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ARTICLE

Markups and export behavior: Firm-level evidence from the French food processing industry

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Abstract

The relationship between a firm's markups and its export behavior is highly relevant to individual firms' strategic decisions as well as to governments' policies regarding competition. We investigate the impact of markups on firms' decisions to export and resulting export intensity in the French food processing industry. Moreover, we assess the effect of entry into and remaining in the export market on firms' markups and evaluate differences in markups between exporters and non-exporters. Our results suggest that higher markups lead to both increased participation in the export market and greater export intensity. In addition, we find that firms obtain higher markups by entering and remaining in the export market. Finally, our results suggest that exporters generate higher markups, on average, than non-exporters. Similar results are found when controlling for differences in firms' productivity. Our findings suggest that trade policies designed to increase firms' participation in export markets, such as limits to border restrictions, may counteract domestic competition policies targeted at price–cost margins.

KEYWORDS

export behavior, firm-level markups, food processing industry

JEL CLASSIFICATION

D22, F14, L11, L66, Q18

1 | INTRODUCTION

Food processing industries worldwide enjoy strong protection against competition from foreign trade.[i] However, recent trade reforms have made foreign markets more accessible to (potential) exporters (Curzi et al., 2015; FAO, 2019). This fosters firms' export activity that can influence their ratio of price over marginal costs, that is, markups. At the same time, countries employ various measures to encourage domestic firms to adopt advanced technologies and to produce higher quality products (FAO, 2019). Such measures also involve changes in markups that can in turn affect export participation and intensity. Consequently, the relation between markups and export behavior is of direct interest to policy makers and firms seeking to successfully align their policies and competitive strategies, respectively (e.g., De Loecker et al., 2016; Ponikvar & Tajnikar, 2011). This article investigates this simultaneous relationship using the example of the food processing sector in France.

One challenge in identifying the relationship between export decisions and markups is that both result from the interaction of factors that affect production and demand.[ii] We disentangle this simultaneity using exogenous characteristics such as firm age and legal form as instruments. First, we analyze the impact of firms' markups on the decision to export and on export intensity. Second, we explore the impact of (i) entering and (ii) remaining in the export market for at least two consecutive years, that is, the effect of export experience on markups. Finally, we evaluate the differences in markups for exporters and non-exporters.[iii]

Theory predicts that firms with relatively low marginal costs and/or higher product quality, that is, larger markups, enter the export market and adjust their product prices depending on the level of competition they expect to encounter at the export destination (Bernard et al., 2003; Melitz & Ottaviano, 2008). Furthermore, markups can change through learning by exporting (LBE) for firms remaining in the export market for a number of years (Bernard & Jensen, 1995). However, the empirical evidence on the relationship between exporting and markups is limited. De Loecker and Warzynski (2012) (hereafter DLW) were the first to empirically study the relevance of firms' export behavior for markups using the Slovenian manufacturing sector as a case study. DLW estimated firm-specific markups based on an extended version of the production function approach in Hall (1988).[iv] The DLW approach is attractive as it does not require assumptions about how firms compete in output markets. It also has lower data requirements compared to New Empirical Industrial Organization approaches (De Loecker & Scott, 2016). Later studies, such as Bellone et al. (2016) and Kilinc (2019), show the relevance of export destination characteristics for markups of companies in France and Luxembourg. However, these results should be understood as a correlation analysis as the authors did not control for the reverse causality between markups and export behavior.

This study adds to the literature in several ways. First, we go beyond the classic DLW methodology, that assumes perfect competition in input markets, when estimating firm-specific markups as a measure of output market power. In this respect, we take into account the potential imperfect competition in the labor input market. Furthermore, to obtain more reliable markup estimates, we improve the estimation of the production function by addressing potential biases in output measurement caused by deflating revenues with industry-wide price deflators. Instead, we use a price index that considers the weighted average of prices in domestic and export markets. Moreover, we account for the firm-specific deviations from the weighted average industry prices in the estimation of the production function. This results in more reliable estimates of production function parameters, which are required for the calculation of markups.

Second, we add to the understanding of the impact of firms' markups on both the probability of participating in an export market and on conditional export intensity. We use a double hurdle control function approach that separates the initial export decision from the conditional intensity while addressing the simultaneity between markups and export decisions based on suitable instrumental variables (IV) (Garcia, 2013). To the best of our knowledge, this impact has not yet been investigated empirically at the firm level.[v]

Third, we follow DLW and test whether markups are affected by the firm's decision to begin exporting and stay in the export market for at least two consecutive years. Moreover, we follow DLW and estimate differences in markups between exporters and non-exporters. Results of previous studies in this area are inconclusive, especially for developed countries (DLW). To obtain our estimates, we deviate from DLW by accounting for the simultaneity of firms' markups and export behavior using an extended regression model IV approach. Therefore, our results offer more reliable evidence on this issue.

We also control for differences in firms' productivity, which can play an important role in the markup–export behavior relationship (De Loecker & Goldberg, 2014; Foster et al., 2008; Greenway & Kneller, 2007). This provides evidence regarding the importance of factors other than productivity that drive the markup–export relationship, such as output quality and demand-side conditions. After controlling for differences in productivity, markups contain information that can be relevant for policy makers in formulating policies affecting domestic competition and for firms in designing strategies for product quality and pricing (De Loecker & Goldberg, 2014).

Our analysis uses a sample of 10,927 firms operating in the French food processing sector over the period 2011–2019. With a 20% market share, France is the largest contributor to total EU food industry turnover, followed by Germany and Italy. Moreover, the food processing sector constitutes the largest manufacturing subsector in France, contributing 17% (€178 billion) of total manufacturing sales in the country (Eurostat, 2019a). The food sector in France is characterized by high market saturation, strong competition along the supply chain, and a high degree of retailer concentration, all of which puts food processors under pressure (European Commission, 2014; Wijnands et al., 2007). In addition, the sector is known as one of the most diverse in the world[vi] with a variety of globally recognized products that provide firms with promising export opportunities (CNIEL, 2015). Accordingly, approximately 24% of French agri-food products are exported, with an emphasis on grain products and beverages whose export rates are 49% and 30%, respectively (FMOAF, 2021). Consequently, the French food processing industry presents an interesting opportunity to examine the relationship between markups and firms' export behavior.

The remainder of this article is structured as follows. We first review earlier studies examining the link between firms' export behavior and markups. Next, we describe the empirical strategy used to estimate markups that accounts for potentially imperfect input markets. We then outline regression specifications for analyzing markup–export relationships, present the data, and discuss the results. Finally, we offer some conclusions.

2 | BACKGROUND AND DERIVED HYPOTHESES

Theoretical and empirical studies on the relationship between trade and markup gained attention following the emergence of trade models of monopolistic competition (see Jacquemin, 1982). In parallel, the literature on this relationship gained in popularity with the introduction of intra-industry trade in homogenous goods into the reciprocal dumping models in Brander (1981) and Brander and Krugman (1983) that allow firms to differentiate between domestic and export markets (see Gullstrand et al., 2014).[vii] Later, the appearance of rich microlevel datasets in the mid-1990s led to three main insights: First, markups affect firms' export behavior. Second, entering and/or staying in export markets may involve changes in firm markups. Third, this two-way relationship can result in differences in markups between exporters and non-exporters.

2.1 | The impact of a firm's markup on export participation and intensity

The influence of markups, that is, the ratio of output price over marginal cost and its components, on firms' export participation and intensity has received considerable attention in the literature. A firm's physical productivity—which determines its marginal cost—has been identified as one of the key determinants of export participation and intensity. Melitz (2003) uses a monopolistic competition model to illustrate that a firm's decision to serve one or multiple foreign market (s) depends on its productivity. Because a firm has to pay fixed export entry costs to access new markets, its productivity must be strong enough to offset this outlay.[viii] Chaney (2008) and Helpman et al. (2008) use Melitz-type models to show that a firm's expected export share is higher when bilateral trade frictions are relatively low.[ix] Although these models predict that productivity will have a positive impact on export intensity, defined as the ratio of export sales over total sales, a reverse effect is also possible (Arkolakis, 2012). Given that firms with a given level of productivity can reach a certain fraction of consumers in both domestic and export markets, improved productivity enables them to increase the fraction of consumers they reach in both markets. If the positive impact of productivity improvements on domestic sales exceeds the positive impact on export sales, productivity, and export intensity will be inversely related.

Output prices are the second component of markup and superior product quality has been identified as a major driver of higher prices (Baldwin & Harrigan, 2011; Bellone et al., 2016; Johnson, 2012; Kugler & Verhoogen, 2012; Manova & Zhang, 2012). Products destined for export must offer an output quality premium over what is available in the domestic market. Consequently, exporters realize higher output prices and higher markups than non-exporters even though they use higher quality, and therefore more costly, inputs (Kugler & Verhoogen, 2012) or technologies that result in higher marginal costs (Antoniades, 2015; Eaton & Fieler, 2019; Hallak & Sivadasan, 2013; Johnson, 2012).[x] Nonetheless, if export markets have a different appreciation for product quality compared to domestic markets, the impact of the product quality component of markups on exports could be negative (Crino & Epifani, 2012). For example, firms located in countries with high domestic quality standards that produce high-quality products are less likely to export to markets with lower quality standards (Crino & Epifani, 2012).

Previous studies have investigated the relationship between the individual components of markups and the decision to export, but we are not aware of any empirical study that analyzes the causal impact of firm markups on the decision to export and resulting export intensity.

Based on these theoretical concepts, we develop Hypothesis 1a: higher markups increase the likelihood of export, and Hypothesis 2a: higher markups lead to higher export intensity, conditional on export participation. We also hypothesize that rising markups after controlling for productivity differences increase the likelihood of export (Hypothesis1b) and lead to incremental increases in export intensity (Hypothesis 2b).

2.2 | The impact of firms' export entry and continuation on markups

We now turn to the effect of a firm's entering into and remaining in export markets on its pricing and marginal costs, and therefore on its markups. Theoretical models suggest that exporters adjust their prices to the price level in the export destination (e.g., Bernard et al., 2003; Melitz & Ottaviano, 2008). Accordingly, an exporter's price depends on rivals' marginal costs in the export market. If exporters' domestic prices are higher (lower) than prices in the export market, their markups will, ceteris paribus, decrease (increase) when they enter the foreign market. Market size in the export destination also affects exporters' markup. Competition is stronger in large, integrated markets, which implies relatively small markups (Melitz & Ottaviano, 2008). Therefore, depending on the level of competition in the export market, a firm's markup may increase, decrease, or remain constant upon entering a foreign market. In addition, firms choosing to begin exporting may reduce their markups strategically, to increase market penetration, enabling them to compete while they attempt to gain a certain share of the market (Dean, 1976). Firms may also upgrade product quality upon entering an export market[xi] or may benefit from economies of scale (DLW), both of which have a positive impact on markups. In that respect, De Loecker et al. (2016) and McQuoid and

Rubini (2019) find that decreased marginal costs as a consequence of trade liberalization are incompletely passed through to prices in India and Chile, respectively. As noted earlier, the food sector is highly competitive (Wijnands et al., 2007); therefore, we do not expect food processors in France to attempt to gain a significant share in the destination market by strategically undercutting their rivals' prices when they enter an export market. Instead, we conjecture that as the French food sector is rather specialized and has many differentiated products (CNIEL, 2015), these products have relatively high prices in export markets. Thus, we formulate the following hypotheses: firm markups increase upon export entry (Hypothesis 3a) and that the effect is robust when we control markups for productivity (Hypothesis 3b).

Furthermore, the literature on exporting and firm performance suggests that firms benefit from learning when they remain in an export market for consecutive periods, that is, they experience LBE (Bernard & Jensen, 1995; Baldwin & Wulgong, 2005; DLW). Potential gains can arise through different channels, such as increased efficiency due to competitive pressures, or the ability to use new technology thanks to international contacts (Baldwin & Wulgong, 2005; Baldwin & Yan, 2015; De Loecker, 2013). In addition, firms that continue to export after entering foreign markets shift their product mixes toward their best-performing products, leading to overall productivity improvements (Mayer et al., 2014). Therefore, we can expect lower marginal costs and, ceteris paribus, higher firm markups for firms that remain in an export market for consecutive periods. DLW's examination of the Slovenian manufacturing sector yielded evidence to support this mechanism. Exporters may also learn to recognize consumer preferences in foreign markets and observe foreign rivals to improve product quality (De Loecker, 2007; De Loecker, 2013). Therefore, we expect that remaining in an export market for consecutive years has a positive impact on markups (Hypothesis 4a) and that this effect is robust when controlling for productivity (Hypothesis 4b).

2.3 | Markup differences between exporters and non-exporters

Differences in markups are likely to arise between exporters and non-exporters (DLW) as firms with higher markups may participate in export markets and benefit from learning effects of participation, which in turn influences their markups. Bellone et al. (2016) investigate differences in markups between exporters and non-exporters by introducing product quality into the framework proposed in Melitz and Ottaviano (2008). They assume that productivity can increase product quality, and therefore markups, leading to participation in export markets. In this framework, the difference between markups of exporters and those of non-exporters depends on the quality-enhancing impact of productivity and the price effects of competition on the export market (Bellone et al., 2016). The authors applied their model to the French manufacturing industry and found that exporters' markups exceed those of non-exporters by 0.013 units because the quality-enhancing impact of productivity exceeds the downward price pressure from competition. However, they do not control for simultaneity in markups and export participation; thus, their estimates may be biased.

We therefore derive Hypothesis 5a, which states that exporters in the food processing sector have higher markups than non-exporters, and Hypothesis 5b, which states that this holds for markups after controlling for productivity.

3 | MEASURING MARKUPS

We adopt the DLW approach and augment it to account for input market power (e.g., see De Loecker & Scott, 2016; Mertens, 2020; Morlacco, 2019) to recover markups of price over marginal cost. We present the approach here briefly and refer the reader to an online Appendix for details. Based on the firm's first-order condition of cost minimization, market power in the output market, that is, markup (μ), is defined as revenue (PY) over the firm's expenditures for a variable input

j (W_jX_j) multiplied by the elasticity of output with respect to input j (θj) adjusted for market power in j's input market, that is, markdown of j (ψ_j),

$$\mu = \frac{PY}{W_jX_j}\theta_j/\psi_j. \tag{1}$$

Although ψ_j is unique for each input j, μ is not. No matter which one of the j inputs we use, Equation (1) will always produce the same markup μ (DLW). Hence, we can equate the right-hand side of Equation (1) using different variable inputs so that.

$$\frac{\psi_k}{\psi_j} = \frac{W_jX_j}{W_kX_k}\frac{\theta_k}{\theta_j}, j \neq k. \tag{2}$$

Although we have estimated the output elasticities and can observe both input expenditures and revenue, we still have $j+1$ unknowns, indicating that the system of j equations is under-determined (we must identify ψ for each j, and μ). However, if we are willing to assume that for some variable inputs, such as intermediate inputs, ψ equals one, that is, there is no market power in input market (the input market is perfectly competitive), we can solve for μ, and for ψ for all variable inputs on which we do not impose perfect competition.

We estimate the following gross output production function to obtain estimates for θ:

$$y = \beta_k k + \beta_l l + \beta_m m + \beta_{kk} k^2 + \beta_{ll} l^2 + \beta_{mm} m^2 + \beta_{kl} kl + \beta_{km} km + \beta_{lm} lm + \omega + \varepsilon. \tag{3}$$

Here y, k, l, and m denote the logs of output, capital, labor, and material, respectively. ω captures firm-specific productivity and ε is a random error component. Although data on physical quantities of labor and capital are available, this is not the case for output and materials. Deflated revenues are frequently used as a measure of output, just as input expenditures are used as a measure of physical input quantities. However, this leads to biased estimates of production function parameters (see e.g. Bond et al., 2020; Morlacco, 2019).

Our strategy for dealing with the bias caused by the absence of output prices is closely related to our theoretical considerations. We assume that exporters and non-exporters typically charge different prices. Therefore, we deflate the revenues of all non-exporters by the same domestic price index, whereas exporters' domestic sales are deflated by the domestic price index, and their export sales are deflated by an export price index. We then assume that most of the deviations from these price indices are firm specific and that these firm-specific deviations change little over time. Therefore, we use firm-specific fixed effects (G_i) to account for firm-specific deviations from average industry prices. The use of firm-specific effects also captures variations in input prices (De Loecker et al., 2016) and accounts for product differentiation in the food sector by picking up unobserved price differences related to product differentiation (c.f. Bonnet & Bouamra-Mechemache, 2016; Richards et al., 2018).[xii] The production function is then specified as

$$y^*_{it} = G_i + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it}{}^* + \beta_{kk} k_{it}{}^2 + \beta_{ll} l_{it}{}^2 + \beta_{mm} m_{it}{}^{*2} + \beta_{kl} k_{it} l_{it} + \beta_{km} k_{it} m_{it}{}^* + \beta_{lm} l_{it} m_{it}{}^* + \omega_{it} + \varepsilon_{it}. \tag{4}$$

The only remaining unobservable is ω, which we proxy using material demand (Levinsohn & Petrin, 2003).[xiii] We define material demand as a function of productivity (ω), capital, the firm's lagged export status as well as firm-fixed effects (G_i). Our parameter identification follows Ackerberg et al. (2015) and De Loecker (2013) who apply a two-step generalized method of moments (GMM) approach (see the online Appendix for details).

Once the GMM estimates have been identified, we can compute the output elasticity with respect to any of the inputs. Here, we are interested in labor and material, that is, the variable inputs in the production process. We use the output elasticity and the expenditure share of materials in

Equation (1) to identify markups by assuming that $\psi_M = 1$. The markup estimates from materials can then be used to identify the divergence from perfect competition in the labor market by plugging μ into Equation (1) specified for labor and solving for ψ_L.

4 | REGRESSION SPECIFICATIONS AND ESTIMATION TECHNIQUES

In this section, we first specify regressions to test Hypothesis 1 and Hypothesis 2, that is, to investigate the impact of markups on export participation and export intensity. Because only a small percentage of firms engage in exporting, the dataset contains a large number of zero trade values. Nevertheless, these zeros must be treated as meaningful observations (Helpman et al., 2008) as they represent the optimal choice for these firms. Therefore, we employ the Cragg hurdle regression (Cragg, 1971; Garcia, 2013; StataCorp, 2017; Wooldridge, 2010b).[xiv] The hurdle model is based on $\mathrm{EI_{it}} = \mathrm{s_{it}} * \mathrm{EI^*_{it}}$ where $\mathrm{EI_{it}}$ denotes export intensity, whereas s_{it} is a latent variable capturing export participation defined as:

$$s_{it} = \begin{cases} 1 \; if \; \alpha_0 + \alpha_1 ln\mu_{it} + \boldsymbol{X}_{it}\boldsymbol{\gamma} + \epsilon_{it} > 0 \\ 0 \; otherwise \end{cases}, \tag{5}$$

where μ_{it} reflects estimated markups.[xv] The control variables and their corresponding coefficients are defined by the vectors $\boldsymbol{X}_{it}$ and $\boldsymbol{\gamma}$, respectively. We control for labor, capital, and material (all in natural log form) to capture differences in factor intensity and size. We also consider year and industry dummies (at the four-digit NACE level) to account for trend and subsector-specific aggregate effects in the dependent variable, respectively. ϵ_{it} is a standard normally distributed error. EI^*_{it} is a continuous latent variable that is observed only if s_{it}=1; it is specified in exponential form as:

$$EI^*_{it} = exp(\beta_0 + \beta_1 ln\mu_{it} + [\boldsymbol{X}_{it}, LagEI_{it}]\boldsymbol{\gamma} + \nu_{it}). \tag{6}$$

Hence, the hurdle model allows us to explore a firm's two-stage decision process (export participation and intensity) using the same explanatory variables for each decision stage but adding the lag of export intensity ($LagEI_{it}$) at the second stage to control for possible dynamic impacts of export intensity (e.g., see Damijan & Kostevc, 2006).[xvi] In Equations (5) and (6), markups are potentially endogenous to export behavior due to the simultaneity described above. We use a control function approach to deal with the potential correlation between $ln\mu_{it}$ and $\nu_{it,}$ and consider three instrumental variables for this purpose. We use the lag of capital and the firm's legal form, both of which correlate strongly with revenue productivity, and therefore markups (see e.g. De Loecker, 2007).[xvii] We also add firm age as an instrument as it can explain differences in revenue productivity as an important component of markup (Hsieh & Klenow, 2009; Restuccia & Rogerson, 2008). Moreover, markups vary systematically with firm age (Peters, 2020).

The LBE-related hypotheses (H3 and H4) are tested by investigating whether there is a significant difference between markups of firms that (i) were never active on an export market or left the export market following a period of export activity; (ii) starters, that is, firms that enter the export market following a non-exporting period; and (iii) continuers, that is, firms that are exporting and have been doing so for at least two consecutive years. We estimate the model as:

$$ln\mu_{it} = \lambda_0 + \lambda_1 Entry_{it} + \lambda_2 Continue_{it} + [\boldsymbol{X}_{it}, Lagln\mu_{it}]\boldsymbol{\gamma} + \nu_{it}, \tag{7}$$

where $Entry_{it}$ is a dummy variable equal to one if a firm is an exporter during t but was not an exporter in t-1, whereas $Continue_{it}$ is a dummy variable equal to one when a firm exports during both t and t-1.[xviii] Consistent with earlier literature on the LBE effect, we also include the lagged dependent variable ($Laglnμ_{it}$) on the right-hand side to capture the difference in markups due to entering and staying in the export market (e.g., see Fernandes & Isgut, 2005; Van Biesebroeck, 2005). The constant term reflects the average markup for firms in the base group that have either never entered an export market or do not export during t. We are interested in the coefficients λ_1 and λ_2 that measure differences in markups between starters and continuing exporters compared to the firms in the base group.

In Equation (7), *Entry* and *Continue* are potentially endogenous due to their being simultaneously determined with markups and are therefore correlated with the error term, leading to biased estimates for λ_1 and λ_2. For this reason, we use an extended regression model estimator (Stata Press, 2019). This approach uses maximum likelihood estimation to determine the parameters of a joint distribution of an endogenous continuous dependent variable and binary endogenous covariates conditional on exogenous covariates. The likelihood function is defined as the product of the marginal distributions of error terms v_i with variance σ^2, $\phi(v_i,\sigma^2)$, and the cumulative joint distributions of the error terms in the reduced form equations for b endogenous binary covariates with lower limits $\boldsymbol{l}$ and upper limits $\boldsymbol{u}$ for each binary covariate and the adjusted correlation matrix of reduced form errors $\sum_{i,b|1}$, $\Phi_b^*(\boldsymbol{l}_i,\boldsymbol{u}_i,\boldsymbol{\Sigma}_{i,b|1})$ (Bartus & Roodman, 2014; Roodman, 2011; Stata Press, 2019):

$$LnL = \sum_{i=1}^{N} §_i Ln\left\{\phi\left(v_i,\sigma^2\right)\Phi_b^*\left(\boldsymbol{l}_i,\boldsymbol{u}_i,\boldsymbol{\Sigma}_{i,b|1}\right)\right\}, \tag{8}$$

where $§_i$ are weights.

This approach requires instrumental variables for the endogenous covariates that are correlated with *Entry* and *Continue* in the reduced form models, but uncorrelated with v_{it} in the structural model. We rely on the same set of instrumental variables (i.e., age, lagged capital and ownership) that we used above for markups, as the same underlying process simultaneously drives the firms' markups and export variables.

Hypothesis 5, "Exporters have higher markups than non-exporters," is tested empirically by relating estimated markups to firms' export status as follows:

$$ln\mu_{it} = \delta_0 + \delta_1 Export_{it} + \left[\boldsymbol{X}_{it}, Lagln\mu_{it}\right]\boldsymbol{\gamma} + \nu_{it}, \tag{9}$$

where $Export_{it}$ denotes a binary variable equal to one if firm i is an exporter in period t and zero otherwise. Its associated coefficient δ_1 reflects the percentage markup performance premium for exporters. Because export status is likely endogenous to markups, we use the same identification and estimation strategy as in Equation (8) with the difference that in Equation (9), the cumulative distribution of errors terms is associated with only one endogenous binary covariate, $Export_{it}$, rather than a joint distribution of two endogenous covariates.

In the regressions specified in Equations (5)–(7) and (9), we assess whether our results are robust to controlling markups for productivity. This involves regressing markups on productivity estimates so that the resulting residuals measure the part of markups that are unrelated to productivity. These "productivity-adjusted" markups are then used in Equations (5)–(7) and (9) in place of the original markups. Instruments and estimation techniques remain unchanged.

5 | DATA AND DESCRIPTIVE STATISTICS

We use firm-level data from the ORBIS database provided by Bureau van Dijk (Bureau Van Dijk, 2020). ORBIS contains financial data for firms in all European countries and economic sectors. The database also contains information on firms' export participation and total export sales. We

TABLE 1 Comparison of the sample and population of food processors in France, by firm size

	Sample	Population [as of 2015]
Total number of firms	11,104	59,757
Percentage share of firms per size class		
Small firms	91.30	97.59
Medium firms	6.36	1.87
Large firms	2.34	0.54

Note: Small: <50 employees; medium: 50–249 employees; large: >249 employees. Shares for the population are calculated based on Eurostat (2019c).

selected all French firms involved in manufacturing food or beverages as defined by NACE codes 10 and 11 in the years from 2011 to 2019. Although information on other countries is readily available in ORBIS, France is the only country where the number of firms that publish their export revenues is sufficient to support an empirical analysis in line with the objectives of our study. There are a total of 28,618 observations in our sample comprising 11,104 firms, where each observation refers to a legal entity publishing its financial information in a specific year. Table 1 compares our sample with the population with respect to size categories. We see that the sample reflects about 18.6% of the total number of firms (59,757) in French food processing industry and adequately represents the distribution of the population with respect to size (Table 1). Note that small firms are slightly underrepresented due to lower requirements with respect to financial information disclosure for companies with fewer than 10 employees (European Commission, 2013). Table A1 of the online Appendix provides descriptive statistics for the firm-level variables. Labor is defined as the number of employees used to estimate the production function. We use deflated material costs for materials and the value of fixed assets for capital. The production function is estimated by deflating material costs and capital using the respective industrial producer price indices with base year 2015 (Eurostat, 2019a). Revenue is deflated to obtain a measure of physical output. Although the domestic price index is the harmonized index of consumer prices (Eurostat, 2019b), we construct an industry-specific price index for exports using data on country-level export quantities and prices from PRODCOM (Eurostat, 2020). The overall sample shows considerable variations in firm revenues, input variables, export intensity (only applicable to exporters), and firm characteristics, such as age and ownership (cf. Table A1 of the online Appendix). These variables also tend to differ between exporters and non-exporters, with exporters having higher average revenues and input use. Moreover, exporters tend to be older firms compared to non-exporters.

Several studies show that estimates of production function coefficients and regression coefficients may be affected by outliers or faulty observations in firms' reported data (see for example, Cainelli et al., 2015; De Loecker et al., 2016; Demirer, 2020; Hirsch, Lanter, & Finger, 2020a; Hirsch, Mishra, et al., 2020b). Therefore, we apply the BACON algorithm that identifies multivariate outliers using Mahalanobis distances (Billor et al., 2000; Weber, 2010). This reduces the number of firms (firm-year specific observations) to 10,203 (24,594). Accordingly, we use two sets of observations for our analysis. We use "all observations" including outliers as our baseline data then repeat the estimations using the "observations excluding outliers" as a robustness check.

6 | RESULTS AND DISCUSSION

We present the mean of the estimated markups for all observations and compare the 10th, 50th, and 90th percentiles in Table A3 of the online Appendix.[xx] Our estimates show that 10% of firms charge markups of less than 1.03 (i.e., a price that is no more than 3% above marginal cost), 50% charge markups below/above 1.84 (i.e., a price that is less/more than 84% above marginal cost), and 10%

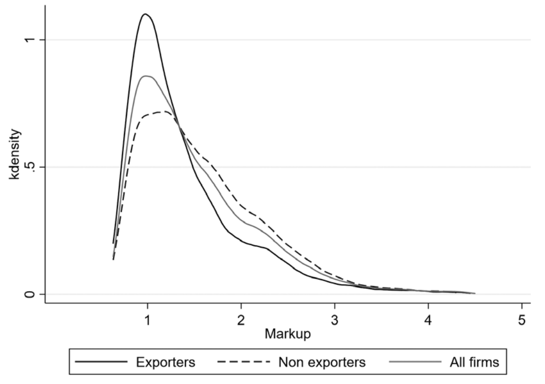

FIGURE 1 Firms markup distributions

charge markups greater than 2.75 (i.e., a price that is 175% above marginal cost). These results indicate a positively skewed distribution (see Figure 1) and substantial variation across firms, supporting previous findings of firm-level heterogeneity in markups (e.g. Curzi et al., 2020; Garrone & Swinnen, 2018; Karagiannis et al., 2018; Vancauteren, 2013).[xxi] The arithmetic mean of markups across all firms is 1.97; however, given the heterogeneity in firm size and the skewed distribution of markups, we calculate an average industry markup as the sales-weighted average of markups and obtain a value of 1.29. This lies within the range of estimated average markups of 1.02 to 1.70 previously reported for the food processing sector (see Garrone & Swinnen, 2018; Karagiannis et al., 2018; Lopez et al., 2018; Vancauteren, 2013; Wilhelmsson, 2006). Our results also show substantial variation in wage markdowns, suggesting the importance of considering firms' market power in the labor market (see Table A3 of the online Appendix). There is also considerable heterogeneity in markups among firms operating in different subsectors of the food industry, as supported by the Bartlett test that rejects equality of variance, and hence means and medians, between almost all pairs of subsectors. This highlights the need for subsector dummy variables in our regression analysis.

6.1 | The impact of markups on firms' export participation and intensity

The results of the hurdle model in capturing the impact of markups on export participation and intensity as specified in Equations (5) and (6) are reported in Table 2. The statistical significance of the coefficients on the reduced form residuals in both stages of the structural model shows the endogeneity of markups and ensures the other parameters are estimated consistently in this case.[xxii] The coefficient for markup in the export participation equation is positive for both datasets ("all observations" and "observations excluding outliers"). Because markups are measured in logarithmic form we derive the marginal effect of markups on levels.[xxiii] The results are reported at the bottom of Table 2 and reveal that a 1% increase in markups increases the probability that a firm will participate in export markets by 0.018 (all observations) and 0.006 percentage points (observations excluding outliers), on average. Table 2 also reveals that controlling for productivity lowers the positive effect of markups on the probability firms will participate in export markets, producing marginal effects of 0.016 and 0.006 for all observations and observations excluding outliers, respectively. This suggests that output quality and demand-side conditions influence firms' export decisions. These findings confirm Hypothesis 1 and Hypothesis 2, and are in line with recent theories of trade (e.g., Melitz & Ottaviano, 2008) in terms of providing evidence that firms with higher markups and high-quality products self-select into export markets.

TABLE 2 Impact of markups on export participation and export intensity

	All observations		Observations excluding outliers	
Export status				
LnMarkup	4.070***		4.436***	
	(0.692)		(0.491)	
LnL	−0.957***	−0.711***	−0.938***	−0.940***
	(0.194)	(0.192)	(0.129)	(0.139)
LnM	1.624***	1.018***	1.768***	1.276***
	(0.243)	(0.177)	(0.176)	(0.132)
LnK	−0.293***	−0.230***	−0.345***	−0.341***
	(0.050)	(0.049)	(0.043)	(0.045)
LnMarkup (adjusted)		2.838***		3.839***
		(0.611)		(0.458)
Residual from reduced form equation	−3.888***	−2.676***	−4.237***	−3.692***
	(0.694)	(0.612)	0.494	0.461
Constant	−12.032***	−5.643***	−12.351***	−5.823***
	(1.618)	(0.685)	(1.120)	(0.473)
Export intensity				
LagExpInt	5.727***	5.738***	5.831***	5.838***
	(0.128)	(0.127)	(0.182)	(0.182)
LnMarkup	4.598***		2.346**	
	(1.218)		(0.997)	
LnL	−1.238***	−1.227***	−0.734***	−0.789***
	(0.339)	(0.337)	(0.263)	(0.285)
LnM	1.628***	1.188***	1.012***	0.804***
	(0.427)	(0.312)	(0.358)	(0.269)
LnK	−0.266***	−0.259***	−0.147*	−0.161*
	(0.089)	(0.087)	(0.089)	(0.094)
LnMarkup (adjusted)		4.047***		2.211**
		(1.077)		(0.938)
Residual from reduced form equation	−4.708***	−4.144***	−2.253**	−2.111**
	(1.216)	(1.075)	1.000	0.940
Constant	−14.681***	−8.539***	−10.989***	−7.734***
Observations	14,944	14,944	12,177	12,177
LR Chi2	9449.25***	9434.64***	5347.67***	5333.23***
Log likelihood	3421.281	3414.076	1432.890	1425.668
Marginal impacts on export participation				
LnMarkup	1.828*** (0.502) {0.018}		0.586** (0.256) {0.006}	
LnMarkup (adjusted)		1.609*** (0.444) {0.016}		0.553** (0.240) {0.006}

(Continues)

TABLE 2 (Continued)

Export status	All observations		Observations excluding outliers	
Marginal impact on export intensity				
LnMarkup	1.705*** (0.368) [9.4]		0.677*** (0.161) [3.8]	
LnMarkup (adjusted)		1.419*** (0.323) [7.8]		0.611*** (0.150) [3.3]

Note: *LnMarkup (Adjusted)* refers to *LnMarkup* controlled for *LnProductivity*; Standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Numbers in {} refers to the approximated average change in the probability of export participation caused by a marginal increase of 1% in markups. Numbers in [] refer to the average percentage change in export intensity caused by a marginal change of 1% in markups (see footnotes 23 and 24). Sector and year dummies are included as explanatory variables.

The estimated coefficients that measure the effect of markups on export intensity are also positive. A 1% increase in markup before controlling for productivity leads to an increase in export intensity of 9.4% (all observations) and 3.8% (outliers excluded); after controlling for productivity the increases are 7.8% and 3.3%, respectively.[xxiv] This suggests that export intensity has an elastic reaction to improvements in markups and quality.

6.2 | The impact on markups of firms' export entry and continuation

Here we assess the change in markups caused by entering into export markets. The results from the reduced form equations are shown in Table A4 of the online Appendix and indicate that the ownership variable affects entry, and that both ownership and age influence the decision to continue export activities, in particular when outliers are removed from the data sample. Table 3 shows the result of estimating the regression specified in Equation (7). The null hypothesis of "no endogeneity" is only rejected in the case of the *Continue* variable and when markups are not controlled for productivity, as indicated by the significant correlation of the error terms of the structural and reduced form equations in these cases. We use instruments for *Entry* and *Continue* but subsequently perform a robustness check to compare the results with the case where no instruments are used. The coefficient of the *Entry* variable measures the markup premium or deduction in the first year of exporting. Although there is no evidence that entry has any effect on markups when all observations are used, the influence becomes clear when outliers are excluded; here, entry is associated with a 2.4% increase in markups. Similarly, when controlling for productivity differences, a firm's first year after starting to export is associated with a 2.5% increase in markups. This result is in line with DLW and suggests that when a firm enters an export market, its markup performance improves. This may be due to the firm upgrading the quality of its products to be competitive in the export market or to a decision to export to markets where the level of competition is lower than in the domestic country. As the difference between the markup premiums when entering the export market before and after controlling for productivity are almost equal, we infer that the markup premium is associated with price or quality variations.[xxv] Thus, our results support Hypothesis 3, that is the presence of an immediate learning effect that leads to improved efficiency and quality, but only when outliers are removed from the data.

The coefficient of the *Continue* variable obtained with the dataset containing all observations suggests that firms that export for at least two consecutive years charge markups that are 2.1% higher than markups charged by firms that either exited the export market or never exported at all. This result is robust when outliers are excluded from the data, resulting in an increase in markups of

TABLE 3 Learning by exporting

Variables	All observations: Markups	All observations: Markups controlled for productivity	Observations excluding outliers: Markups	Observations excluding outliers: Markups controlled for productivity
LnL	0.067***	0.063***	0.057***	0.052***
	(0.004)	(0.004)	(0.004)	(0.005)
LnK	0.019***	0.018***	0.022***	0.020***
	(0.002)	(0.002)	(0.002)	(0.002)
LnM	−0.090***	−0.063***	−0.089***	−0.057***
	(0.005)	(0.004)	(0.006)	(0.004)
Lag.LnMarkup	0.756***		0.762***	
	(0.012)		(0.013)	
Enter	0.013	0.011	0.024**	0.025**
	(0.009)	(0.010)	(0.011)	(0.011)
Continue	0.021***	0.015**	0.017***	0.013**
	(0.006)	(0.006)	(0.006)	(0.006)
Lag.LnMarkup (adjusted)		0.796***		0.811***
		(0.011)		(0.012)
Constant	0.495***	0.153***	0.469***	0.106***
	(0.033)	(0.024)	(0.036)	(0.027)
Correlation of error terms of structural and reduced form for Entry	0.008	0.008	−0.0128	−0.0117
	(0.014)	(0.015)	(0.019)	(0.020)
Correlation of error terms of structural form and reduced form for Continue	−0.017**	−0.005	−0.0203**	−0.011
	(0.007)	(0.005)	(0.009)	(0.009)
Observations	14,944	14,944	14,944	14,944
Log pseudo Likelihood	−1187.222	−1430.699	1838.646	1606.674
Wald chi2	117834.18***	82410.17***	1082790.2*	79195.46*

Note: *LnMarkup (adjusted)* refers to *LnMarkup* controlled for *LnProductivity*; Heteroskedasticty robust standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Sector and year dummies are included as explanatory variables.

1.7%. When controlling for productivity differences the estimated coefficients are lower, with markups increasing by 1.5% for all observations and 1.3% for the sample that excludes outliers. These results indicate that continuing to export is related to marginal costs and price changes induced by learning effects that lead to improvements in productivity and product quality. Thus, our results support Hypothesis 4, that is, the LBE hypothesis conditional on continuous exporting. The results are also consistent with the finding in DLW that by entering the export market firms can benefit from learning effects if they remain committed to exporting for at least two consecutive years.

In addition, as a robustness check we follow DLW by analyzing the effect of entering the export market and continuing to export without instrumenting these variables (see Table A5 of the online Appendix). As in DLW, we use OLS but also apply between effects (BE) estimation.[xxvi, xxvii] Moreover, because we reject the null hypotheses that markups and the natural log of markups are normally distributed based on a Shapiro–Wilk test, we use a novel and robust 0.5-quantile regression estimator for panel data that is particularly well-suited to handle the strong skewness and extreme values observed in estimated markups (Baker et al., 2016).[xxviii] This allows us to assess the extent to which the coefficients of entry and continuation are affected by the skewness of markups. Table A5 of the online Appendix shows that our results are robust to both the use of instruments and the skewed distribution of markups. More precisely, when using OLS and quantile estimation we find that firms' entry is associated with an increase in markups, whereas remaining in the export market for at least two consecutive years is associated with higher markups across all estimators (Table A5, online Appendix).[xxix]

6.3 | Markup differences: Exporters versus non-exporters

Finally, in Table 4 we present the results from estimating the regression in Equation (9) to show the difference in markups between exporters and non-exporters. The null hypothesis of "no endogeneity" with respect to export status is rejected (i.e., there is significant correlation between the correlation of the error terms in the structural and reduced form equations), except for the case where outliers are not excluded and markups are not controlled for productivity differences.[xxx] The coefficient of the binary export variable suggests a markup premium of 2.0% and 2.2% for exporters compared to non-exporters, based on datasets that include and exclude outliers, respectively. This result is consistent with DLW's study of firms in Slovenian manufacturing sectors and also with recent theories of international trade, such as those proposed by Bernard et al. (2003), Melitz and Ottaviano (2008), and Bellone et al. (2016), which suggest that exporters on average have higher markups than non-exporters. When we control for productivity the estimated coefficients are lower

TABLE 4 Difference between exporters and non-exporters markup performance

	All observations		Observations excluding outliers	
Variables	**Markups**	**Markups controlled for productivity**	**Markups**	**Markups controlled for productivity**
LnL	0.067***	0.063***	0.057***	0.052***
	(0.004)	(0.004)	(0.004)	(0.005)
LnK	0.019***	0.018***	0.022***	0.020***
	(0.002)	(0.002)	(0.002)	(0.002)
LnM	−0.090***	−0.063***	−0.089***	−0.057***
	(0.005)	(0.004)	(0.006)	(0.004)
Lag.LnMarkup	0.756***		0.762***	
	(0.012)		(0.013)	
Export status	0.020***	0.015**	0.022***	0.017***
	(0.005)	(0.005)	(0.006)	(0.006)
Lag.LnMarkup (adjusted)		0.796***		0.811***
		(0.011)		(0.012)
Correlation of error terms in structural and reduced form	−0.003	−0.015**	−0.0284**	−0.0174**
	(0.0073)	(0.007)	(0.008)	(0.008)
Constant	0.494***	0.153***	0.471***	0.108***
	(0.033)	(0.024)	(0.036)	(0.027)
Observations	14,944	14,944	12,177	12,177
Wald chi2	117838.90***	82413.92***	108254.57***	79180.83***
Loglikelihood	313.194	68.401	2787.680	2555.187

Note: *LnMarkup (adjusted)* refers to *LnMarkup* controlled for *LnProductivity*; Heteroskedasticty robust standard errors are in parentheses; *** $p < 0.01$, ** $p < 0.05$; Sector and year dummies are included as explanatory variables.

but still result in positive markup premiums of 1.5% and 1.7%, respectively. These results imply that exporting firms either have superior productivity and higher quality products and/or that the demand conditions they face allow them to charge higher prices. As a robustness check, we estimate Equation (9) using OLS, BE and quantile regression and continue to find that exporters have higher markup performance (see Table A6 of the online Appendix). Consequently, our results also generally support Hypothesis 5.

7 | CONCLUSION

This article investigates the relationship between firms' export behavior and markups for the case of the food processing sector in France, based on a dataset of 11,104 firms over the period from 2011–2019. The analysis of this relationship in the food sector is particularly relevant for firms' strategic orientation in competitive food markets as well as for understanding the impact of trade and domestic policies. Trade barriers in the food sector are higher than in other sectors of an economy, implying that trade policies could have direct implications for firms' markups and consumer welfare. Moreover, policies designed to improve firm efficiency and eradicate welfare losses due to market power could influence firms' export behavior.

We evaluate the relationship between firms' markups and export behavior focusing on (i) the impact of markups on export participation and intensity, (ii) the effect of entering the export market and of continuing to export for at least 2 years on markups, and (iii) differences in markup performance between exporters and non-exporters. We estimate firm-specific markups using a modification of DLW's production function approach, allowing for the possibility of imperfections in both output and input markets. Subsequently, we apply various regression specifications that address the reverse causality between firms' markups and export variables to evaluate the firm export–markup relationship.

Our results suggest that on average, firms in the French food processing industry charge prices that exceed marginal costs by 29%. Average markups differ significantly across and within subsectors. We also find that the distribution of markup values, both for the entire sample and for individual subsectors, exhibit a positive skew.

With respect to the impact of markups on export participation and intensity, our analysis reveals that higher markups increase the likelihood that a firm will engage in exporting and will also exhibit a higher export intensity. Our investigation of the effect of export market entry shows an immediate markup increase upon entry. Moreover, we detect that the markup increases further if export activities continue for at least two consecutive years. Finally, our findings indicate that exporters and non-exporters differ in terms of their ability to exercise market power, as firms with higher markups self-select into export markets. This enables them to charge even higher markups.

We also control for productivity differences to study the relationship between firm markups and export behavior. Theoretically, higher markups could be associated with differences in both marginal cost (i.e., productivity) and price. When we control for cost differences across firms we obtain similar results, albeit of lower magnitude. This suggests that factors other than productivity, such as product quality and demand-side conditions, are also important in explaining markup differences across firms and also affect the markup– export relationship. The observed relationship—even after controlling for productivity differences—highlights the importance of product quality and/or differentiation to a firm's choice of export destination markets when designing an export strategy.

The results have some important implications. The uneven distribution of markup values within the food industry in France—even within subsectors—suggests that domestic policy measures that are common to all firms may have adverse effects on domestic prices. These may be anti-trust policies but could also take the form of quality standards, for example, that increase the cost of production for most firms. In this setting low-markup firms are most likely to exit the market first so that the supply curve shifts upward, leading to higher prices. Secondly, downward pressure on prices in the domestic market due to domestic policy measures incentivizes firms to participate in export markets, further reducing domestic supply.

The observed relationship between markup and export behavior suggests that firms can rely on internal adaptation to increase markups and participate in export markets. Once firms begin to export, markups may increase further. This implies a consistency in firms' decisions to increase markups by relying on firm-specific resources and to participate in export markets.

The observed positive relationship also implies that policies intended to promote exports, particularly policies promoting border trade, may induce firms to charge higher prices in domestic markets. This is supported by our findings as firms' markups increase with experience in the export market. Hence, a policy promoting exports may have an adverse impact on domestic consumer welfare. Policymakers should consider these adverse effects carefully when weighing domestic anti-trust and/or export promotion measures.

There are some limitations to the research presented here. Despite our careful strategy to use firm-specific deflators to obtain a measure of firms' physical output, there could still be some unobserved variation in firm prices that affects the estimated markups. Therefore, the estimated markup values should be interpreted with caution. Data limitations meant that we could not attribute price differences to their potential sources, that is, output or input qualities, and it was likewise not possible to differentiate demand-side conditions by market size, consumer preferences, or income levels. Accordingly, the markups here are the average of the markups in domestic and export markets. However, export pricing strategies, and thus markups, depend heavily on the destination market. Therefore, these results should be viewed with a degree of caution. Progress in this respect would require a richer dataset that includes firm-specific domestic production quantities and sales, as well as export quantities and prices differentiated by destination. A richer dataset would offer considerable scope for future research.

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ENDNOTES

[i] At the global level the food sector's Most Favored Nation status and applied tariffs weighted by trade shares are 31% and 22%, respectively (World Bank, 2017).

[ii] The overall markup–export relationship can be explained by the correlation between individual components of markups and firm export behavior (see Bellone et al., 2016; De Loecker, 2013; De Loecker, 2016; De Loecker & Warzynski, 2012; Kilinc, 2019). Firm markups are linked with factors that affect production costs, such as productivity, input prices and quality, firms' oligopsonistic (input buyer) power, and variations in those factors that influence product prices, such as product quality, trade costs, and demand-side conditions (market size, consumer preferences, income levels) (see e.g. Hottman et al., 2016). These factors can be firm, product, or market specific, and their variation is affected by and/or has an impact on a firm's export behavior. This reflects the idea that the relationship between firms' markups and export behavior is the combination of production- and demand-side factors affecting cost and product prices.

[iii] There is evidence for the presence of significant firm- and industry-level markups in the food sector (e.g. Curzi et al., 2020; Garrone & Swinnen, 2018; Karagiannis et al., 2018; Koppenberg & Hirsch, 2021; Lopez et al., 2018; Sexton & Xia, 2018; Vancauteren, 2013; Wilhelmsson, 2006). Firms' ability to charge markups is partly due to their export behavior and can partly explain that behavior (Bellone et al., 2016; De Loecker, 2013; Kilinc, 2019).

[iv] Similarly, Zhang and Zhu (2017) investigate the relevance of firms' export behavior to markups in China.

[v] Note that although our study considers the firm markup and export relationship, several other studies have assessed the relationship between the individual components of markups, such as firm productivity and product quality, with export market participation and export intensity (see e.g. Bellone et al., 2016; Bernard et al., 2007; Curzi & Olper, 2012; Eickelpasch & Vogel, 2009). See also, Melitz and Redding (2014) for a review.

[vi] For example, over 1500 different dairy products are produced by food processors in France (CNIEL, 2015).

[vii] A recognition of the relationship between trade and markups dates back to traditional dumping theory that analyzes monopolistic price discrimination between national markets (i.e., the formal theory of dumping) (see Ethier, 1982; Tarr, 1979). Schwartzman (1959) was the first to empirically show that market structures (i.e., price over average cost margin) of individual industries differ depending on their level of involvement in trade activities (see Caves, 1980, 1985 for a review).

[viii] Using a Ricardian model with geographic barriers, Eaton and Kortum (2002) show that firms' exports increase with productivity due to marginal cost advantages over their competitors. However, the model is based on perfectly competitive markets (i.e., firms do not charge markups).

[ix] Chaney (2008) shows that bilateral fixed and variable costs of trade are important factors in determining the role of a firm's productivity in its participation in export markets (extensive margin of trade) and subsequent export quantity (intensive margin of trade): The higher the bilateral fixed and variable costs, the lower the extensive margin of trade; the higher the variable cost the lower the intensive margin. Similarly, Helpman et al. (2008) show that bilateral trade frictions between countries influence firms' exports to different destinations and their export values. These models have been widely used in empirical analyses with gravity models. For example, see the application of Chaney (2008), and Helpman et al. (2008) on the impacts of bilateral frictions on food trade in Chevassus-Lozza and Latouche (2012), and Eum et al. (2021), respectively.

[x] These references are based on the insights in Sutton (2007) and employ different functional forms to link sources of product quality with cost and price components of markups.

[xi] Quality upgrading occurs in response to customer demand in foreign markets, product quality of rivals (De Loecker, 2007), and to the greater incentive to invest in quality upgrading when supplying a larger market (Hallak & Sivadasan, 2013).

[xii] Note: the authors used fixed effects to capture product differentiation when estimating a demand system.

[xiii] Here we also refer to Curzi et al. (2015) who use intermediate input as a proxy for unobserved productivity in the food sector.

[xiv] Note: we use a hurdle model, rather than modern gravity models that consider both the participation and decision to export, as the firm trade data in our study is not destination specific. The hurdle model is also more flexible than a simple Tobit model as export participation and export intensity decisions are determined by different processes, which implies that the impact of the same variable may differ.

[xv] We consider the logs of markups because markups have highly skewed distributions.

[xvi] Note: We are not interested in interpreting the coefficient of the lagged dependent variable and therefore ignore its possible correlation with the error term. Moreover, the Cragg hurdle model assumes that errors for the participation decision (first stage) and the quantity decision (second stage) are uncorrelated. However, the results are not sensitive when this assumption is relaxed (Ricker-Gilbert et al., 2011).

[xvii] Note: De Loecker (2007) uses these instruments in a matching treatment approach to analyze the relationship between firms' productivity and export status. See also Gaigné et al. (2015) for the importance of ownership structure on firm export behavior.

[xviii] In addition to the highly skewed distributions observed for markups, an important advantage of using log markups as a dependent variable is that even if all variable inputs that are considered in computing markups are subject to adjustment costs, results of the regression analysis are unchanged as long as the export status is not related to those costs (DLW).

[xix] Consider the correlation of error terms in structural and reduced form models as $\boldsymbol{\Sigma} = \begin{bmatrix} \boldsymbol{\Sigma}_b & \boldsymbol{\sigma}_b \\ \boldsymbol{\sigma}_b' & \sigma^2 \end{bmatrix}$ where $\boldsymbol{\Sigma}_b$ is the correlation of errors in reduced form models, $\sigma^2$is the variance of errors in structural model, and σ is the correlation of error terms in each reduced form model with the error terms in structural model. The adjusted correlation matrix of reduced form model errors is defined as $\boldsymbol{\Sigma}_{i,b|1} = \boldsymbol{\Sigma}_b - \frac{\boldsymbol{\sigma}_b \boldsymbol{\sigma}_b'}{\sigma^2}$. Accordngly, the cumulative joint distribution of the error terms in the reduced form equations is $\Phi_b^*(\mathbf{l}_i, \mathbf{u}_i, \boldsymbol{\Sigma}_{i,b|1}) = \int_{l1}^{u_1^i} \ldots \int_{l_d}^{u_d} \phi(\boldsymbol{\varepsilon}, \boldsymbol{\Sigma}_{,b|1})\, d\varepsilon_1 \ldots d\varepsilon_d$. For details on the likelihood function, see also Stata Press (2019).

[xx] The production function coefficients associated with the markup estimation obtained from all observations is presented in Table A2 of the online Appendix. The estimated coefficients indicate the importance of labor, capital, and material inputs as well as the complementarity of labor and material inputs on firms' gross output.

[xxi] This resembles findings for the distribution of productivity across firms (e.g., Gabaix, 2008).

[xxii] The results from the reduced form equations are shown in Table A4, Column 1 of the online Appendix. It can be observed that the instruments significantly impact firm markups, particularly when the outliers are removed, which speaks for the suitability of instruments.

[xxiii] Note: the average marginal effect (*AME*) of markup on export participation is $AME = \mathbf{\Delta}P/\mathbf{\Delta}Ln\mu$ where P is the probability of export participation. We use a linear approximation of $\Delta P/\mu$ as follows: $\mathbf{\Delta}P = AME * (Ln\mu_2 \text{ -} Ln\mu_1) \Rightarrow \mathbf{\Delta}P = AME$ $*Ln\left(\frac{\mu_2}{\mu_1}\right)$. Accordingly, a 1% rise in markup results in $\mathbf{\Delta}P = AME *Ln(1.01)$. This indicates that a 1% increase in markups raises the probability of export participation by $\mathbf{\Delta}P$ percentage points, on average.

[xxiv] As in footnote 23, $\mathbf{\Delta}\ EI = AME\ *Ln(1.01)$. Accordingly, the percentage change in export intensity is approximated by dividing $\mathbf{\Delta}\ EI$ by the average export intensity of firms as reported in Table 1A of the online Appendix.

[xxv] As DLW postulate, the small productivity differences shown here could also be related to measurement bias associated with productivity measurement.

[xxvi] We refrain from estimating Equations (7) and (9) using firm-fixed-effects as a large number of firms (>90% of exporters) in the dataset do not change their exporting status over time.

[xxvii] Due to the asymptotic normality of the estimators, inference based on OLS and panel estimators is possible even in the absence of a normally distributed dependent variable (Wooldridge, 2010a). A sample of 1500 observations is large enough to assume that the central limit theorem will hold (Wooldridge, 2010a), and our dataset comprises more than 15,000 observations.

[xxviii] See Hirsch et al. (2020b) for a recent application of quantile regression to agribusiness firm-level data.

[xxix] Note: we do not interpret the results from OLS, BE and quantile as causal relationship, as endogeneity is not controlled.

[xxx] The results from the reduced form equations are shown in Table A4 of the online Appendix and reveal that both age and ownership structure impact firms' exporting behavior.

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