supporting the notion of quality differences. It should be noted, however, that these findings also lend support to the existence of segmented markets. As there is both a cost and a price effect on the markup, a higher markup could be associated with factors on the demand side. In particular, the elasticity of demand might vary on foreign markets or consumers could value goods differently (see, e.g., De Loecker and Warzynski, 2010). In the presence of search costs in consumption, the fact that price information is more costly in markets where the product is less well-established could result in a positive correlation between distance and export prices.

Our results also show that the firm's export intensity is positively correlated with export prices in the agricultural, food processing and wholesale sectors. This finding, which is similar to that identified in previous studies (i.e., Görg et al., 2010, and Manova and Zhang, 2009), clearly indicates that markets are segmented and that demand side factors in the destination countries matter for the firm's pricing decision.

Notably, of the firm characteristics, only skill intensity seems to influence the firms' pricing decision, whereas we do not find any effects of productivity. The skill intensity has a positive correlation with export prices of firms in the wholesale and retail sector, indicating that skill-abundant intermediaries charge higher prices. Although the lack of correlation between a firm's productivity level and its export price should be interpreted with caution as the estimations

[24] The negative GDP effect found for the wholesale sector is a general anomaly in export price regressions.

include firm-product fixed effects, the result could suggests that product quality has little influence on the firm's foreign price decision.[25]

[Table 5 about here]

6. Conclusions

This paper starts from the observation that firms charge different prices on different export markets. We propose an imperfect competition explanation based on segmented markets and argue that these price variations reflect price discrimination. We then investigate markups within the different parts of the Swedish food supply chain and whether within-firm price variations are correlated with firm markup. Thus, the study offers a comprehensive analysis of pricing behavior of exporters when we follow products downstream.

The results from the markup estimations show that pricing decisions vary for firms in different parts of the food chain. In particular, it is only in the food processing industry that firms with a greater ability to discriminate between markets are associated with a higher markup. In all other cases the markup does not vary with a variation in export prices. This result lends support to survey findings suggesting that price discrimination is more prevalent in the manufacturing sector than in other sectors. The paper also identifies other variations across different parts of the supply chain showing how price setting and markups are a complex function of firm characteristics. Together, these results suggest that the conclusions of firm behavior from other studies focusing on firms in the manufacturing sector cannot easily be extended to firms in other sectors of the economy.

[25] Görg et al. (2010) also controls for firm productivity in their estimations. They find a positive productivity effect on export prices at a more aggregated product level (the 6-digit HS industry level).

References

Aw, B.Y., 1993. Price discrimination and markups in export markets. *Journal of Development Economics*, 42 (2): 315-336.

Aw, B.Y., Baatra, G., and M.J. Roberts, 2001. Firm heterogeneity and export–domestic price differentials: A study of Taiwanese electronics products. *Journal of International Economics*, 54(1): 149-169.

Aw, B.Y., Chung, S., and M. Roberts, 2003. Productivity, Output, and Failure: A Comparison of Taiwanese and South Korean Manufacturers. *Economic Journal*, 113: 485-510.

Badinger, H., 2007. Has the EU's single markup programme fostered competition? Testing for a decrease in mark-up ratios in EU industries. *Oxford Bulletin of Economics and Statistics*, 69(4): 497- 519.

Baldwin, R., and J. Harrigan, 2007. Zeros, quality and space: trade theory and trade evidence. NBER Working paper No. 13214.

Bernard, A., Grazzi, M., and C. Tomasi, 2010. Intermediaries in international trade: Direct versus indirect modes of export. National Bank of Belgium, Working Paper No. 199.

Bernard, A., Eaton, J., Jensen, J.B., and S. Kortum, 2003. Plants and productivity in international trade. *American Economic Review*, 93(4): 1268-1290.

Brander, J., 1981.Intra-industry trade in identical commodities. *Journal of International Economics*, 11(1): 1-14.

Brander, J., and P. Krugman, 1983. A "reciprocal dumping" model of international trade. Journal of International Economics, 15 (3-4): 313-321.

De Loecker, J., 2007. Do export generate higher productivity? Evidence from Slovenia. *Journal of International Economics*, 73: 69-98.

De Loecker, J., and F. Warzynski, 2009. Markups and firm-level export status. NBER Working Paper No. 15198.

Domowitz, I., Hubbard, R., and B. Petersen, 1988. Market structure and cyclical fluctuations in US manufacturing. *Review of Economics and Statistics*, 70(1): 55-66.

Economides, N.S., 1988. The economics of trademarks. *Trademark Reporter*, 78: 523-539.

Fabiani, S., Druant, M., Hernando, I., Kwapil, C., Landau, B., Loupias, C., Martins, F., Mathä, T., Sabbatini, R., Stahl, H., and A. Stokman, 2005. The pricing behavior of firms in the euro area: new survey evidence. ECB Working Paper No. 535.

Goldberg, P.K., and M.M. Knetter, 1999. Measuring the intensity of competition in export markets. *Journal of International Economics*, 47: 27-60.

Görg, H., Halpern, L., and B. Muraközy, 2010. Why do within firm-product export prices differ across markets? Kiel Working Papers No. 1596, Kiel Institute for the World Economy.

Görg, H., and F. Warzynski, 2003. Price cost margins and exporting behavior: Evidence from firm-level data. German Institute for Economic Research Discussion Paper No. 365.

Greenaway, D., Gullstrand, J., and R. Kneller, 2008. Firm heterogeneity and the geography of international trade. University of Nottingham, GEP Discussion Papers No. 08/41.

Greenhut, M.L., Ohta, H., and J. Sailors, 1985. Reverse dumping: A form of spatial discrimination. *The Journal of Industrial Economics*, 34(2): 176-181.

Gullstrand, J., and C. Jörgensen, 2008. Deeper integration and productivity: the Swedish food and beverage sector. *Food Economics – Acta Agriculturae Scandinavia, Section C*, 5(1): 1-13.

Gullstrand, J., and C. Jörgensen, 2011. Local Price Competition: The Case of Swedish Food Retailers. AgriFood Working Paper No. 2011:3.

Gullstrand, J., 2011. Firm and destination-specific export costs: The case of the Swedish food sector. Forthcoming in *Food Policy*.

Hall, R.E., 1988. The relation between price and marginal costs in U.S. industry. *Journal of Political Economy*, 96(5): 921-947.

Harrison, A., 1994. Productivity, imperfect competition and trade reform: Theory and evidence. *Journal of International Economics*, 36: 53-73.

Hoover, E., 1937. Spatial price discrimination. The Review of Economic Studies, 4(3): 182-191.

Hummels, D., and A. Skiba, 2004. Shipping the good apples out? An empirical confirmation of the Alchian-Allen conjecture. *Journal of Political Economy*, 112(6): 1384-1402.

Johnson, R.C., 2009. Trade and prices with heterogeneous firms. Working paper, Dartmouth College.

Konings, J., and H. Vandenbussche, 2005. Antidumping protection and markups of domestic firms. *Journal of International Economics*, 65: 151-165.

Levinsohn, J., 1993. Testing the import-as-market-discipline hypothesis. *Journal of International Economics*, 35: 1-22.

Manova, K., and Z. Zhang, 2009. Quality heterogeneity across firms and export destinations. Working Paper No 15342.

McAfee, R.P., Mialon, H.M., and S.H. Mialon, 2006. Does large price discrimination imply great market power? *Economic Letters*, 92: 360-367.

McCorriston, S., 2002. Why should imperfect competition matter to agricultural economists? *European Review of Agricultural Economics*, 29: 349-371.

Melitz, M.J., and G.I. Ottaviano, 2008. Market size, trade, and productivity. *Review of Economic studies*, 75(1): 295-316.

Martin, J., 2010. Markups, quality and transport costs. Working paper, Paris School of Economics.

Rauch, J.E., 1999. Networks versus markets in international trade. *Journal of International Economics*, 48: 7-35.

Roeger, W., 1995. Can imperfect competition explain the difference between primal and dual productivity measures? Estimates for U.S. manufacturing. *Journal of Political Economy*, 103(2): 316-330.

Tirole, J., 1988. *Theory of Industrial Organization*. Cambridge, MA:MIT.

Tybout, J.R., 2003. Plant and firm-level evidence on “new” trade theories. In Choi, K. and J. Harrigan (eds.), *Handbook of International Trade*, Oxford: Basil-Blackwell.

Wilhelmsson, F., 2006. Market power and European competition in the Swedish food industry. *Journal of Agricultural & Food Industrial Organization*, 4(1): article 7.

Tables

Table 1. Descriptive figures

	Agriculture		Food processing		Wholesale		Retail	
	Multi-destination	Single destination	Multi-destination	Single destination	Multi-destination	Single destination	Multi-destination	Single destination
Average number of employees	22	2.4	230	49	39.6	10	167	17
Average sales (1 000 SEK)	53 000	3 800	562 000	116 000	288 000	70 000	1 910 000	259 000
Average export value (1 000 SEK)	15 100	130	75 000	1 200	15 000	840	9 100	590
Average number of destinations	5.4	1	10	1.3	6.0	1.2	4.9	1.2
Average number of exported products	6.4	1.3	16	2.5	19	3.4	48.7	3.1
Average total factor productivity	2.4	1.9	3.2	1.3	2.0	1.8	1.0	3.6
Number of firm-product-destination observations	856	2 314	75 247	3 667	48 618	9 952	4 740	1 217
Number of firms	43	1 287	337	568	612	1 604	46	256

Table 2. Data descriptives

Variables	Definition	Mean	Standard deviation
Price variation variables			
Coefficient of variation	The coefficient of variation of the unit value export price defined at the firm-product level.	0.23	0.37
Local market	A dummy variable taking the value one if a firm's product unit exports value differs with more than 40 percent from the average firm-product price.	0.25	0.43
Other firm characteristics			
Productivity (TFP)	Total factor productivity multilateral index defined as in Aw et al. (2003) $\ln TFP_t^i = (q_t^i - \overline{q}_t) + \sum_{s=2}^{t}(\overline{q}_s - \overline{q}_{s-1}) - \{\sum_j \frac{1}{2}(\alpha_{tj}^i - \overline{\alpha}_{tj})(x + \sum_{s=2}^{t}\sum_j \frac{1}{2}(\overline{\alpha}_{sj} - \overline{\alpha}_{s-1j})(\overline{x}_{sj} - \overline{x}_{s-1j})\}$, where lower-case letters indicate natural logarithm of output (*q*) and inputs (*x*), bars indicate un-weighted average over all firms (*i*) and hence the hypothetical firm used as a reference, and a is input-cost shares. Inputs (*j*) used are number of employees, capital stock and raw materials.	1.25	0.57
Skill intensity	The share of employees with university degree.	0.03	0.08
Export intensity	Export values as a share of total sales.	0.19	0.23
Export market characteristics			
Distance	The distance, in kilometers, from Stockholm to the capital of the export destination (cepii's population weighted distance) weighted with firm export shares, calculated with the great circle distance formula from CSI's World Fact.	1324	1968
GDP	Gross domestic product (millions of current US$, cepii) weighted with firm export shares	554939	1115196
GDP per capita	GDP divided by population (cepii) weighted with firm export shares	32318	13197

Table 3. Price discrimination and markup

	Agriculture		Food processing		Wholesale		Retail	
	Price variation coefficient	Local market (0.40)	Price variation coefficient	Local market (0.40)	Price variation coefficient	Local market (0.40)	Price variation coefficient	Local market (0.40)
Markup (μ)	**1.371***	-0.146	**1.255 ***	**1.250 ***	**1.156 ***	**1.154 ***	**0.872 ***	**0.872 ***
	(0.00)	(0.78)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
PriceVar	0.1817	0.087	**-0.021**	**-0.0014**	0.002	0.003	**0.031**	**0.016**
	(0.61)	(0.53)	(0.00)	(0.00)	(0.77)	(0.51)	(0.00)	(0.00)
μ × PriceVar	-0.303	**1.491**	**0.208**	**0.077**	-0.062	**-0.038**	0.018	-0.009
	(0.71)	(0.01)	(0.01)	(0.03)	(0.07)	(0.04)	(0.74)	(0.47)
N	97	97	8 046	8 046	6 643	6 643	963	963
R^2	0.57	0.61	0.86	0.86	0.86	0.86	0.99	0.99

Note: The regressions include firm-product fixed effects and time dummies (not shown here). P-values within brackets are based on robust standard errors.
* indicates markup significantly different from 1.

Table 4. Price discrimination and markup, extended

	Agriculture		Food processing		Wholesale		Retail	
	Price variation coefficient	Local market (0.40)	Price variation coefficient	Local market (0.40)	Price variation coefficient	Local market (0.40)	Price variation coefficient	Local market (0.40)
Markup (μ)	**2.949***	**2.676***	**1.274***	**1.281***	**1.444***	**1.441***	**1.231***	**1.229***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
PriceVar	0.056	-0.008	**-0.018**	-0.0016	0.005	0.004	-0.0001	-0.0005
	(0.75)	(0.96)	(0.00)	(0.56)	(0.50)	(0.39)	(0.91)	(0.45)
μ × PriceVar	-0.219	0.100	**0.202**	**0.068**	0.004	-0.004	-0.003	-0.0003
	(0.58)	(0.84)	(0.01)	(0.05)	(0.90)	(0.83)	(0.39)	(0.82)
μ × ln(tfp)	-1.811	-1.814	**0.281**	**0.290**	0.048	0.048	**1.551**	**1.551**
	(0.26)	(0.34)	(0.00)	(0.00)	(0.08)	(0.08)	(0.00)	(0.00)
μ × ln(export intensity)	**0.314**	0.311	**0.047**	**0.046**	**0.037**	**0.037**	**-0.102**	**-0.102**
	(0.02)	(0.11)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
μ × number of destinations	-0.081	-0.202	-0.032	-0.030	**-0.037**	**-0.037**	**-0.638**	**-0.638**
	(0.78)	(0.67)	(0.23)	(0.27)	(0.00)	(0.00)	(0.00)	(0.00)
μ × ln(dist)	-0.06	-0.005	0.003	0.003	-0.024	-0.024	-0.0001	-0.00000
	(0.56)	(0.83)	(0.86)	(0.86)	(0.16)	(0.16)	(0.98)	(0.98)
N	97	97	8 046	8 046	6 643	6 643	963	963
R^2	0.94	0.94	0.89	0.88	0.91	0.91	0.99	0.99

Note: The regressions include firm-product fixed effects and time dummies as well as direct effects of all the interacted variables (not shown here). P-values within brackets are based on robust standard errors.
* indicates markup significantly different from 1.

Table 5. Determining export prices

	Agriculture	Food processing	Wholesale	Retail
ln(tfp)	-0.008	-0.009	-0.016	-0.132
	(0.90)	(0.68)	(0.58)	(0.28)
ln (skill intensity)	-0.106	-0.009	**0.062**	**0.322**
	(0.34)	(0.42)	(0.02)	(0.00)
ln(export intensity)	**0.186**	**0.023**	**0.035**	0.066
	(0.00)	(0.01)	(0.00)	(0.17)
ln(gdp)	0.029	-0.006	-0.009	0.017
	(0.68)	(0.14)	(0.06)	(0.44)
ln(gdp per capita)	0.064	**0.062**	**0.025**	0.144
	(0.49)	(0.00)	(0.00)	(0.01)
ln(distance)	-0.037	**0.066**	-0.002	**0.201**
	(0.76)	(0.00)	(0.89)	(0.00)
N	3161	77750	57852	5920
R^2 (within)	0.030	0.008	0.002	0.047
Rho	0.881	0.821	0.878	0.838

Note: The regressions include firm-product fixed effects and time dummies (not shown here). P-values within brackets are based on robust standard errors.

Figures

Figure 1. Firm-product price dispersion for multi-destination exports (2003-2006)

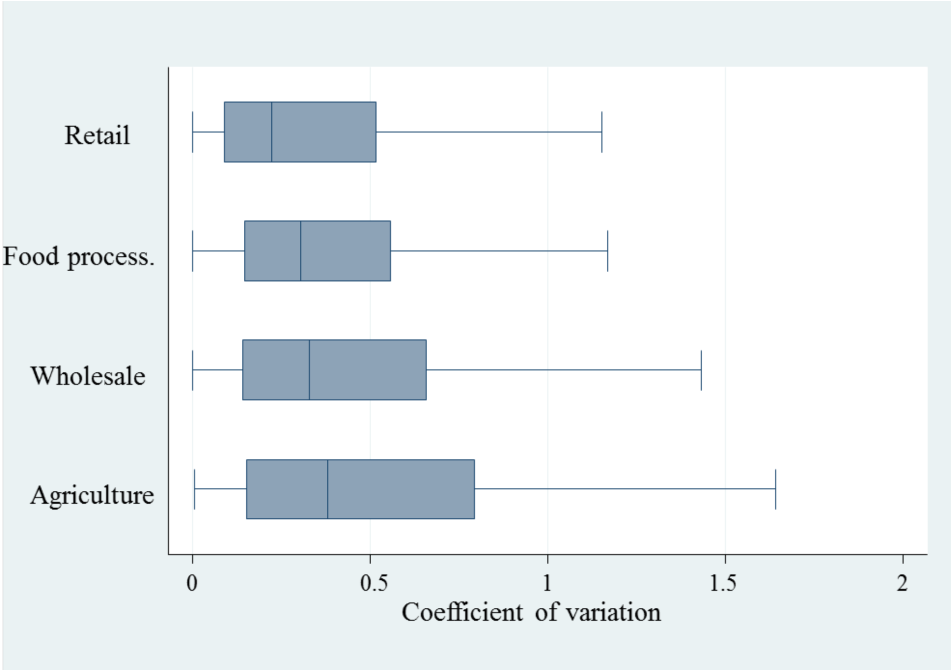


Figure 2. Price discrimination: Share of local price setting (2003-2006)

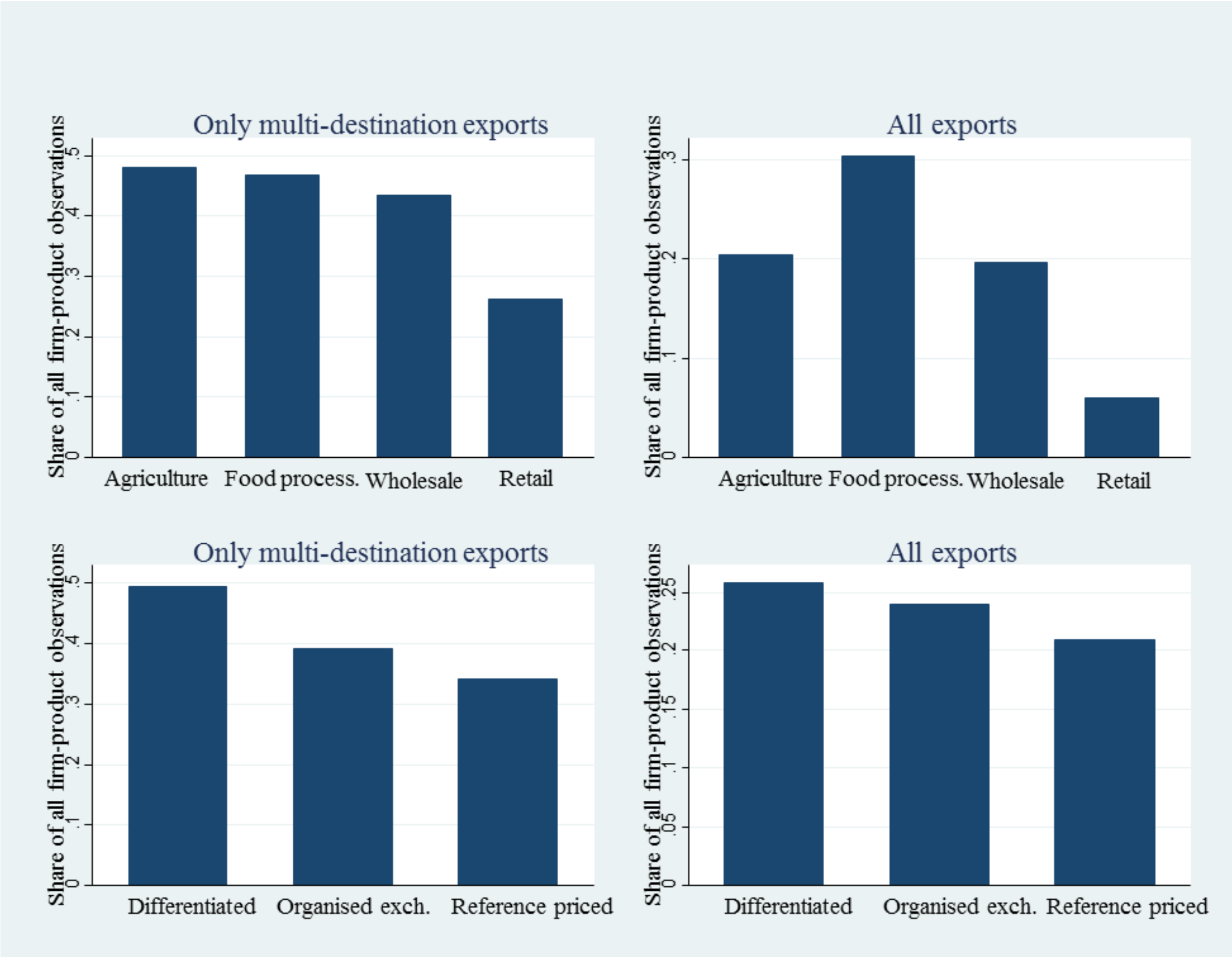
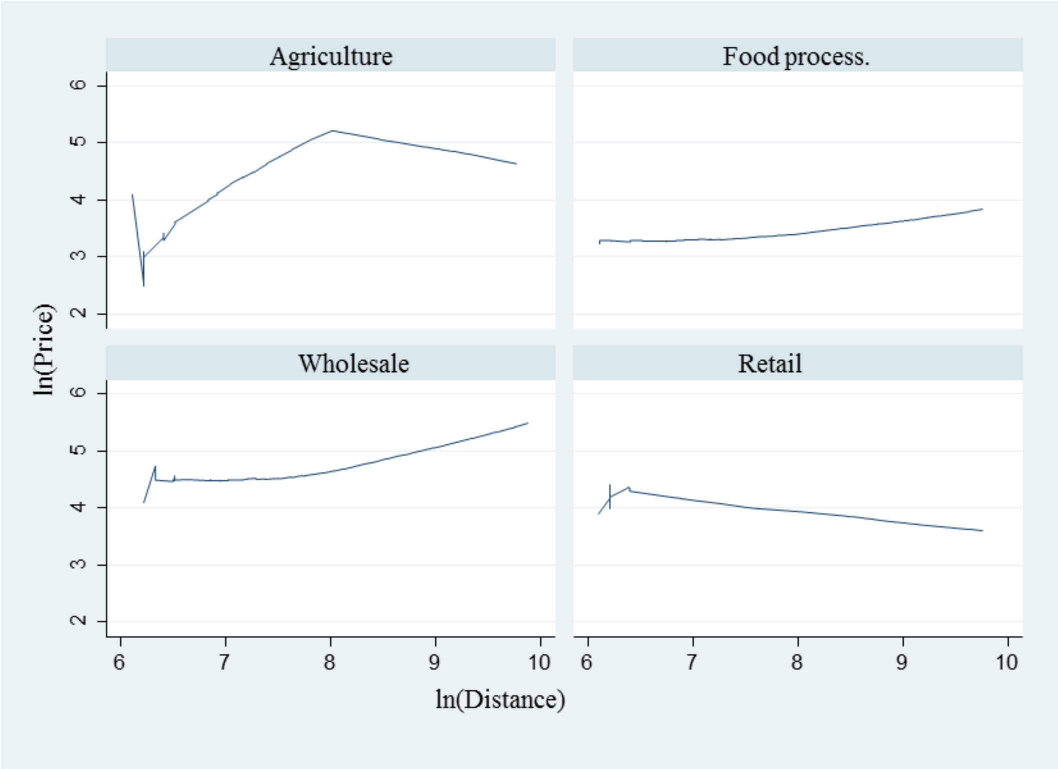


Figure 3. Export prices and distance (2006)



Appendix

Markup variables

The variables in equation (6) are defined as follows:

$\Delta Y_{it} = \Delta\ln(\textit{sales}) - \Delta\ln(\textit{value of capital})$

$\Delta X_{it} = \alpha_{Lit}L_{it}[\Delta\ln(\textit{wage costs}) - \Delta\ln(\textit{value of capital})] +$

$\alpha_{Mit}M_{it}[\Delta\ln(\textit{costs of raw materials}) - \Delta\ln(\textit{value of capital})]$

where

$\alpha_{Lit}L_{it}$ = *labor costs share in output = (wage costs) / (sales)*

$\alpha_{Mit}M_{it}$ = *raw material costs share in output = (costs of raw material) / (sales)*

which is calculated for each product *j* defined at the 8-digit level of the Combined Nomenclature (CN8). The capital stock is calculated by the perpetual method using book value the first year. Depreciation rate for equipment and for buildings are 0.1 and 0.05, respectively.