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Markup and productivity of exporters and importers

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Abstract

This paper studies the relationship between firm markups and importing intermediate inputs and exporting using detailed firm-level data from Hungary in 1995-2003. We estimate production functions structurally to obtain firm-year-level productivity and markup estimates. We find that importing intermediate inputs is associated with large markup premium, while the exporter markup premium is nonexistent when we control for the importer status. We interpret our results in a simple theoretical framework, where firms lower their markup when exporting to more competitive foreign markets and where importing intermediate inputs leads to higher-quality products.

Keywords: markups, exporting, importing, detailed trade data, Hungary

JEL classification: D22, D24, F14, L11, L60

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Az exportáló és importáló vállalatok termelékenysége és haszonkulcsa

Hornok Cecília – Muraközy Balázs

Összefoglaló

Ez a tanulmány részletes magyar vállalati adatok segítségével azt vizsgálja, milyen összefüggés figyelhető meg a vállalati haszonkulcsok és a félkésztermékek importja, valamint a késztermékek exportja között. Strukturális eljárással becslünk termelési függvényeket, amelyekből megkapjuk a vállalati éves szintű termelékenységet és haszonkulcsot. Az eredmények azt mutatják, hogy az importáló vállalatok haszonkulcsa lényegesen magasabb, de az exportálás nem jár magasabb haszonkulccsal, ha az importálást is figyelembe vesszük. Ezeket az eredményeket egy olyan egyszerű modellkeretben interpretáljuk, amelyben a termelékenyebb vállalatok választják az importálást és az exportálást is, de az exportpiacon erősebb a verseny, mint a hazain, az importálás viszont magasabb minőségű termékek gyártását teszi lehetővé.

Tárgyszavak: haszonkulcs, exportálás, importálás, részletes külkereskedelmi adatok, Magyarország

JEL kódok: D22, D24, F14, L11, L60

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April 2015

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This paper studies the relationship between firm markups and importing intermediate inputs and exporting using detailed firm-level data from Hungary in 1995-2003. We estimate production functions structurally to obtain firm-year-level productivity and markup estimates. We find that importing intermediate inputs is associated with large markup premium, while the exporter markup premium is nonexistent when we control for the importer status. We interpret our results in a simple theoretical framework, where firms lower their markup when exporting to more competitive foreign markets and where importing intermediate inputs leads to higher-quality products.

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1 Introduction

Recent empirical work has shown that trading firms are much different from non-traders. Exporting firms are larger, more productive, pay higher wages and charge higher prices (Bernard and Jensen, 1995). A more recent literature have concluded that firms importing intermediate inputs are also more productive, larger, charge higher prices and pay more for imported goods (Halpern, Koren and Szeidl, 2011; Kugler and Verhoogen, 2009). Large exporters are also large importers, and a large part of the exporter premium can be explained by differences in the import status (Amiti, Itskhoki and Konings, 2012). Why trading firms perform better is however still subject to debate. Self-selection into trading and reallocation of market shares toward better performing firms as in Melitz (2003) seem to be only part of the explanation; recent research suggests that trading induces improvements also within the firm.[1]

Traders' premia in productivity and size may imply that the market power of internationalized firms is also larger. Indeed, De Loecker and Warzynski (2012) provide evidence that exporting firms charge higher markup over marginal cost. In this paper we dig deeper into the question how the different dimensions of internationalization are related to market power. We argue that importing has an unambiguously positive association with markups because both self-selection and a quality-improving effect of imported inputs point into a markup premium of importers. Exporting, on the other hand, may have a more ambiguous relationship with markups, because the effect of self-selection may be offset by the effect of

[1] Access to export markets may foster innovation activities within the firm (Yeaple, 2005; Bustos, 2011) and the availability of new and better input varieties through imports can also improve firm performance (Halpern, Koren and Szeidl, 2011).

tougher competition on export markets.

We provide empirical evidence on Hungarian manufacturing firms in years 1995-2003 to confirm these arguments. First, we estimate firm-level markup and TFP from balance sheet data following the methodology of De Loecker and Warzynski (2012), who in turn build on the work of Hall (1986) and Klette (1999).[2] Then, we create measures for the scope of importing intermediate inputs and exporting activities from detailed trade data and investigate the relationship between markup, TFP and trading. Our main empirical findings are the following. First, we show that importing is associated with a large markup premium, while the premium of exporting becomes insignificant when we control for the import status. Second, we find that larger import intensity in material use is associated with higher markups, while this is not the case for export intensity. Third, productivity differences explain much from trading premia, but the importer premium remains positive even when controlling for productivity. Fourth, on large developed foreign markets, where competition is supposedly tougher, export premia are smaller (more negative).

We use a variable markups heterogeneous firm model to explain these observations. The model follows the Melitz and Ottaviano (2008) framework in terms of the market structure. We extend this model with the assumption that, after paying some fixed cost, firms can import high quality inputs, which enables them to increase the quality of their output. To model this, we use the structure of the model in Antoniades (2015), but with replacing innovation in that model with importing. In our framework importing inputs leads to an

[2]De Loecker (2011) and De Loecker, Goldberg, Khandelwal and Pavcnik (2012) use physical production data instead of values to estimate markups, which is shown to extends the flexibility of markup estimation. We cannot follow this approach for data limitations.

improvement in quality and an increase of the markup.[3] This was motivated by the increasing amount of empirical evidence that higher markup firms use higher quality inputs which may come from importing (e.g. Kugler and Verhoogen, 2009, 2012a; Atkin, Chaudhry, Chaudry, Khandelwal and Verhoogen, 2015).

The model also provides predictions for the export side, which are also in line with our observations. While positive productivity sorting leads to a positive association between exporting and markups, the tougher competition on the export market may offset this effect. We show that as a result the relationship between productivity and firm-level average markups becomes non-monotonic: firms with small export shares can have lower average markups than firms with a productivity level just below the threshold for exporting.

The mechanisms we study here are related to the questions on the magnitude of gains from trade. Arkolakis, Costinot, Donaldson and Rodríguez-Clare (2012) argue that taking into account variable markups yields weakly lower gains from trade resulting from trade liberalization, because exporters to the domestic market reduce their prices by less than the tariff cut. Our results provide additional support for the gain-reducing role of variable markups because, as our findings suggest, the pass-through of lower import costs to prices is also incomplete. In this regard, we provide complementary evidence to De Loecker, Goldberg, Khandelwal and Pavcnik (2012), who also show on the example of India's trade liberalization the incomplete cost pass-through to prices. In contrast to this gain-reducing effect, however,

[3] An alternative way to model the beneficial effects of importing would be to rely on a productivity-increasing mechanism as in Halpern, Koren and Szeidl (2011). We have chosen the quality-improving hypothesis because its more in line with our empirical finding that importer markup premia are positive even when controlling for productivity.

we also argue that international trade may offer an additional advantage. Trade liberalization may help importers to produce higher quality goods, which is suggested by our empirical finding that importer markups are higher even when controlling for productivity.

Our paper builds on a growing empirical literature on the productivity premium from importing intermediate inputs, which is often found to be at least as important as the productivity premium from exporting. Kasahara and Rodrigue (2008), for example, showed that starting to import intermediate goods led to a productivity increase in Chile. The productivity premium of importers, and especially two-way traders, is found to be large by Smeets and Warzynski (2013) for Denmark and Vogel and Wagner (2010) for Germany. Amiti and Konings (2007), Topalova and Khandelwal (2011), and Goldberg, Khandelwal, Pavcnik and Topalova (2010) document the productivity-increasing effect of import liberalization episodes. A theoretical contribution to this literature is Halpern, Koren and Szeidl (2011), who have built a model in which importing each intermediate input requires some sunk cost, but using more high-quality imported intermediate inputs leads to increased productivity. They confirm the predictions of this model using the same Hungarian firm data we analize in this paper. Kasahara and Lapham (2013) uses a similar framework of simultaneous choice whether to export or use imported intermediaries, and test the predictions on Chilean firm-level data. In this paper we also find that importers and exporters are indeed more productive than non-traders and this productivity difference partly explains the markup premia.

We also relate to the recent literature which investigates the role higher quality inputs play in better firm performance. A mechanism for how input quality affects productivity is proposed in Kugler and Verhoogen (2012b) in a heterogeneous firm model framework, in which firms can choose both inputs and outputs endogenously. Atkin, Chaudhry, Chaudry, Khandelwal and Verhoogen (2015) show that soccer ball producers in Pakistan who charge higher markups also produce higher quality balls and buy more expensive inputs. The results of Kugler and Verhoogen (2009) suggest that importing is potentially a key source of higher quality inputs. In this paper we provide suggestive evidence for a large set of firms that importing indeed helps in producing higher quality outputs, for which they can charge higher markups.

A line of literature develops heterogeneous firm models with variable markup by departing from the CES utility function.[4] The influential paper of Melitz and Ottaviano (2008) develops a general framework with a quadratic utility function and monopolistic competition in which markups in export markets differ systematically because of different competitive conditions. Mayer, Melitz and Ottaviano (2014) have expanded this model to multi-product firms to generate new predictions on the product mix of exporters. Our simple theoretical framework builds on Melitz and Ottaviano (2008) and the hypothesis that importing enables a firm to access higher quality inputs and, hence, produce higher quality output.[5] When introducing the model, we also take into account that we can only observe markups at the firm, rather than the firm-product-destination level. This framework shows that exporting and importing can have quite different effects on markups because of the possibility that competition in export markets is stronger.

The structure of the paper is the following. Section 2 introduces the dataset and presents

[4]See e.g. Krugman (1979), Melitz and Ottaviano (2008) with quadratic utility function, and Feenstra and Weinstein (2010) or Novy (2013) with translog expenditure function.

[5]Amiti, Itskhoki and Konings (2012) build a model of exchange rate pass-through which includes both variable markups and the imported input productivity premium from Halpern, Koren and Szeidl (2011). An alternative variable markups model was developed by Atkeson and Burstein (2008).

its most important characteristics. Section 3 introduces the methodology of estimating markups and productivity and provides descriptive evidence on the estimates. In Section 4 we develop our theoretical framework. Section 5 presents the main empirical findings, while Section 6 includes the robustness checks. Section 7 concludes.

2 Data and estimation sample

Our database consists of the universe of Hungarian manufacturing firms with more than 5 employees in years between 1995 and 2003. It combines data from the firms' balance sheets and earnings statements and detailed export and import data from the Hungarian Customs Statistics.

In the balance sheet and earnings statement data we observe sales, employment, fixed assets, various cost measures including expenditures on labor and materials, as well as ownership structure (foreign-owned, domestic state-owned, domestic privately owned). We do not observe product and factor input prices or quantities, although the average wage per employee can be calculated as the ratio of the total wage expenditure to the number of employees.

The Customs Statistics report data on essentially all export and import flows, both as value and quantity, of each firm by 6-digit HS (Harmonized System) product category, partner country and year. We identify imports of intermediate inputs as the imports of products that belong to the relevant BEC (Broad Economic Categories) codes.[6]

We clean the export flows of firms in order to eliminate possible carry-along export

[6] BEC codes 111, 121, 21, 22, 31, 322, 42, 53 cover intermediate inputs, as defined by the United Nations.

activities or sales of irregular items, including capital goods. We measure a firm's export sales as total exports of goods that belong to the firm's core export profile, where we define the core profile as the two-digit product code of which the firm generates the largest export revenue during the sample period.

We also eliminate from the sample firms with state ownership above 10% ever during the sample period. This makes us exclude 1,081 unique firms. Pricing decisions of state-owned firms are more likely to have been affected by some form of price regulation, which we want to rule out here.

Furthermore, we exclude firm-year observations with a large amount of processing trade. Firms engaged in processing trade import and re-export intermediate goods after performing a task on them for a fee, while the product remains the property of the foreign party. Prices in such activities may be determined very differently than in the case of non-processing trade, hence including this may bias our estimates. Processing trade is not reported in balance sheet data, but it is part of the customs statistics. Following Halpern, Koren and Szeidl (2011) we capture processing trade as the difference between customs exports and balance sheet exports of a firm, if positive. We drop firm-years, where the share of processing trade to total revenue exceeds 5%, which is the median share across firms with processing trade. This makes us exclude around 8,800 firm-year observations.

After all data cleaning, our sample includes 31,333 firm-year observations with 7,832 unique firms in nine years (1995-2003).

Table 1 reports some descriptive statistics. Trading firms are larger, both in terms of employment and sales revenue, more productive in terms of sales per worker, and more capital-intensive than non-traders. Firms that both export their products and import materials

Table 1: Descriptive statistics

	Non-trader	Exporter	Importer	Two-way	Full sample
Employment	29	35	44	152	82
Sales per worker (mn HUF)	7.2	8.2	12.5	14.6	10.9
Capital per worker (mn HUF)	1.7	2.2	2.7	3.9	2.8
Material share in output	61.3%	64.4%	67.2%	65.6%	64.1%
Export intensity		15.7%		29.1%	13.7%
Import intensity			13.3%	25.2%	11.8%
Foreign owned	5.7%	8.5%	14.6%	44.0%	22.7%
Number of observations	11,592	3,397	3,484	12,860	31,333
Number of firms	3,821	1,724	1,722	3,612	7,832

Notes: All are means unless otherwise reported. Trading status is determined for firm-year observations. Numbers of firms by status add up to more than the number of firms in the whole sample due to firms switching status. Export intensity is export sales over total sales, import intensity is expenditure on imported intermediate inputs over total expenditure on intermediate inputs.

(two-way traders) are by far the largest and trade more intensively than others. The share of exports in their sales revenue (export intensity) and the share of imported intermediate inputs in their total expenditure on intermediate inputs (import intensity) are considerably larger than for firms that either export only or import only. Finally, the prevalence of foreign ownership also increases considerably with the involvement in international trade.

3 Estimating productivity and markups

We estimate the total factor productivity (TFP) and the markup of the firm jointly following De Loecker and Warzynski (2012). The method of estimating TFP relies on structural production function estimation in the spirit of Levinsohn and Petrin (2003) and, more closely, Ackerberg, Caves and Frazer (2006). The markup estimate is based on the insight of Hall (1986) that, for a cost-minimizing producer, markup equals the ratio of the output elasticity of a variable input free of adjustment costs (labor or materials) to the input's revenue share.

The first-order condition for a cost-minimizing producer i with continuous and twice differentiable production function in period t implies that, for a given variable input (here labor, l), the markup is

$$\mu_{it} = \theta_{it}^{l} \left(\alpha_{it}^{l}\right)^{-1}, \tag{1}$$

where μ_{it} denotes firm markup in period t, θ^{l} is the output elasticity of labor and $\alpha^{l} = \frac{wL}{PQ}$ is the share of the expenditure on labor (wagebill, wL) in the total revenue of the firm (PQ). While the revenue share of labor is directly observable in the data, the output elasticity can only be estimated from a production function.

As baseline we assume a Translog production technology with Hicks-neutral productivity, and estimate a production function on the value added as follows.

$$y_{it} = \beta_{l} l_{it} + \beta_{k} k_{it} + \beta_{ll} l_{it}^{2} + \beta_{kk} k_{it}^{2} + \beta_{lk} l_{it} k_{it} + \omega_{it} + \epsilon_{it}, \tag{2}$$

where all variables are in logs, y is value added of production, l and k denote labor and capital, respectively, and the βs are parameters. Total factor productivity is captured by ω and ϵ is the error term containing unanticipated shocks to the producer and measurement error.

To allow for industry differences in the production technology parameters, we do the estimation procedure separately for 19 broad industry groups.[7] We measure value added with firm revenue less expenditures on material inputs, labor with the number of employees, and capital with the book value of tangible assets. Unfortunately, we observe neither physical

[7] These are the two-digit NACE industries from 15 to 37. We merge some smaller industries into larger ones (tobacco with food, office machinery with electrical machinery, recycling with manufacturing n.e.c.) and exclude energy manufacturing (23).

quantities nor firm-level prices. Therefore we deflate all variables with available industry-specific price indices.[8]

For robustness, we will experiment with alternative specifications of the production function (Section 6). These include a Cobb-Douglas specification and production functions on gross output. Clearly, in the case of a gross output production function there are two variable inputs (labor and materials) from which the markup (1) can be calculated.

With the help of structural estimation (first proposed by Olley and Pakes (1996)) our estimation accounts for the fact that we do not observe ω_{it} in (2). That productivity is unobservable to the econometrician but not to the firm is problematic, because firm decisions on variable inputs are most likely endogeneous to such contemporaneous productivity changes. If we estimate (2) with simple OLS and an error term $u_{it} = \omega_{it} + \epsilon_{it}$, the correlatedness of the variable input on the right-hand side with ω in the error will lead to biased and inconsistent parameter estimates.

The method we use follows Ackerberg, Caves and Frazer (2006) and proxies unobserved productivity with observed input choices, more specifically by inverting the demand function for materials (assuming that it is strictly monotonic, hence invertable). Productivity is then expressed as

$$\omega_{it} = h_t(m_{it}, k_{it}, l_{it}, \mathbf{z_{it}}),$$

where $h_t(.)$ is the inverted demand function for materials which, for simplicity, is treated as non-parametric, m_{it} denotes materials, k_{it} and l_{it} are capital and labor, both determined

[8]While the use of deflation is clearly inferior, De Loecker and Warzynski (2012) show that it affects only the level of the markup estimates, and not the correlation between markups and firm-level characteristics (such as the exporting or importing status).

before the firm decides on its material input, and $\mathbf{z_{it}}$ contains other controls affecting material demand. In this application we include dummies for being exporter or material importer in t as other controls.

The estimation proceeds in two steps and closely follows the procedure of De Loecker and Warzynski (2012). In the first stage we estimate (2) with the proxy for productivity, $h_t(.)$, substituting for ω_{it}. Note that in this step none of the β parameters can be estimated, since the inputs and the proxy for productivity are perfectly collinear. However, using the first-stage fitted values, $\hat{\phi}_{it}$, we can express productivity as

$$\omega_{it}(\beta) = \hat{\phi}_{it} - \beta_l l_{it} - \beta_k k_{it} - \beta_{ll} l_{it}^2 - \beta_{kk} k_{it}^2 - \beta_{lk} l_{it} k_{it}. \tag{3}$$

In the second stage, we estimate the production function parameters with a GMM procedure. We assume a law of motion for productivity, where current-period productivity is a nonparametric function (approximated by a third-order polynomial) of the productivity level in the previous period, plus an innovation term, ξ_{it},

$$\omega_{it} = g_t(\omega_{it-1}) + \xi_{it}. \tag{4}$$

The orthogonality conditions exploit the fact that the current-period innovation to productivity must be uncorrelated with the input levels set by the firm in the previous period. Hence, the moment conditions are

$$E\left(\xi_{it}(\beta)\begin{pmatrix} l_{it-1} \\ k_{it} \\ l_{it-1}^2 \\ k_{it}^2 \\ l_{it-1}k_{it} \end{pmatrix}\right) = 0,$$

where $\xi_{it}(\beta)$ is given by (3) and (4) and we take into account that current-period capital is determined in the previous period.

Having the estimated production function coefficients and the fitted values from the first-stage regression at hand, we can calculate firm-level productivity from (3). We calculate the firm markup by applying (1) to the labor input, where the output elasticity of labor under the Translog production technology is

$$\hat{\theta}^l_{it} = \hat{\beta}_l + 2\hat{\beta}_{ll} l_{it} + \hat{\beta}_{lk} k_{it}. \tag{5}$$

When calculating the revenue share of labor (α^l_{it}) we take into account that output may be subject to measurement error and so the observed output is $\tilde{Q}_{it} = Q_{it} \exp(\epsilon_{it})$. Hence, following De Loecker and Warzynski (2012), we obtain $\hat{\alpha}^l_{it}$ using a corrected output measure, $\frac{\tilde{Q}_{it}}{\exp(\hat{\epsilon}_{it})}$, where $\hat{\epsilon}_{it}$ is the residual from the first-stage regression.[9]

We find that the median firm in our sample charges around 50% markup over marginal cost.[10] As we will show in Section 6 this figure may vary by altering the specification of the production function, but the correlation among the alternative estimates is strong. Our median markup estimate is also comparable to, though slightly larger than, the estimates of De Loecker and Warzynski (2012) on Slovenian and De Loecker et al. (2012) on Indian

[9]Note the difference between the Translog and the Cobb-Douglas production function. Under Cobb-Douglas the estimated output elasticity of labor is constant within each industry and markups vary across firms because the differences in revenue share. As opposed to that, the Translog specification yields output elasticities which vary across firms, so markup variation comes both from the variation in the estimated output elasticity and the revenue share.

[10]We clean the markup estimate from outliers below zero or above 10. Occurrence of outliers is low, not exceeding half a per cent of the observations.

data.[11]

The estimated markup is quite stable across the years, showing a slight increase up to year 1998 and then a slow but gradual decline. Clearly, there is considerable variation in markups across industries, which explains close to 40% of the total variation in the logarithm of the firm-year markups. We find the largest markups in the tobacco industry (above 200%) and printing and publishing (160%), while smaller ones are more common in, for example, leather, wearing and apparel and wood manufacturing. Overall, the median markup estimates in most two-digit industries fall in the reasonable range of 1–2.

Table 2: Markups and productivity

	(1)	(2)	(3)
Dependent variable: log markup			
log TFP	0.368***	0.351***	0.338***
	(0.028)	(0.026)	(0.088)
foreign owned		0.053***	-0.032
		(0.016)	(0.021)
Size dummies		yes	yes
Industry-year dummies	yes	yes	
Firm dummies			yes
Year dummies			yes
Observations	31,333	31,333	31,333
R-squared	0.465	0.469	0.906

Notes: Markup and TFP are estimated from a value added Translog production function following De Loecker and Warzynski (2012). Size dummies are defined on the number of employees (between 5 and 20, between 20 and 100, above 100). Industry-year fixed effects are with two-digit industries. Robust standard errors with two-digit industry clusters are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

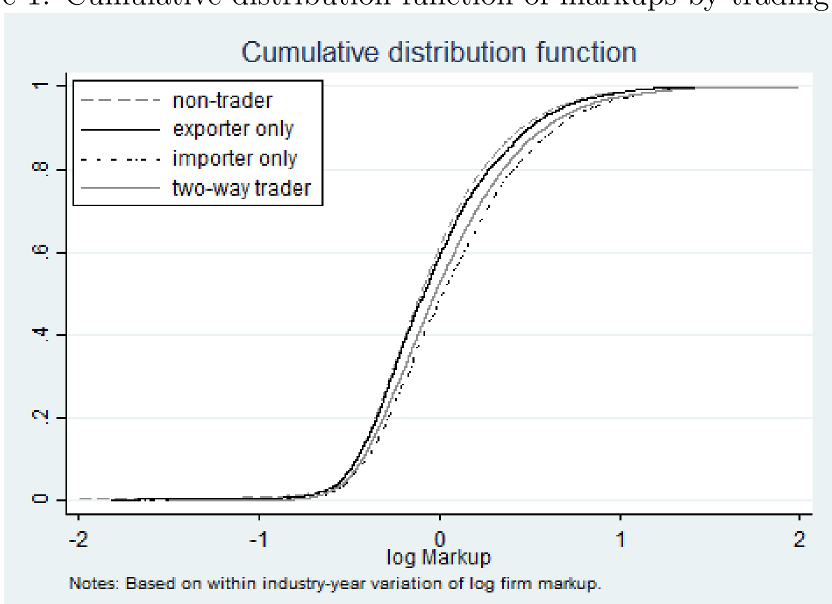
We find strong positive association between firm-level markups and productivity. Table 2 reports results from regressions of the logarithm of markup on the logarithm of productivity.

[11]In contrast to our database, which includes privately owned manufacturing firms above 5 employees, the Slovenian data includes all manufacturing firms regardless of size and ownership, while the Indian study uses the Prowess panel of mainly medium-sized firms.

Both within industry-years and within firms higher firm productivity is accompanied by higher markup, even after controlling for foreign ownership and the size of the firm. The finding that more productive firms charge significantly higher markups is in line with the implications of existing variable markup models.

Finally, let us look at how our markup estimate vary with the trading status of the firm. Figure 1 shows the cumulative distribution of markups (in logarithm) by trading status after netting out industry trends. Firms that import materials seem to charge higher markups than non-importer firms in the same industry and year. This positive markup premium is larger for firms that import only than for two-way traders. Non-traders and firms that export only have very similar markup distributions, the equality of which cannot be rejected by a Kolmogorov-Smirnov test at 5% significance level.

Figure 1: Cumulative distribution function of markups by trading status



In the next section we aim to explain with a theoretical framework the patter of markups in relation to the firm's trading status. Then, in Chapter 5 we provide further empirical evidence and test some of the model implications.

4 Theoretical approach

We interpret our results with a simple framework including variable markups with fixed entry costs into the import market. Our framework is based on a partial equilibrium version of the Melitz and Ottaviano (2008) model extended with endogenous product quality following Antoniades (2015). In our framework, import share will play a similar role as quality in the Antoniades model: a product produced with a larger share of imported inputs is more valuable for the consumers, hence shifts the demand curve up. We also append the model in two ways to adapt it more to the characteristics of importing. First, we introduce a fixed cost for starting to import. As opposed to investing in quality in general, which all firms do to some extent, not all firms import, which calls for the presence of a fixed cost. Moreover, a fixed cost of importing is also in line with our findings of large importer premiums and with the observation that few firms import small quantities. Second, in contrast to Antoniades (2015), we assume that a firm has to pay the fixed cost of importing only once rather than separately for the domestic and import markets. While this modification reduces tractability, we find it more realistic in our case.[12] Note however that this modification does not matter much for the main predictions of the model.

We also simplify the model in order to make it more tractable. First, we focus our attention on the two country case. The two countries are home and the rest of the world,

[12] Under the assumptions of the original Antoniades (2015) model we would find many firms selling higher quality versions of their products in the domestic market than in the export market.

and we assume that the rest of the world is larger, and competition in that market is stronger (which is a general equilibrium consequence of the larger market size in the full Melitz-Ottaviano framework), hence prices are lower there. This simplification of having two countries is mainly driven by the nature of our dataset, where we can only observe one markup for each firm-year, hence we cannot observe the markup in each country. Deriving such an average from a model with many countries would require many assumptions about the joint distribution of country size and strength of competition across countries.

Our model focuses on the quality-increasing effects of importing. As Halpern, Koren and Szeidl (2011) argues, however, another important consequence of importing is increased productivity, which should also be related to markups. Still, we focus on quality improvement for two reasons. First, as we can control form productivity empirically, we can show that markups are higher even after partialling out productivity, hence our framework should be able to explain this stylized fact. Second, as we study markups, we focus on the novel mechanism which directly affects markups rather than indirectly through productivity.

Intuitively, the story is the following. First, the model will predict a positive effect of imports on markups because of their quality-increasing effects. Also, as the bundle of imported inputs is determined endogenously, more productive firms will tend to import more intermediate inputs. This selection effect simply reinforces the positive relationship between imported inputs and markups.

Second, the model predicts a non-monotonic relationship between the scope of exports and firm-level markups. On the one hand, there is a selection effect: more productive firms are more likely to enter the export market. On the other hand, competition is stronger on the export market, which drives down the markups of exporters. We will show that this effect introduces a non-monotonic relationship between productivity and firm-level markups: the positive relationship between the two variables will be interrupted with an interval where average markup decreases in productivity. The negative slope is explained by a composition effect: as the productivity of exporting firms increase, they export an increasing share of their production to the (more competitive) export market, and for some productivity values this composition effect is stronger than the within-market positive relationship between productivity and markups. As a result, exporting firms may have lower markups than similar non-exporting firms.

Finally the model introduces a complementarity between importing and exporting. This means that starting to import is more profitable when the firm also exports, thanks to the larger market size. Also, starting to export is more profitable on the margin for firms which also import thanks to the lower cost and higher quality associated with importing.

This logic leads to three cases in terms of productivity sorting. First, when the fixed cost of importing is relatively low, the productivity threshold of importing is higher than that of exporting. Second, when the cost of importing is high, the threshold of exporting is higher. Complementarity however means that there is an intermediate set of parameter values when the two thresholds are identical.

4.1 Demand

The basic structure of the model follows a partial equilibrium version of the model in Antoniades (2015) and Yu (2013), which, in turn builds on Melitz and Ottaviano (2008). We distinguish between two countries, domestic and foreign (D and F, respectively). We assume that the foreign country (the rest of the world) is larger than the home country, hence $L^F > L^D$. The most important deviation from the Antoniades model is that of interpretation: the quality parameter, z_i for firm i will be interpreted in our model as the share of imported inputs.

The utility function of each consumer c is the following:

$$U = q_0^c + \alpha \int_{i\in\Omega} (q_i^c + z_i)\, di - \frac{1}{2}\gamma \int_{i\in\Omega} (q_i^c - z_i)^2\, di - \frac{1}{2}\eta \left(\int_{i\in\Omega} \left(q_i^c - \frac{1}{2} z_i \right) di \right)^2, \quad (6)$$

where q_0^c and q_i^c are consumed quantities of the numeraire good and variety i ($i \in \Omega$), respectively, and α, γ and η are positive demand parameters.

This yields a linear market demand system for each variety i that is consumed in country l ($l = D, F$) (this set of products is denoted by $\Omega^{*l} \subset \Omega$):

$$q_i^l \equiv L^l q_i^c = \frac{\alpha L^l}{\eta N^l + \gamma} - \frac{L^l}{\gamma} p_i^l + L^l z_i^l + \frac{\eta N^l}{\eta N^l + \gamma} \frac{L^l}{\gamma} \overline{p}^l - \frac{1}{2} \frac{\eta N^l L^l}{\eta N^l + \gamma} \bar{z}^l, \qquad l = D, F, \quad (7)$$

where N^l is the measure of consumed varieties, $\overline{p}^l = (1/N^l) \int_{i\in\Omega^{*l}} p_i^l di$ is their average price and $\bar{z}^l = (1/N^l) \int_{i\in\Omega^{*l}} z_i^l di$ is the average import share of varieties sold in country l.

Consumers only consume products for which

$$p_i^l \leq \gamma z_i^l + \frac{1}{\eta N^l + \gamma} (\gamma\alpha + \eta N^l \overline{p}^l - \gamma\eta N^l \bar{z}^l) \equiv p_{max}^l(z), \qquad l = D, F, \quad (8)$$

where p_{max}^l is the price where demand is driven to 0 for a product with $z_i^l = 0$.

The larger size of the foreign market implies both increased competition and higher quality in the general equilibrium version of the Antoniades (2015) model, hence we also assume that $\overline{p}^F < \overline{p}^D$. The larger market size also implies more entry, hence $N^F \geq N^D$. These assumptions are quite reasonable in our empirical investigation, in which we study a small country with lower average quality level than in its main trade partners. According to

Equation (8) these assumptions imply that $p^F_{max} < p^D_{max}$. Without much loss of generality we also assume that the price difference is not extreme, $p^F_{max} > p^D_{max}\tau/2$.[13]

4.2 Firm behavior

We look at firm behavior from the perspective of firms in the domestic economy. For simplicity, the wage level is set to unity. The model is one of monopolistic competition: differentiated goods producers take the average number of firms and prices as given.

Production exhibits constant returns to scale: each firm can produce one unit of output at marginal cost c. c represents realizations of a random draw from a common distribution $G(c)$ as in Melitz and Ottaviano (2008). Importing includes sunk costs which include a fixed part, f^I, and a part increasing in import share, θz_i^2. Here, the novel element is the f^I. This is motivated by the very plausible entry costs of building capacity for importing and finding foreign sellers and also by the robust observation that only a minority of firms import directly. The convexity of the latter function can be motivated by the mechanism described in Halpern, Koren and Szeidl (2011) that importing each kind of input requires the same sunk cost, and firms first start to import their most important input followed by inputs which play smaller and smaller role in their production process.[14]

[13] This assumption is only needed to guarantee that there is an increasing part (with respect to productivity) in the markup function of exporting firms. Otherwise it can happen that, for exporters, the competition effect is always stronger than the markup increasing effect of productivity increase

[14] For tractability, we do not handle the constraint that import share cannot be larger than 1. Building in this constraint would complicate the model but would not change the most important results.

Under these assumptions, the cost function is the following:

$$TC = \begin{cases} cq & \text{if not importing} \\ cq + f^I + \theta z^2 & \text{if importing} \end{cases} \tag{9}$$

In what follows, we will study four trade modes: (i) no import or export (ii) import but no export (iii) export but no import and (iv) both import and export.

TRADE MODE (i): NO TRADE. Let $c^D = p^D_{max}$ be the cost level when such a firm is indifferent between entering the market and exiting. In such a case, the price, quantity, profit level and markup of the firm are:

$$p^i(c) = \frac{1}{2}(c_D + c) \tag{10}$$

$$q^i(c) = \frac{L^D}{2\gamma}(c_D - c) \tag{11}$$

$$\Pi^i(c) = \frac{L^D}{4\gamma}(c_D - c)^2 \tag{12}$$

$$\mu^i(c) = \frac{1}{2}(c_D - c) \tag{13}$$

TRADE MODE (ii): ONLY IMPORT. With a given cost level and import share the performance measures are:

$$p^{ii}(c,z) = \frac{1}{2}(c_D + c) + \frac{\gamma}{2}z \tag{14}$$

$$q^{ii}(c,z) = \frac{L^D}{2\gamma}(c_D - c) + \frac{L^D}{2}z \tag{15}$$

$$\Pi^{ii}(c,z) = \frac{L^D}{4\gamma}(c_D - c)^2 + \frac{L^D}{2}z(c_D - c) + \frac{L^D\gamma}{4}z^2 - \theta z^2 - f^I \tag{16}$$

Maximizing the profit function yields:

$$z^*(c) = \frac{L^D}{4\theta - L^D\gamma}(c_D - c) \tag{17}$$

To get a positive optimal import share (conditional on importing), we assume that $4\theta > (L^D + L^F)\gamma > L^D\gamma$. The optimality condition shows that more productive firms import a higher share, hence supply higher quality goods. Also, firms import more inputs when serving larger markets or when the differentiation between varieties, γ, is larger.

An important characteristic of this setting is that one can express the performance measures with the technology parameters:

$$p^{ii}(c) = \frac{1}{2}(c_D + c) + \frac{\gamma L^D}{8\theta - 2L^D\gamma}(c_D - c) \tag{18}$$

$$q^{ii}(c) = \frac{L^D}{2\gamma}(c_D - c) + \frac{(L^D)^2}{8\theta - 2L^D\gamma}(c_D - c) \tag{19}$$

$$\Pi^{ii}(c) = \frac{L^D}{4\gamma}(c_D - c)^2 + \frac{(L^D)^2(c_D - c)^2}{16\theta - 4\gamma L^D} - f^I \tag{20}$$

$$\mu^{ii}(c) = \frac{1}{2}(c_D - c) + \frac{\gamma L^D(c_D - c)}{16\theta - 4L^D} \tag{21}$$

The performance measures behave differently in terms of productivity. As productivity increases, prices may go up or down, depending on the relative importance of quality. Second, quantity is increasing unambiguously with productivity. Third, profits are also increasing, thanks to two channels: directly, higher productivity is associated with lower cost, and, indirectly, higher productivity generates more imports. Finally, the markup level linearly increases in productivity reflecting both the direct and the indirect channel.

TRADE MODE (iii): ONLY EXPORT. When exporting, firms pay iceberg-type transportation costs, $\tau > 1$, and so the unit cost of delivering becomes τc. Let $c^F = p^F_{max}/\tau$

denote the cost level of firms who are indifferent to entering the foreign market, given no imports. Since $p^D_{max} > p^F_{max}$ and $\tau > 1$, $c^D > c^F$.

The price and quantity in the foreign market is given by:

$$p^F(c) = \frac{\tau}{2}(c_F + c) \tag{22}$$

$$q(c) = \frac{L^D}{2\gamma}(c_D - c) + \frac{L^F}{2\gamma}\tau(c_F - c) \tag{23}$$

The total profit level of such a firm is the sum of profits in the domestic and foreign markets:

$$\Pi^{iii}(c) = \frac{L^D}{4\gamma}(c_D - c)^2 + \frac{L^F}{4\gamma}\tau^2(c_F - c)^2 \tag{24}$$

The firm-level markup is the quantity-weighted average of its markups in the two markets:

$$\mu^{iii}(c) = \frac{L^D(c_D - c)^2 + L^F\tau^2(c_F - c)^2}{2L^D(c_D - c) + 2L^F\tau(c_F - c)} \tag{25}$$

The performance measures behave as expected with the exception of the markup measure. This measure is a weighted average of the markups on the two markets. While markup increases linearly on the two markets, the composition effect can lead to an interval when the markup actually decreases. We will return to this question.

TRADE MODE (iv): TWO-WAY TRADE. As we have discussed, we will deviate from Antoniades (2015) in allowing firms to pay the fixed cost of importing only once, which authorizes them to produce with the same import intensity in both markets. Antoniades assumes that firms have to pay the quadratic fixed costs on both markets which makes the model more tractable, but it is less realistic in our setting. Note, however, that our main predictions are robust to the setting chosen by Antoniades (2015).

The profit function for this mode is:

$$\Pi^{iv}(c) = \frac{L^D}{4\gamma}(c_D - c)^2 + \frac{L^F}{4\gamma}\tau^2 (c_F - c)^2 + \left[\frac{L^D}{2}(c_D - c) + \frac{L^F\tau}{2}(c_F - c)\right] z + \left(\frac{\gamma}{4}L^D + \frac{\gamma}{4}L^F - \theta\right) z^2 - f^I \tag{26}$$

Differentiating the profit function with respect to z yields:

$$z^* = \frac{L^D(c_D - c) + L^F\tau(c_F - c)}{4\theta - \gamma(L^D + L^F)} \tag{27}$$

Note that optimal import share is increasing in productivity. Also, a firm choosing trade mode (iv) invests more into importing inputs than a firm choosing mode (ii), ceteris paribus, since the firm takes into account the benefits from both markets which is reflected in the smaller denominator in this formula. Plugging in the optimal share yields:

$$\Pi^{iv}(c) = \frac{L^D}{4\gamma}(c_D - c)^2 + \frac{L^F}{4\gamma}\tau^2 (c_F - c)^2 + \frac{1}{4}\frac{\left[L^D(c_D - c) + L^F\tau(c_F - c)\right]^2}{4\theta - \gamma(L^D + L^F)} - f^I \tag{28}$$

Similarly to mode (ii), the profit from this mode is also increasing in productivity both through the direct channel of lower costs and the indirect channel of higher export intensity.

Using the previous notation we can express the firm-level average markup:

$$\mu^{iv}(c) = \frac{L^D(c_D - c)^2 + L^F\tau^2(c_F - c)^2 + [2\gamma L^D(c_D - c) + 2\gamma L^F\tau(c_F - c)]z^* + (\gamma^2 L^D + \gamma^2 L^F)(z^*)^2}{2L^D(c_D - c) + 2L^F\tau(c_F - c) + (2L^D\gamma + 2L^F\gamma)z^*} \tag{29}$$

Plugging in z^* and after some algebra one can show that μ^{iv} is a modified version of μ^{iii}:

$$\mu^{iv}(c) = \frac{4\theta + \gamma\left(L^D + L^F\right)}{4\theta - \gamma\left(L^D + L^F\right)}\mu^{iii}(c) + \gamma\frac{L^D\left(c_D - c\right) + L^F\tau\left(c_F - c\right)}{4\theta - \gamma\left(L^D + L^F\right)} - \frac{\gamma}{2}\frac{L^D + L^F}{4\theta + \gamma\left(L^D + L^F\right)} \quad (30)$$

The markup function is steeper with respect to unit cost than μ^{iii} thanks to the increase in import share when c decreases.

4.3 Sorting and markup patterns

The model yields sorting patterns which depend on the relative costs and benefits of importing and exporting. In particular, what matters is the threshold between modes (i) and (ii), which shows the relative cost and attractiveness of importing. When importing is very costly, firms will first start to export followed by two-way trade as their unit cost decreases. We will call this the case of "easy export". Second, when importing is relatively cheap, the sorting pattern is importing followed by two-way trade. We will call this case "easy import". Finally, for intermediate values of the threshold firms will start importing and exporting at the same threshold, called the case of "complementarity".

Naturally, firms will not enter the market whenever $c > c_D$, as in the original Melitz-Ottaviano model. Note that when $c = c_D$, only trade mode (i) yields a non-negative profit, modes involving importing are associated with strictly negative profits. Hence, given that $f^I > 0$, the threshold cost level for no trade is higher than that of any other trade mode.

The crucial measure for sorting is the threshold between modes (i) and (ii), when $\Pi^i = \Pi^{ii}$. This threshold is the following:

$$\breve{c} = c_D - \frac{\sqrt{f^I\left(4\theta - \gamma L^D\right)}}{L^D} \quad (31)$$

Another measure is the threshold when exporting becomes profitable. As in Melitz and Ottaviano (2008) it is at $c = c_F$ when the firm does not import. When importing, however, the quality of the product is higher, so consumers will buy the product even at a higher choke price. From the demand function and the optimal investment into import the choke price for exporting when also importing is: $c = \frac{4\theta - \gamma L^D}{4\theta - \gamma L^D + 1} c_F + \frac{\gamma L^D}{4\theta - \gamma L^D + 1} c_D$. Intuitively, it is a weighted average of the domestic and (non-importing) foreign threshold.[15]

The three cases are the following. First, in the "easy export" case $\breve{c}$ is lower than c_F, hence firms start to export first followed by importing. Second, we have "easy import" when $\breve{c}$ is so high, that at $\breve{c}$ exporting is not profitable even when importing. Finally, when $\breve{c}$ is between these two intermediate values, the threshold for importing and exporting is the same.

1. "easy export": $\breve{c} < c_F$

In this case, exporting is easy relative to importing. As a result, the sorting pattern will be mode (i), (iii) and (iv). Naturally, the threshold between modes (i) and (iii) is c_F. We have to calculate the threshold between mode (iii) and (iv), which we will denote with $\bar{c}$.

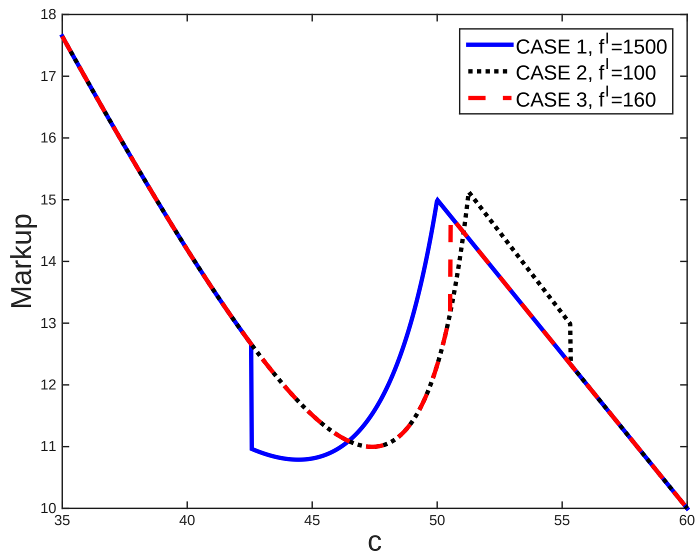
$$\bar{c} \equiv \frac{\sqrt{\frac{4}{3} f^I \left[4\theta - \gamma\left(L^D + L^F\right)\right]} + L^D c_D + L^F \tau c_F}{L^D + \tau L^F} \tag{32}$$

Note that choosing trade mode (ii) is never optimal is this case, because firms have to pay the same amount for importing independently from their export status, and the benefit from importing is larger when the firm already exports. One can write up the average markup as a function of productivity:

[15]Note that at the threshold exported quantity is zero, hence the optimal import share is that of TRADE MODE (ii).

$$\mu(c) = \begin{cases} \frac{1}{2}(c_D - c) & \text{if } c_F < c \leq c_D \\ \frac{L^D(c_D-c)^2+L^F\tau^2(c_F-c)^2}{2L^D(c_D-c)+2L^F\tau(c_F-c)} & \text{if } \bar{c} < c \leq c_F \\ \mu^{iv}(c) & \text{if } c \leq \bar{c} \end{cases} \tag{33}$$

Figure 2: Firm markup as function of marginal cost



A typical example for this function is shown in Figure 2 when f^I is set to 1500. The parameter values in the figure are set at $c_D = 80$, $L^D = 50$, $L^F = 250$, $\gamma = 4$, $\theta = 1000$, $\tau = 1.2$. Let us consider how the markup changes as productivity increases (marginal cost decreases). First, for firms without import and export, the markup is a linear function of productivity. Second, as the firm starts to export, the average markup decreases on some interval because of the composition effect from the more competitive market. The decreasing interval is followed by an increasing part when the markup-increasing effect of higher productivity becomes stronger than the composition effect. All in all, the markup function follows a U-shaped pattern between $c = 0$ and $c = c_F$.[16]

[16]Under our assumptions, this is always the case. The numerator of the derivative of $\mu^{iii}(c)$ is

Starting to import also has two counterbalancing effects. First, starting to import increases the quality of the product, hence it is associated with higher markups. Second, when importing, it is optimal for the firm to export more. This leads to the composition effect coming from the lower markups in the export market. The net effect of importing depends on the distance between the thresholds for exporting and importing. If the two are close to each other, hence $\bar{c}$ is on the increasing part of $\mu^{iii}(c)$,[17] the composition effect may dominate, while otherwise starting to import is associated with a positive jump in the markup function (shown on Figure 2).

Figure 3 shows how the U-shape pattern of the markup function varies with the toughness of competition on the foreign market. Fiercer competition (lower c_F) enables only the more productive firms to enter the export market and, after entering, the fall of the firm markup

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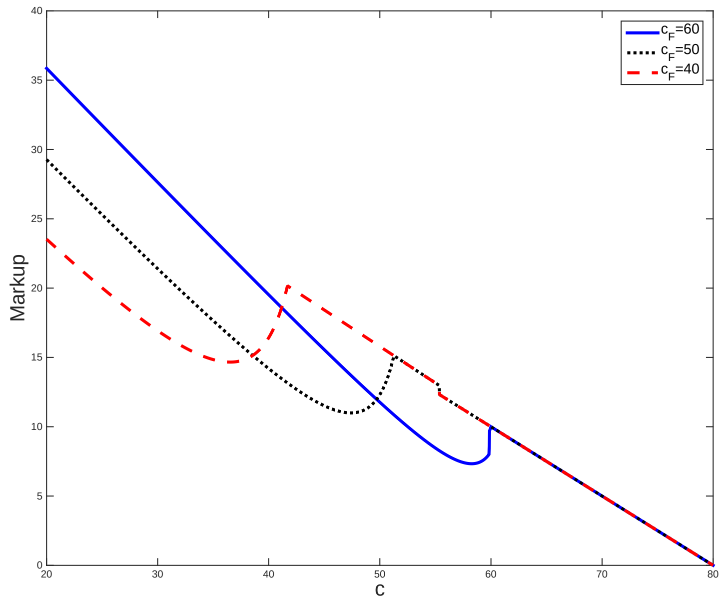
$\left[-2(L^D)^2 + 2L^D L^F \tau\right](c_D - c)^2 + \left[-2(L^F)^2\tau^3 + 2L^D L^F \tau^2\right](c_F - c)^2 - 4L^D L^F \tau(1+\tau)(c_D - c)(c_F - c)$. This can be rewritten as $\mu^{iii'}(c) = -2\left(L^D + L^F\tau\right)\left(L^D + L^F\tau^2\right)c^2 + 4\left(L^D c_D + L^F \tau c^F\right)\left(L^D + L^F\tau^2\right)c - 2\left[\left(L^D c_D + L^F\tau c^F\right)\left(L^D c_D + L^F\tau^2 c^F\right) - L^D L^F \tau\left(c_D - c_F\right)\left(c_D - \tau c_F\right)\right]$. We will prove that this quadratic function is increasing from a negative value at $c = 0$ to a positive value at $c = c_F$, and hence, the markup function is U-shaped in this interval. Plugging in $c = 0$ yields negative number under our assumption that $p^F_{max} > p^D_{max}\tau/2$. Plugging in $c = c_F$ yields a positive derivative because under our assumption that $L^F > L^D$, $-2(L^F)^2\tau^3 + 2L^D L^F\tau^2 > 0$ in the first form of the derivative. Finally, one can calculate the roots of the derivative function. This takes the form $c_{1,2} = \frac{L^D c^D + L^F \tau c_F}{L^D + L^F\tau} \pm \sqrt{\frac{(L^D c^D + L^F\tau c_F)^2}{(L^D + L^F\tau)^2} - \frac{(L^D c_D + L^F\tau c^F)(L^D c_D + L^F\tau^2 c^F) - L^D L^F \tau (c_D - c_F)(c_D - \tau c_F)}{(L^D + L^F\tau)(L^D + L^F\tau^2)}}$. The first term is a weighted average of c_D and c_F, so it is larger than c_F. This means that the second root is also larger than c_F, hence only the first root can be within $[0, c_F]$ interval. The fact that the derivative function takes a negative value at the lower end of the interval and a positive on the upper end implies that the first root is within this interval. All in all, the $\mu^{iii}(c)$ function is U-shaped in the interval with a minimum.

[17] More precisely, the dividing point is where $\mu^{iii}(c) = \mu^{iv}(c)$.

due to the composition effect is larger than on less competitive foreign markets.

Figure 3: Firm markup and export market competition



2. "easy import": $\frac{4\theta-\gamma L^D}{4\theta-\gamma L^D+1}c_F + \frac{\gamma L^D}{4\theta-\gamma L^D+1}c_D < \breve{c}$

In this case the cost structure of exporting is more demanding than that of importing. Hence firms start to import first and switch to two-way trade only with higher productivity levels. The threshold for this, $\Pi^{ii} = \Pi^{iv}$ will be denoted by $\hat{c}$. This is the cost level where the exported quantity is equal to zero when the positive import share is taken into account :

$$\hat{c} \equiv \frac{4\theta - \gamma L^D}{4\theta - \gamma L^D + 1}c_F + \frac{\gamma L^D}{4\theta - \gamma L^D + 1}c_D \tag{34}$$

Note that this threshold is larger than the threshold in the "easy export" case and the Melitz-Ottaviano model thanks to the demand increasing effect of higher quality. Hence, importing firms enter the export market earlier because of the complementarity between importing and exporting.

The function of markups take the following form:

$$\mu(c) = \begin{cases} \frac{1}{2}(c_D - c) & \text{if } \frac{\sqrt{f^I(4\theta-\gamma L^D)}}{L^D} < c \leq c_D \\ \frac{1}{2}(c_D - c) + \frac{\gamma L^D}{16\theta - 4L^D\gamma}(c_D - c) & \text{if } \hat{c} < c \leq \frac{\sqrt{f^I(4\theta-\gamma L^D)}}{L^D} \\ \mu^{iv}(c) & \text{if } c \leq \hat{c} \end{cases} \quad (35)$$

A typical such function is shown in Figure 2 with parameter $f^I = 100$. Again, the markup of non-trading firms is linearly increasing in productivity. When firms start to import, their markup jumps and the function becomes steeper. Finally, starting to export exhibits the negative interval thanks to the composition effect followed by another increasing part.[18]

3. "complementarity": $c_F \leq \check{c} \leq \frac{4\theta-\gamma L^D}{4\theta-\gamma L^D+1} c_F + \frac{\gamma L^D}{4\theta-\gamma L^D+1} c_D$

In the third case importing and exporting have the same threshold, because $\check{c}$ is between the choke price with and without importing. Hence, as soon as the firm finds it optimal to start importing, $\Pi^{iv} \geq \Pi^i$, it also starts to export.

Note that the measure of this set is non-zero thanks to the complementarity: there is an interval of parameter values where firms switch from no trade to two-way trade immediately thanks to the complementarity of exporting and importing.

The threshold is where $\Pi^i = \Pi^{iv}$, which we will denote with $\vec{c}$.[19] The markup function is

[18] This is again always the case under our assumptions, because $\mu^{iv}(c)$ behaves very similarly to $\mu^{iii}(c)$. The derivative function of $\mu^{iv}(c)$ is proportional to $\mu^{iii\prime}(c) - \gamma[4\theta - \gamma(L^D + L^S)](L^D + \tau L^F)$. Consequently it is also a concave parabola with a negative value at $c = 0$ and a positive one at $\frac{4\theta-\gamma L^D}{4\theta-\gamma L^D+1} c_F$, hence the markup function is again U-shaped in the relevant interval. The difference between the two derivative functions is a decreasing linear function. This means that the downward-sloping part of $\mu^{iv}(c)$ is steeper than that of $\mu^{iii}(c)$, hence increasing productivity leads to a larger increase in the markup of two-way traders than that of only exporters. Also, the minimum of $\mu^{iv}(c)$ is at higher cost level than the minimum of $\mu^{iii}(c)$.

[19] $\vec{c} = \frac{2L^F M\tau^2 c_F + 2\gamma(L^D+L^F)(L^D c_D + L^F c_F)}{2L^F M\tau^2 + 2\gamma(L^D+L^F)^2}$

the following:

$$\mu(c) = \begin{cases} \frac{1}{2}(c_D - c) & \text{if } c \leq c_D \\ \mu^{iv}(c) & \text{if } c \leq \vec{c} \end{cases} \tag{36}$$

4.4 Empirical predictions

- Unconditionally, importers should have higher markups than non-importers both because of the selection effect and the markup increasing effect of higher quality. This is true in all three cases with the partial exception of close thresholds for exporting and importing in the "easy import" case. This part of the parameter space does not seem to be large enough to counter the strong positive association between importing and markups in all other cases.

- Unconditionally, exporters may or may not have higher markups than non-exporters. The ambiguity comes from the countervailing forces of selection and the composition effect. The composition effect may be stronger in all three cases on the increasing part of the markup function.

- Conditioning on productivity importers should have higher markups than non-importers. The difference should be smaller than in the unconditional case. To see this, we may compare two firms with different f^Is. The one with larger fixed cost starts importing later, and has a lower markup in the interval between the two thresholds. Again this prediction should be qualified by the partial exception in the "easy import" case.

$- \frac{\sqrt{(2L^F M\tau^2 c_F + 2\gamma(L^D+L^F)(L^D c_D + L^F c_F))^2 - 4(L^F M\tau^2 + \gamma(L^D+L^F)^2)(L^F M\tau^2 (L^F)^2 + \gamma(L^D c_D + L^F c_F)^2 - 4\gamma M f^I)}}{2L^F M\tau^2 + 2\gamma(L^D+L^F)^2}$ where $M = 4\theta - \gamma\left(L^D + L^F\right)$.

- Conditioning on productivity, exporters may have higher or lower markup than non-exporters. The premium should be lower than the unconditional premium.
- Ceteris paribus, larger import intensity is associated with higher markups thanks to the larger share of quality-enhancing inputs. Higher export intensity may be associated with smaller markups because it means that a larger share of the firm's output is sold on the more competitive market.
- Exporting and importing are supermodular: ceteris paribus, exporters have a lower productivity threshold for importing and vice versa.

5 Empirical results

In what follows we look at empirically how the firm markup varies with trading status. Unless otherwise noted we use the markup and productivity estimates from the value added Translog production function. Later we show that the results are qualitatively the same for the alternative markup and TFP estimates.

5.1 Within-industry evidence

We first look at how the markup of firms similar in size and ownership varies with the trading status within industry-year groups. We run the following regression equation

$$\ln \mu_{it} = \gamma^{ex} D_{it}^{ex} + \gamma^{im} D_{it}^{im} + \gamma^{x} X_{it} + \delta_{kt} + \varepsilon_{it}, \tag{37}$$

where $\ln \mu_{it}$ on the left-hand side is the logarithm of markup of firm i (operating in industry k) and year t. On the right-hand side D_{it}^{ex} and D_{it}^{im} are dummies for the exporting and importing status, respectively. Exporter is a firm-year with positive export sales, importer is a firm-year with positive material imports.[20] Other firm-specific explanatory variables (size, ownership) are in X_{it}, δ_{kt} denotes the full set of industry-year dummies and ε_{it} is the idiosyncratic error term. Firms are classified into 22 two-digit manufacturing (NACE) industries.

Table 3: Markup and productivity premium estimates

Dependent variable:	log markup				log TFP	
	(1)	(2)	(3)	(4)	(5)	(6)
exporter	0.071***	0.016	-0.005	-0.002	0.156***	0.062**
	(0.020)	(0.016)	(0.013)	(0.012)	(0.025)	(0.024)
importer		0.136***	0.070***	0.061***		0.237***
		(0.017)	(0.019)	(0.019)		(0.021)
foreign	0.094***	0.067***	0.046***	0.004	0.132***	0.052
	(0.013)	(0.013)	(0.013)	(0.045)	(0.032)	(0.083)
exporter * foreign				-0.032		-0.057
				(0.041)		(0.065)
importer * foreign				0.083***		0.092**
				(0.024)		(0.042)
log TFP(-1)			0.293***	0.292***		
			(0.023)	(0.023)		
Size dummies	yes	yes	yes	yes	yes	yes
Industry-year dummies	yes	yes	yes	yes	yes	yes
Observations	31,333	31,333	22,651	22,651	31,333	31,333
R-squared	0.413	0.423	0.456	0.456	0.700	0.721

Notes: Markup and TFP are estimated from a value added Translog production function following De Loecker and Warzynski (2012). Size dummies are defined on the number of employees (between 5 and 20, between 20 and 100, above 100). Industry-year fixed effects are with two-digit industries. Robust standard errors with two-digit industry clusters are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

We estimate a positive and significant markup premium for exporters (column 1) only as long as we do not control for the importer status and past productivity. Exporting firms

[20] To avoid classifying small irregular cross-border transactions as genuine foreign trade we disregard exports and imports of individual firms in a given year and 6-digit product under HUF 100,000 (ca. US$ 500 according to the sample period average exchange rate).

charge roughly 7% higher markups, on average, than firms of similar size and ownership that sell only domestically in a given industry and year. This estimated premium is, however, largely due to the fact that most exporters use imported intermediate inputs, and importing firms charge significantly higher markups than non-importers. If we control for the importing status, we get an importer markup premium of 14%, while the exporter premium falls below 2%, and becomes statistically insignificant (column 2). This is much in line with our predictions that importing is strongly positively associated with markups thanks both to selection and higher quality generated from imports, while in the case of exporting the positive self-selection may be counterbalanced by the stronger competition in export markets.

If we control for the past productivity level of the firm (column 3), the exporter premium falls to zero and the importer premium roughly halves. This supports the idea that trading firms charge higher markups (at least partly) because they are also more productive.[21] The fact that productivity differences do not explain the importer premium fully suggests that imports generate other advantages, most likely the quality advantage proposed in our model.

The exporter markup premium falls close to zero irrespective of the ownership status of the firm. In column (4) we interact the trading status dummies with the foreign ownership dummy and find that the estimated markup premium for foreign-owned exporters is statistically not different from the estimate for domestically owned exporters. In contrast, importing materials associates with a significantly higher markup premium for foreign-owned firms than for domestic ones. This suggests that foreign-owned producers may face lower costs of importing and/or make better use of the imported materials. These may partly

[21]It is not the change in the sample size that causes the change in the coefficient estimates. Reproducing regressions (1)–(2) on the shorter sample yields qualitatively the same results as on the whole sample.

be explained by better access to international production networks and partly by possible complementarities between imported materials and other production factors (technology and worker or managerial sills).

In the last two columns of Table 3 we report estimates for the productivity premium of trading firms. The regression equation is similar to (37) but with the logarithm of TFP on the left-hand side. We find significantly positive productivity premia for both exporting and importing. The especially large importer premium estimate can reflect both a large selection effect and that importing leads to better firm performance, such as higher productivity or product quality. It is important to note here that our TFP estimate captures revenue productivity, which differs from pure physical efficiency in that it likely also reflects firm heterogeneity in demand-side effects, pricing strategies or factor input prices.[22] Hence, beside higher physical productivity, the importer premium we estimate may as well reflect importers' higher *profitability* in general.

Next we look at the relationship between the firm markup and the intensity of trade. We again estimate equation (37), but now, in addition to the exporter and importer dummies we also include the intensity variables. We define export intensity as the share of export sales in total sales and import intensity as the share of imported materials in the total expenditure on material inputs.

According to our model framework, for a given productivity level, a larger export intensity associates with a lower firm markup simply because a larger share of sales is destined to the more competitive foreign market. A larger import intensity however should coincide with a

[22]See De Loecker and Goldberg (2013) for a recent summary and discussion on the differences between revenue and physical TFP estimates.

higher markup both conditional on productivity and unconditionally.

Table 4: Markup premium with export and import intensities

Dependent variable: log markup						
	full sample			domestic firms		
	(1)	(2)	(3)	(4)	(5)	(6)
exporter	0.031	0.002		0.043**	0.018	
	(0.018)	(0.015)		(0.017)	(0.014)	
export intensity	-0.100***	-0.052		-0.112***	-0.082**	
	(0.034)	(0.034)		(0.039)	(0.037)	
export intensity in Q_1			0.030			0.043**
			(0.020)			(0.019)
export intensity in Q_2			-0.012			-0.004
			(0.013)			(0.014)
export intensity in Q_3			-0.050***			-0.028*
			(0.015)			(0.016)
export intensity in Q_4			-0.024			-0.022
			(0.021)			(0.021)
importer	0.116***	0.057***		0.120***	0.064***	
	(0.016)	(0.018)		(0.018)	(0.020)	
import intensity	0.154***	0.110***		0.138***	0.097***	
	(0.028)	(0.030)		(0.030)	(0.028)	
import intensity in Q_1			0.061***			0.072***
			(0.022)			(0.018)
import intensity in Q_2			0.066***			0.066***
			(0.020)			(0.021)
import intensity in Q_3			0.081**			0.083**
			(0.035)			(0.035)
import intensity in Q_4			0.126***			0.123***
			(0.025)			(0.022)
foreign	0.058***	0.038***	0.039***			
	(0.014)	(0.011)	(0.011)			
log TFP(-1)		0.287***	0.285***		0.291***	0.289***
		(0.023)	(0.022)		(0.027)	(0.027)
size dummies	yes	yes	yes	yes	yes	yes
industry-year dummies	yes	yes	yes	yes	yes	yes
Observations	31,333	22,651	22,651	24,218	17,416	17,416
R-squared	0.426	0.457	0.458	0.456	0.478	0.479

Notes: Markup and TFP are estimated from a value added Translog production function following De Loecker and Warzynski (2012). Size dummies are defined on the number of employees (between 5 and 20, between 20 and 100, above 100). Industry-year fixed effects are with two-digit industries. Robust standard errors with two-digit industry clusters are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Our model predictions find strong empirical support in Table 4, where we report results both for the full sample and for domestically owned firms only. The markup of firms is found smaller the larger the export intensity is, which is supportive for the composition effect, namely that the average firm markup falls if a larger share of sales goes to the foreign market. This finding holds both with and without controlling for past productivity, although the full sample estimate in column 2 is not significantly different from zero. We also find that markup increases strongly in import intensity, again both with and without controlling for past productivity. A firm which sources all of its inputs from abroad charges roughly 10% higher markup than an equally productive firm which buys almost all of its inputs domestically.

In columns 3 and 6 of Table 4 we investigate the possible presence of a non-linear relationship between markup and the trade intensities and replace the exporter and importer status and intensity variables with four-four dummy variables that indicate which quartile of the export and import intensity distribution the firm belongs to. We expect that, after controlling for productivity, firms falling into higher export (import) quartiles charge increasingly lower (higher) markups.

As for exporting, our expectation seems to hold true up to the third quartile, where the negative association between the export intensity and the markup is the strongest. In the fourth quartile, i.e. for firms with 75%-100% of export intensity, the coefficient estimate gets smaller in magnitude. This non-linear pattern can only partly be explained by the large share of multinationals in the fourth export quartile, since it is also present - although less strongly - among domestically owned firms.

As for importing, we find strongly significant positive markup premia in all the four quartiles. In line with our expectations, the point estimates increase in magnitude gradually (from 6 to 12 per cent) toward the higher end of the import intensity distribution. Importers charge higher markup than non-importers, and the more of their intermediate inputs they import, the higher their markup premium is.

5.2 Markup and export destination

An important feature of our model is the asymmetry in the toughness of competition between the home and the foreign economy. Firms in the home country charge lower markups on the export market than domestically, because the foreign market is bigger and hence more competitive than the domestic one.

Next we look at how the markup vary with the type of the export destination. Our hypothesis is that Hungarian firms exporting to large developed markets such as the EU15 (European Union before 2004) and the US face tougher competition than firms exporting to other less developed, and probably more fragmented, markets. As a result, the exporter markup premium should be smaller (or more negative) for the former than for the latter group of firms.

We estimate (37) adding an additional variable that measures what share of a firm's exports is directed to developed markets. Mainly for robustness, we also add a similar developed share variable for imports. Our group of developed countries include the EU15 countries, the four EFTA members (Iceland, Norway, Switzerland, Liechtenstein) as well as Australia, Canada, Israel, Japan, New Zealand, South Korea and the US. The median firm in our database sends roughly 95% of its exports to this group of countries. The results are robust to restricting the developed group to the EU15 and the US, where our median firm sends 85% of its exports.

Table 5: Markup premium and the foreign market

Dependent variable: log markup		
	full sample	domestic firms
	(1)	(2)
exporter	0.044***	0.045***
	(0.015)	(0.014)
export intensity	-0.014	-0.056
	(0.036)	(0.040)
developed share in exports	-0.079***	-0.052***
	(0.013)	(0.014)
importer	0.047*	0.057*
	(0.027)	(0.027)
import intensity	0.107***	0.094***
	(0.030)	(0.028)
developed share in imports	0.013	0.010
	(0.020)	(0.016)
foreign	yes	no
log TFP(-1)	yes	yes
Size dummies	yes	yes
Industry-year dummies	yes	yes
Observations	22,651	17,416
R-squared	0.459	0.479

Notes: Markup is estimated from a value added Translog production function following De Loecker and Warzynski (2012). Size dummies are defined on the number of employees (between 5 and 20, between 20 and 100, above 100). Industry-year fixed effects are with two-digit industries. Robust standard errors with two-digit industry clusters are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5 reports the results for the full sample and for domestically owned firms only. The estimates clearly give support to our hypothesis. The share of developed markets among export destinations strongly negatively correlates with the firm markup conditional on all other observables. The finding is especially strong on the full sample, which also includes foreign-owned firms. According to these estimates, exporting in general, which is captured by the exporter dummy, associates with significantly larger markup. This markup premium however rapidly falls with the share of developed markets in exports. At the extreme, firms exporting exclusively to developed markets may have negative markup premia.

We find no evidence that the importer markup premium would vary across developed and less developed source countries. The coefficient estimate for the developed share in imports variable is statistically not different from zero, though positive.

We also look at the relationship between export intensity and firm markup by selected individual developed countries (Table 10 in Appendix). The coefficient estimates are negative – though not always statistically significant – for almost all important EU15 trading partners and the US. The results are qualitatively similar, though weaker in significance, for domestically owned firms. The estimates are typically larger in magnitude on the full sample and especially so for some smaller countries, notably Ireland. Against this background we cannot rule out that tax optimization of multinationals through transfer pricing might drive some of our full sample results.

5.3 Markup and quality

Our model suggests that imports lead to higher output quality and hence an importer markup premium. The evidence that the importer markup premium does not vary with the source country's level of development is somewhat at odds with this hypothesis, because one would expect that imports from more developed countries can foster quality improvement better than imports from less developed economies. A possible explanation is that not all types of imported goods matter for output quality. Some inputs are relatively homogeneous and do not matter much for the output quality, while others - notably differentiated goods with a wide range of available varieties - can make large differences in the quality of output. We identify the imported inputs of each firm which are differentiated goods according to the (liberal) classification of Rauch (1999) and will look at how the markup of firms varies with the share of differentiated goods in the firm's total imports of intermediate inputs.

Next, it is reasonable to assume that imports raise output quality only if the imported input itself is also of high quality. Hence, we should observe firms which import higher quality inputs charging higher markup. To explore this we proxy high-quality imports with the unit value of the imported input. We observe unit values by 6-digit product, firm and year as the value of imports divided by the quantity of imports (in kilogram). We look at how these firm-product unit values deviate from the unit value of the same product imported to the EU-15 as a whole in the same year.[23] If, in a year, the ratio of the former to the latter, which we call 'import unit value ratio', is higher than its sample average across firms, we define the firm-product import as high quality.

In Table 6 we report regression estimates with the differentiated goods share and the high-quality share variables, both of which - as expected - associate positively with the markup variable. Firms importing only differentiated goods or only higher quality goods, as measured by the unit value, charge roughly 4% higher markup than similar firms which import only non-differentiated or lower quality inputs.

We can also ask whether importing intermediate inputs leads to higher-quality export products, where we again proxy the quality of an export product by its unit value. On a detailed panel of exporting firms by 6-digit product and destination country we regress the

[23]Data on the value and quantity of imports of the European Union is sourced from Eurostat.

Table 6: Markup premium and type of imports

Dependent variable: log markup			
	(1)	(2)	(3)
exporter	0.002	0.002	0.003
	(0.015)	(0.015)	(0.015)
export intensity	-0.052	-0.052	-0.052
	(0.035)	(0.034)	(0.035)
importer	0.031	0.048***	0.025
	(0.021)	(0.016)	(0.019)
import intensity	0.114***	0.115***	0.118***
	(0.030)	(0.030)	(0.030)
differentiated share in imports	0.043***		0.040**
	(0.014)		(0.015)
high-quality share in imports		0.039*	0.034*
		(0.019)	(0.020)
foreign	yes	yes	yes
log TFP(-1)	yes	yes	yes
Size dummies	yes	yes	yes
Industry-year dummies	yes	yes	yes
Observations	22,651	22,651	22,651
R-squared	0.458	0.457	0.458

Notes: Markup is estimated from a value added Translog production function following De Loecker and Warzynski (2012). Size dummies are defined on the number of employees (between 5 and 20, between 20 and 100, above 100). Industry-year fixed effects are with two-digit industries. Robust standard errors with two-digit industry clusters are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

logarithm of the export unit value on, among other regressors, a firm-specific dummy for importing and a dummy for importing high-quality inputs. High-quality importers are firms whose import unit value ratio (average across products, weighted by quantity) is above the median across firms. At this level of aggregation the sample includes 315,851 observations with 7,214 firms exporting 4,153 products to 211 destinations in 9 years.

Results are shown in Table 7, where we report two types of estimates: one with product-year and destination dummies in the first two columns and one with firm-year, destination and two-digit product dummies in the last two columns.[24] The estimates show that exporters who also import (i.e. two-way traders) sell products abroad with a significantly higher unit value than exporters who source their materials only domestically, and that this pattern is clearly driven by high-quality importing. Moreover, what we find is not merely a cross sectional relationship but is also present within the firm, albeit with smaller point estimates (columns 3 and 4).

Table 7: Export unit value and importing

Dependent variable: log export unit value				
	(1)	(2)	(3)	(4)
importer	0.057***	-0.080***	0.026**	0.013
	(0.016)	(0.017)	(0.013)	(0.014)
high-quality importer		0.320***		0.029***
		(0.013)		(0.011)
foreign	yes	yes		
size dummies	yes	yes		
firm-year dummies			yes	yes
product-year dummies	yes	yes		
two-digit product dummies			yes	yes
destination dummies	yes	yes	yes	yes
Observations	315,851	315,851	315,851	315,851
R-squared	0.802	0.806	0.782	0.782

Notes: Dependent variable is log export unit value by firm, destination country, product and year. Firm size dummies are defined on the number of employees (between 5 and 20, between 20 and 100, above 100). Clustered robust standard errors with firm-year clusters are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

[24] Coefficient standard errors are clustered by firm-year in all estimations, but the results are robust to alternative levels of clustering (e.g. firm, destination, firm-product, product-year).

5.4 Markup and starting to trade

In this section we ask how the markup behaves as the firm starts to trade. We compare the markup of firms that started to export or import materials with firms that never traded during the sample period. Hence, we always exclude firms from the sample that were traders throughout the whole sample period.

We estimate how the markup of individual firms change as the trading status of the firm changes with the firm fixed-effects regression,

$$\ln \mu_{it} = \gamma^{ex} D^{ex}_{it} + \gamma^{im} D^{im}_{it} + \gamma^{x} X_{it} + \delta_i + \delta_t + \varepsilon_{it}, \tag{38}$$

where δ_i are firm fixed effects and δ_t are common year dummies. Unlike the within-industry-year estimates in the previous section, the fixed effects estimation identifies the effect of trading from the changes of firm markups over time.

The results are shown in Table 8 for two samples, the latter excluding firm-year observations after the firm stops exporting or importing (exits). Regardless of the estimation sample we find no significant change in the firm markup as a result of starting to export, while we find clear evidence for an increase in the markup (of around 3%) after the firm starts to import materials.

Next we carry out a within-firm event study to look at how the markup premium evolves years before and after a firm starts to trade. Again we estimate (38) but replace the single exporter and importer dummies with dummies specific to the event year, s, i.e. the number of years before or after the firm starts to trade. We define a four-year event window and choose the year preceding the trade entry as the reference year.[25] This means that we include

[25]We classify the few observations five and more years away from the year of starting to trade in the -4

Table 8: Markup and starting to trade - within-firm estimates

Dependent variable: log markup		
	sample without always traders (1)	sample without always traders and firms after exit (2)
exporter	0.014	-0.003
	(0.013)	(0.024)
importer	0.032**	0.033*
	(0.012)	(0.019)
foreign	-0.021	-0.033
	(0.030)	(0.041)
Size dummies	yes	yes
Firm dummies	yes	yes
Year dummies	yes	yes
Observations	15,878	12,347
R-squared	0.897	0.915

Notes: Markup is estimated from a value added Translog production function following De Loecker and Warzynski (2012). We exclude firms that always export or import. Size dummies are defined on the number of employees (between 5 and 20, between 20 and 100, above 100). Robust standard errors with two-digit industry clusters are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

exporter and importer dummies for event years $s \in$ (-4,-3,-2,0,1,2,3,4). Importantly, to avoid overlapping event windows, we estimate on the sample that excludes firm-year observations after trade exits.

Figure 4 in the Appendix plots the estimated exporter and importer markups against the event years, relative to event year -1, which is normalized to zero. The evolution of the markup line from year 0 indicates the effect of trading on the firm markup (in log). The important finding here is the declining path of the markup after the first (full) year of exporting, as compared to its relatively stable pre-entry pattern. This decline is not visible from the simple fixed-effects estimation in Table 8 column 2, because observations for higher

and 4 event year categories.

event years are relatively few.

Finally, the graph for importing shows that the firm markup increases already in the year of starting to import (year 0) and remains above its average pre-entry level in later years.

6 Robustness

As robustness checks we reproduce our main estimation results for two alternative markup estimates, also reported in Table 9, and two modified sample periods. In short, our results are robust to these changes.

Alternative markup estimates. We take the markup estimates based on two different production function specifications: the Cobb-Douglas production function on the value added (VA-CD) and the Translog production function on gross output (GO-TL).

The Cobb-Douglas production function is a special case of equation (2), where the parameters of the quadratic and interaction terms are set to zero. The estimated output elasticity of labor is then constant across firms in the same industry and year and, hence, all firm-level variation in the estimated markup comes from the revenue share of labor.

The Translog production function on the gross output is a modified version of equation (2), where y_{it} is the logarithm of gross output of firm i in year t and the right-hand side also includes the terms with the material input, m (in log), $\beta_m m_{it} + \beta_{mm} m_{it}^2 + \beta_{lm} l_{it} m_{it} + \beta_{km} k_{it} m_{it} + \beta_{lkm} l_{it} k_{it} m_{it}$. This production function is more flexible than our baseline specification, which implicitly assumes that materials are used in fixed proportion with gross output. It also enables us to obtain markup estimates from two variable inputs by applying equation (1) to either labor or materials.

We report the sample median, mean and coefficient of variation of the baseline and the alternative markup estimates in Table 9.[26]

Our GO-TL markup is a composite estimate, because we obtain it by taking the geometric mean of the labor-based and material-based markup estimates. We do this in order to correct for a possible measurement issue in the labor and material input variables. Outsourcing in-house services or parts of the production process to independent suppliers, which was a common practice in the period among Hungarian firms, shows up in the data as substitution of materials for labor. This leads to decreasing labor and increasing material revenue shares and, in turn, increasing labor-based and decreasing material-based markup estimates. We let the two trends offset each other in the geometric mean.

Table 9: Alternative markup estimates

Specification	median	mean	CV
Value added Translog (VA-TL)	1.53	1.79	0.56
Value added Cobb-Douglas (VA-CD)	1.76	2.12	0.61
Gross output Translog (GO-TL)	1.26	1.37	0.34

Notes: CV (coefficient of variation) is standard deviation over the mean. The GO-TL markup is the geometric mean of the labor-based and material-based GO-TL markup estimates.

The median markup estimates take reasonable values, but differ considerably across specifications. The markup estimate from a value added Cobb-Douglas (VA-CD) production function is higher (76%), while that from a gross output Translog (GO-TL) production function is clearly lower (26%) than our baseline estimate. The lower end of the reported estimates is comparable to the markup estimates of De Loecker and Warzynski (2012) for

[26] We clean the markup estimates from outliers below zero or above 10. Occurrence of outliers is low, not exceeding half a per cent of the observations, for all types of estimates.

Slovenian firms during 1994-2000 and to those of De Loecker, Goldberg, Khandelwal and Pavcnik (2012) for India during 1989-2003.

Despite the differences in levels our baseline markup and the VA-CD and GO-TL markups are strongly positively correlated. The pairwise correlation coefficients of the markups (in logs) within industry and year are in the range of 0.7–0.9.

Finally, Table 11 shows the regression estimation results, which reproduce our baseline estimates in Table 3 columns (2) and (4) and Table 4 columns (1) and (2) on the alternative markups. Importantly, our main findings on the large importer markup premium and the non-existent exporter markup premium remain remarkably robust. The findings on the trade intensities and the role of foreign ownership are also reinforced.

Different sample periods. Next we check the robustness of our findings to varying the sample period. During the 1990s, and especially in the early years, Hungary was better characterized as a transition economy with episodes of mass privatization and market liberalization as well as opening up to trade with "Western" markets. Also, before 1995 the Hungarian currency was repeatedly subject to large devaluations. Our baseline sample period is 1995-2003, hence it excludes the most turbulent years of transition.

As a robustness check we replicate our results on the period of 1992-2003, which extends to the early years of transition, and on the shorter period of 1998-2003. We report the estimates in Table 12. Again, our main results remain remarkably robust, also concerning the magnitude of the estimates.

7 Conclusion

This paper has studied how importing and exporting is related to firm-level markups. In the theoretical part of the paper we have provided a model which takes into account the role of self-selection based on productivity, the potentially different degree of competition in different markets and the role of importing in providing access to higher quality inputs. For this, we use a variable markups framework in which importers have to pay a fixed cost but can produce higher quality goods which can be sold for a higher markup. Such a framework emphasizes that markups are not only determined by productivity differences, but also by differences in competition and quality.

The main message and prediction of the model is that while self-selection based on productivity implies a positive relationship between trade and markups, other factors may modify this relationship. In the case of importing, the potentially higher quality of imports may amplify the positive relationship. When exporting is considered, however, stronger competition on export markets may counterbalance self-selection at the firm-level.

The empirical part of the paper has analyzed detailed Hungarian firm-level data to establish the role of exporting and importing in determining markups. Exporting proves to be significantly positive only when we do not control for importing. This is much in line with the potential counterbalancing effect of strong competition on export markets. This suggestion is supported by our finding that the export premium is smaller or more negative for firms which export to markets where competition is supposed to be stronger. Importers, on the other hand, have a robustly positive markup premium, which is only partly explained by their productivity premium. This provides evidence for our hypothesis that importing may result in quality improvements as well as higher productivity.

Our empirical results are in line with other predictions of the model. The export premium seems to be lower (or more negative) on larger and more competitive markets. Also, import share is positively, while export share is negatively associated with markups. Also, importing and exporting are strongly correlated, probably partly because of the complementarity proposed in our framework.

In general, these results suggest that while productivity plays a very important role in determining markups, other factors, which may affect prices even more directly can also be significant. Our results are in line with an important role of the different levels of competition in different markets and that quality differences can affect markups even beyond their effect on estimated productivity. Such effects may be taken into account in welfare calculations of trade policy changes.

An important conclusion of our results is that exporter premia may be explained to a large degree by the high correlation between exporter and importer status. Modeling the two decisions jointly can be important when studying many trade questions. The potential complementarity between the two modes emphasized in our model suggests that successful entry into foreign markets may often require simultaneously starting importing and exporting. Policies helping firms to do so may be more effective then policies focusing only on exporting.

The quality enhancing and export-helping effect of imports suggested by our results provides an additional argument for liberalizing trade for the import of intermediate inputs and even for policies supporting firms in finding foreign suppliers able to provide high-quality inputs. On the other hand, the incomplete pass-through of cost savings into importers' prices suggests that variable markups may play an even more important role in reducing gains from trade than supposed by Arkolakis, Costinot, Donaldson and Rodríguez-Clare (2012) who focuses on exporter markups.

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8 Appendix

Table 10: Exporter markup premium and foreign markets

Dependent variable: log markup		
	full sample	domestic firms
exporter	0.034**	0.039***
	(0.015)	(0.013)
export intensity	-0.013	-0.055
	(0.034)	(0.038)
– Austria	-0.057**	-0.039*
	(0.022)	(0.021)
– Belgium	0.048	-0.065
	(0.068)	(0.043)
– Germany	-0.086***	-0.052***
	(0.014)	(0.013)
– Spain	-0.150*	-0.146**
	(0.078)	(0.056)
– France	-0.027	0.020
	(0.045)	(0.060)
– UK	-0.077*	-0.106*
	(0.043)	(0.060)
– Ireland	-0.240**	-0.130
	(0.098)	(0.081)
– Italy	-0.096***	-0.058
	(0.018)	(0.035)
– Netherlands	-0.068	-0.024
	(0.048)	(0.076)
– Sweden	-0.032	0.007
	(0.050)	(0.051)
– rest of EU15	-0.099	-0.045
	(0.063)	(0.072)
– US	-0.062	-0.083*
	(0.039)	(0.041)
importer	0.058***	0.065***
	(0.018)	(0.020)
import intensity	0.108***	0.096***
	(0.032)	(0.028)
foreign	0.038***	
	(0.011)	
log TFP(-1)	0.280***	0.286***
	(0.023)	(0.026)
Size dummies	yes	yes
Industry-year dummies	yes	yes
Observations	22,651	17,416
R-squared	0.459	0.479

Notes: Markup is estimated from a value added Translog production function following De Loecker and Warzynski (2012). Size dummies are defined on the number of employees (between 5 and 20, between 20 and 100, above 100). Industry-year fixed effects are with two-digit industries. Robust standard errors with two-digit industry clusters are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Figure 4: Firm markup before and after entering the foreign market

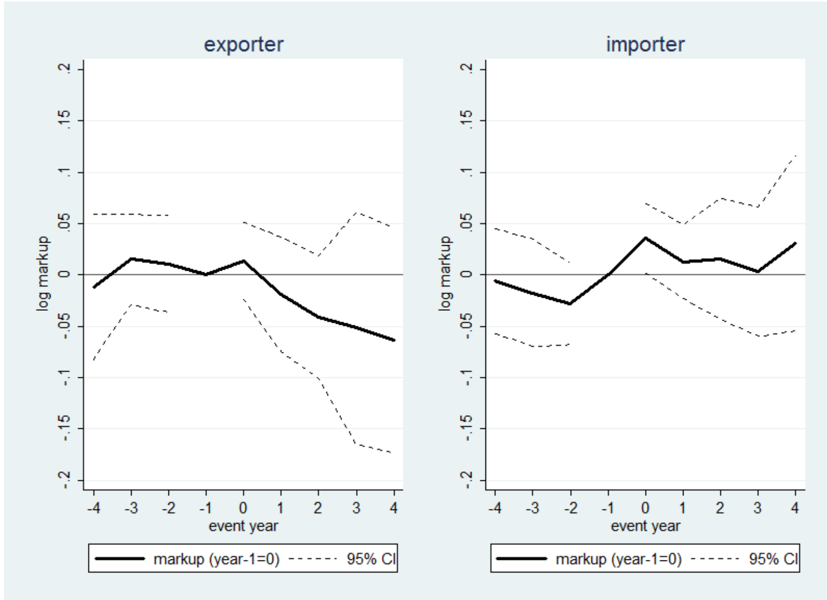

Table 11: Robustness - alternative markup estimates

Dependent variable: log markup								
	VA Cobb-Douglas				GO Translog (composite)			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
exporter	0.036	0.019	0.058**	0.027	0.011	0.017	0.029	0.029
	(0.022)	(0.018)	(0.025)	(0.022)	(0.023)	(0.024)	(0.022)	(0.022)
export intensity			-0.141***	-0.084**			-0.114***	-0.109***
			(0.040)	(0.038)			(0.026)	(0.026)
importer	0.154***	0.074***	0.134***	0.073***	0.099***	0.088***	0.086***	0.081***
	(0.011)	(0.009)	(0.013)	(0.011)	(0.007)	(0.007)	(0.009)	(0.008)
import intensity			0.161***	0.110***			0.108***	0.104***
			(0.032)	(0.036)			(0.026)	(0.025)
foreign	0.105***	0.014	0.101***	0.069***	0.043***	0.034	0.043***	0.041***
	(0.016)	(0.036)	(0.017)	(0.018)	(0.012)	(0.027)	(0.011)	(0.012)
exporter * foreign		-0.044				-0.039*		
		(0.031)				(0.022)		
importer * foreign		0.113***				0.047**		
		(0.029)				(0.020)		
log TFP(-1)		0.287***		0.282***		0.230**		0.223*
		(0.039)		(0.039)		(0.110)		(0.108)
Size dummies	yes	yes	yes	yes	yes	yes	yes	yes
Industry-year dummies	yes	yes	yes	yes	yes	yes	yes	yes
Observations	31,333	22,651	31,333	22,651	31,324	22,644	31,324	22,644
R-squared	0.432	0.506	0.437	0.507	0.243	0.267	0.251	0.275

Notes: Markup is estimated from a value added Translog production function following De Loecker and Warzynski (2012). Size dummies are defined on the number of employees (between 5 and 20, between 20 and 100, above 100). Industry-year fixed effects are with two-digit industries. Robust standard errors with two-digit industry clusters are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 12: Robustness - alternative estimation samples

Dependent variable: log markup	1992-2003				1998-2003			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
exporter	0.016	-0.002	0.039**	0.011	0.021	-0.000	0.037*	0.005
	(0.014)	(0.009)	(0.016)	(0.012)	(0.015)	(0.014)	(0.018)	(0.017)
export intensity			-0.141***	-0.101**			-0.107**	-0.068
			(0.035)	(0.037)			(0.040)	(0.042)
importer	0.125***	0.055***	0.108***	0.051***	0.131***	0.066***	0.112***	0.061***
	(0.008)	(0.010)	(0.009)	(0.010)	(0.010)	(0.011)	(0.013)	(0.013)
import intensity			0.141***	0.103***			0.150***	0.106***
			(0.021)	(0.024)			(0.037)	(0.036)
foreign	0.064***	0.021	0.063***	0.045***	0.048***	0.006	0.042**	0.029*
	(0.015)	(0.031)	(0.015)	(0.012)	(0.013)	(0.038)	(0.016)	(0.015)
exporter * foreign		-0.026				-0.039		
		(0.044)				(0.043)		
importer * foreign		0.056**				0.071***		
		(0.024)				(0.023)		
log TFP(-1)		0.281***		0.275***		0.254***		0.250***
		(0.017)		(0.016)		(0.036)		(0.035)
Size dummies	yes	yes	yes	yes	yes	yes	yes	yes
Industry-year dummies	yes	yes	yes	yes	yes	yes	yes	yes
Observations	32,000	23,405	32,000	23,405	26,299	18,009	26,299	18,009
R-squared	0.344	0.412	0.349	0.415	0.405	0.445	0.408	0.446

Notes: Markup is estimated from a value added Translog production function following De Loecker and Warzynski (2012). Size dummies are defined on the number of employees (between 5 and 20, between 20 and 100, above 100). Industry-year fixed effects are with two-digit industries. Robust standard errors with two-digit industry clusters are in parentheses. *** p<0.01, ** p<0.05, * p<0.1