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Abstract:

This paper presents empirical evidence about the relationship between market openness and markup distribution of manufacturing firms. The empirical analysis uses a panel data set of Spanish firms in the period 1990-2005, with a structural approach that lets us to identify individual mark-ups. The results point out that tougher competition associated to openness reduces the average of marginal costs and prices, while it increases the average firm size. However, the evidence about the effect on average markups and the dispersion of performance variables is weaker. These results partially support the theoretical predictions by the recent literature on efficiency heterogeneity and international trade and, in particular, Melitz and Ottaviano (2008).

Keywords: markups, marginal costs, size, openness

JEL Classification Numbers: F12, L60, L13

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1. Introduction.

The influential paper by Melitz (2003) has stimulated an emerging literature that explains the decision to export with the incorporation of intraindustry heterogeneity in productivity and size. This theoretical framework has been extended and extensively used since then. A main characteristic of such an approach is that it models the demand side using CES preferences which, as usual, generates constant markups.

In Melitz (2003) model the exposure to trade implies two selection processes: only the most productive firms enter into the export market and the less productive firms exit the domestic market. The latter is the result of the competition for labour. As trade liberalization increases the market share and the foreign demand of most productive firms, it also increases the labour factor demand. This produces that real wages rise. As consequence, the marginal cost increases and the less productive firms exit the domestic market because they are not able to cover the fixed cost. Both selection processes leads to a reallocation towards more productive firms and the average productivity of the country increases.

A well-known alternative framework was proposed by Bernard et al (2003), who introduce firm heterogeneity on a probabilistic model of comparative advantage. However, though in that context more efficient firms set higher markups, some surprising predictions for mark-ups are also obtained. Specifically, the distribution of mark-ups is the same in any destination and does not depend on the level of technology or geographic barriers.

More recently, Melitz and Ottaviano (2008) (MO hereinafter) have proposed an alternative framework that establishes predictions on the distribution (average and variance) of four performance measures: productivity, size, price and markup. This model is based on a monopolistically competitive framework with heterogeneous firms and endogenous differences in the 'toughness' of competition across countries, reflected by the number and average productivity of competing firms in that market. Though this model follows many features of Melitz (2003), it has two specific characteristics that determine different (and more realistic) predictions about markup distribution. Firstly, demand side is specified using a linear demand system with horizontal product differentiation developed by Ottaviano, Tabuchi, and Thisse (2002). It allows authors to incorporate endogenous markups. Secondly, trade operates through an increase of product market competition, instead of through the increased labour market competition channel. Firms respond to this tougher product market competition by setting a lower markup that outweighs the selection effect according to which the most productive firms survive and set higher markups.

This paper tests some theoretical predictions of MO. Particular attention is devoted to mark-ups distribution. In contrast to productivity analysis, the literature has devoted scarce attention to the analysis of mark-up distribution. It could be because, as was commented previously, mark-ups were considered constants in Melitz (2003) approach. It can also be due to that mark-up is usually a more difficult variable to approach empirically than productivity. Different alternatives have been used to estimate margins. In this paper we use the methodology proposed by Berntesin and Mohnen (1991). Although this approach requires more information than other alternatives (for example, Roeger (1995)), it allows us to estimate the marginal cost that we need to test the prediction of MO.

The empirical analysis uses a panel data set of Spanish manufacturing firms in the period 1990-2005. The paper is as follows. Section 2 summarizes main predictions of MO and discusses briefly how to approach empirically performance measures and, in particular, mark-ups. Section 3 provides main results and Section 4 concludes.

2. Markup heterogeneity and international trade.

2.1 The MO predictions.

The MO paper incorporates endogenous markups using the linear demand system with horizontal product differentiation developed by Ottaviano, Tabuchi, and Thisse (2002). In that approach, price elasticity not only depends on the level of product differentiation as in the CES demand model, but also on average prices and the number of competing varieties. With respect to firms, they face some initial uncertainty concerning their future productivity when making a costly and irreversible investment decision prior to entry. As usual, such uncertain outcome for marginal cost (the inverse of productivity) is modelled as a draw from a common (and known) distribution G(c) with support on $[0, c_M]$. The key parameter is then the level of marginal cost c_D in which the firm is indifferent about remaining in the industry or exiting. Specifically, all firms with $c > c_D$ exit, while all firms with cost $c < c_D$ earn positive profits and remain in the industry. Firms with lower marginal costs set lower prices and obtain higher profits than high-cost firms. However, they also set higher mark-ups because they are more productive and do not fully translate cost advantages to prices. This is a selection effect.

The cutoff c_D is positively affected by sunk costs and the degree of differentiation of varieties, while it is negatively affected by market size. Larger markets induce tougher competition, with more product variety and more productive firms. These firms are bigger and earn higher profits. However, they respond to the tougher competition by setting a lower price and, consequently, a lower markup that outweighs the selection effect. Additionally, the chosen parametrization of the distribution of marginal costs allows them to obtain some predictions about the dispersion of the performance variable. Specifically, a bigger market reduces the variance of average prices, cost and markups. This is the result of the selection effect that reduces the support of these distributions for any G(c). With respect to firm size, its variance is bigger in larger markets due to the direct magnifying effect of market size.

This set of predictions is valid for both a closed economy and an open economy without trade costs. As MO point out, free trade is equivalent to an increase in market size. Without free trade, the cut off is always lower and such reduction depends on the magnitude of trade costs. It forces to the least productive to exit. The underlying reason is that more import competition increases the price elasticity of the residual demand of all firms. Though surviving firms are more productive (with higher markups), the average markup is reduced. In sum, the pro-competitive effect outweighs the selection effect. This result is similar to that found in Melitz (2003) but it works in a different way. In his model trade induced increased competition as consequence of more competition in the labour market. In MO model, product market competition is the only channel. Labour market does not play any role due to the elastic labour supply.

The MO model also predicts that the cutoff for exporter firms, c_X, is smaller than for domestic firms. That is, only a subset of the more productive firms export. Firms with higher cost, between c_D and c_X, only sell in the domestic market. When trade costs are symmetric, the difference of the cutoff for each country depends on the relative size. Larger countries will have a lower cutoff and, consequently, a higher average productivity, lower average markpus and prices.

2.2 Empirical approach.

Among the performance variables considered in the MO model, markup is the most difficult to approach empirically. We use the same methodology as in Moreno and Rodriguez (2004, 2010)[1], based on a structural specification which comprises a translog cost function, a price-cost margin equation and a factor share equation. However instead of our previous work where a variable cost function was specified, we assume now a long-term context where all factors are considered as variable. In this sense, the cost function is defined as follows:

$$C = C\left(P_f, Y, t\right)$$

where P_f is a vector of prices of factors (labor (X_L), intermediate inputs (X_M) and capital stock (K)) and t is a time trend which represents the state of technology. We assume that factor prices are exogenous to firms. For the empirical specification, a translog cost function is defined[2]:

$$\begin{aligned} \ln C^* = l\,n\left(\frac{C}{P_K}\right) &= \beta_0 + \beta_1 \ln Y + \beta_2 \ln\frac{P_L}{P_K} + \beta_3 \ln\frac{P_M}{P_K} + \frac{1}{2}\beta_4 \left(\ln Y\right)^2 + \beta_5 \ln Y \ln\frac{P_L}{P_K} \\ &+ \beta_6 \ln Y \ln\frac{P_M}{P_K} + \beta_7 \ln\frac{P_L}{P_K} \ln\frac{P_M}{P_K} + \frac{1}{2}\beta_8 \left(\ln\frac{P_L}{P_K}\right)^2 + \frac{1}{2}\beta_9 \left(\ln\frac{P_M}{P_K}\right)^2 + \beta_{10} t + \varepsilon \end{aligned} \tag{1}$$

In the previous specification, the restrictions corresponding to a degree one homogeneous cost function in variable input prices, P_L (labour), P_M (materials) and P_K (capital stock), have

[1] This methodology was proposed by Bernstein and Monhen (1991).
[2] We omit the subscript about firms and time for simplicity.

been imposed. Additionally, t is a time trend which represents the state of technology. With respect to the margin equation, we consider that firms sell a differentiated product in markets characterized by imperfect product competition. In this sense, the price-cost margin can be expressed, as usual, from:

$$P(1-\mu) = C' \qquad (2)$$

where C' is marginal cost, P is product price and μ is the corresponding price-cost margin[3]. Transforming the last equilibrium condition for the product market in terms of the output cost elasticities instead of marginal cost and deriving from translog cost function the output cost elasticities, the price-cost margin equation can be rewritten as follows:

$$\frac{PY}{C}(1-\mu_s+\gamma D) = \beta_1 + \beta_4 \ln Y + \beta_5 \ln\frac{P_L}{P_K} + \beta_6 \ln\frac{P_M}{P_K} + \xi \qquad \textbf{(3)}$$

where (PY/C) is the ratio of nominal sales (revenues) to cost. In (3) the margin of the firm has been parameterized to take into account the heterogeneity of firms across different industries (μ_s) and the impact of the business cycle (D). This indicator is an individual variable calculated from the information given by firms. Specifically, the firms give annual information about market served (up to five) identifying the proportion of sales in each market. They also identify the behavior of market demand during one year with respect to the previous year according to three different categories: recession, stability and expansion. We calculate an index for all markets served by the firm, weighting the values of each market by the proportion of sales in them. Besides, though labor and material cost shares are

[3] If μ is expressed in terms of the demand elasticity and conjectural variations, the equation (2) can be interpreted as the first order condition of the profit maximization.

not necessary to identify the parameters, they are also included in the set of equations for the sake of efficiency[4]:

$$\frac{P_L X_L}{C} = \beta_2 + \beta_5 \ln Y + \beta_7 \ln \frac{P_L}{P_M} + \beta_8 \ln \frac{P_L}{P_K} + \tau \qquad \textbf{(4)}$$

$$\frac{P_M X_M}{C} = \beta_3 + \beta_6 \ln Y + \beta_7 \ln \frac{P_L}{P_M} + \beta_9 \ln \frac{P_L}{P_K} + \upsilon \qquad (5)$$

The equation system to be estimated is comprised of (1), (3), (4) and (5).

3. Results.

The sample consists of an unbalanced panel of Spanish manufacturing firms (about 2,000 firms with ten or more employees) for the period 1990-2005. The variables were obtained from the Encuesta Sobre Estrategias Empresariales (ESEE), survey which is carried out yearly by the Fundacion SEPI. We exclude some firms that do not give enough information to calculate the relevant variables. It mainly affects to the capital stock and price variations (see Appendix for variable definitions). The total number of observations, after those with incomplete information were dropped, was 22,027. Descriptive statistics for all variables and sub-samples (non-exporters, entrants, exiters, switchers - firms that enter or exit more than once throughout the period - and persistent exporters) are showed in Tables A.1 and A.2 of the Appendix.

[4] We use Shephard´s lemma to derive the equilibrium conditions for input demand: $S_f = \frac{\partial \ln C}{\partial \ln P_f}$, where $S_f = \frac{P_f X_f}{C}$ is the cost share of input.

Table 1 shows the joint estimate of the translog cost function, the labor and material cost shares and the margin equation by the Generalised Method of Moments (GMM). Input prices are considered exogenous, while endogeneity in sales is assumed. The estimation is carried out by instrumenting the endogenous variables with their cross-section lagged values at t-2. The Sargan is presented at the bottom of the column and the validity of instruments is accepted. Two additional artificial dummies (Mov1 and Mov2) have been also included to control firms that have experienced mergers or scissions during the period. The time trend, whose associated parameter can be seen as technical progress, presents the expected negative sign and a reasonable value (-2.9). Industrial dummies are also jointly significant.

[Table 1]

With respect to margins, the first column in Table 1 shows the parameter μ_s, calculated as the average of a set of 14 industrial dummies. The F-test at the bottom of Table 1 confirms their significance. The parameter for firm indicator of demand evolution (*D*) presents the expected positive sign,[5] which suggests a procyclical behavior of margins. This parameter, multiplied by the average value of demand evolution, and added to the estimated parameter μ_s, allows us to obtain an average margin of 16.5% for all firms in the complete period. The estimation procedure also allows us to obtain predicted marginal costs for each firm. With respect to prices, an index has been calculated departing from firm-level price variation that the database provides. Finally, firm size has been approached using deflated sales.

The main objective is to relate these performance variables (marginal costs, prices, markups and size) with the degree of openness. As was previously pointed out, larger openness and market-size have similar results: in both cases the cutoff that determines the number of surviving firms is lower. Therefore, more openness may be associated to lower average (and

[5] An increase in this variable means an improvement in market conditions.

variance) price, cost and markups, while larger average (and variance) size is expected. Four measures are used to approach empirically the degree of openness and, indirectly, market size: the percentage of exporters (importers) with respect to all firms (PEX and PIM, respectively) and export (import) propensity (EP and IP, respectively), defined as the percentage of exports (imports) over total sales. We have calculated the average and variance of each performance variable using two-digits NACE industries. As Figure 1 indicates, those industries with a larger percentage of exporters are (as expected) also those with a larger export propensity[6].

[Figure 1]

We have calculated the average and variance of each performance variable following the industrial classification showed in Figure 1. Table 2 and 3 show the correlations between the four measures of openness and performance variables. As can be seen, the expected signs are fulfilled in all cases. Higher openness, both in terms of the percentage of exporter and importers and with respect to export and import propensity, shows lower average marginal costs and prices. However, we find weaker evidence that they are less dispersed. Additionally, as expected, more openness is positively correlated with average firm size, while the distribution is more disperse. With respect to markups, though we find the expected negative sign in average and variance, the correlation is not statistically significant. This result can be interpreted as the two expected effects of openness on markups, pro-competition and selection effect, are almost mutually cancelled.

Although the MO predictions are in terms of productivity levels, we present complementary information in the last row of Table 2 and 3 about the relationship between the growth of total factor productivity[7] and the degree of openness. As can be seen, the correlation

[6] These two measures are closely related to the usual distinction between extensive and intensive margins.
[7] See Appendix for the definition of TFP.

supports previous results with respect to marginal costs: tougher selection effect in larger markets produce stronger productivity growth.

4. Conclusions.

There is abundant evidence about the relationship between trade decisions and productivity heterogeneity among firms. This paper presents complementary results, testing the theoretical predictions developed by Melitz and Ottaviano (2008). A relevant feature of that model is that it obtains predictions about markups that, in most of the models, *a la Melitz,* have been considered as constant. The results support the hypothesis that tougher competition linked to openness (exports and imports) reduces the average of marginal costs and prices, while it increases the average firm size. However, the evidence about the effect on average markups and the dispersion of performance variables is weaker. Though the obtained signs are as expected, the inter-industry correlation is low.

Appendix: Variable definitions and descriptive statistics

C (Costs): The sum of intermediate consumption (raw materials purchases, energy and fuel costs and other external services) plus labor costs minus the stock variation plus.

$D_{it,}$ (Individual indicator of the business cycle in all markets): In the ESEE survey, each firm identifies the behavior of market demand during one year with respect to the previous years according to three different categories: recession (1), stability (2) and expansion (3). Although the original variable takes values 1, 2 and 3 in each market (up to five) where the firm sells, the index that we calculate for each firm takes are "continuous" between 1 and 3.

EP (Export propensity): Proportion of exports over total sales.

IP (Import propensity): Proportion of imports over total sales.

P_M (Price index for intermediate inputs): It is calculated as a Paasche index, weighting the price variations of raw materials, energy and services purchased of surveyed firms.

P_L (Cost per worker): Labor cost divided by the average workers of the firm during the year.

P_K (Price of capital): The user cost of capital is calculated as the long-run debt interest rate paid by the firm plus equipment good depreciation minus the rate of change of the capital goods price index.

P (Price index for output sold): The surveyed firms give annual information about markets served (up to five), identifying their relative importance (in percentage) in total sales of the firm. This information allows us to calculate a price index for all markets and for each market, using the proportions with respect to total sales as weighting.

K (Capital stock): It is net stock of capital for equipment in real terms. It is calculated by using the perpetual inventory formula:

$$K = (1-d)K_{t-1}(P_t / P_{t-1}) + I_t$$

where P is the price index for equipment, d are the rates of depreciation, and I is the investment in equipment.

TFP growth (Solow residual): It has been calculated using the Tornqvist index, $TFP = y - s_L l - s_K k - s_M m$, where y is the real output variation and the weights s are the annual cost shares of each input. The changes of labor input, intermediate consumption and capital stock are l, m and k, respectively.

Y (Output sold): It is calculated by deflating nominal sales by price (P).

Table A.1 Variable descriptive firms (logarithmic variations rates, 1991-2005)

	All firms	Non-exporters	Entrants	Exiters	Switchers	Exporters
Output (volume terms)	3.1	1.2	6.2	-1.9	3.3	3.7
Output (nominal terms)	4.6	2.8	7.8	0.0	4.7	5.0
Cost per worker (P_L)	4.8	4.6	5.4	4.9	4.7	4.9
Price index for intermediate inputs	3.3	3.7	3.4	3.2	3.4	3.0
Price of capital	-1.5	-1.6	-1.7	-1.3	-1.5	-1.4
Stock of real capital	6.2	4.7	8.9	4.7	6.9	6.1
Cost	5.2	3.6	7.8	1.5	5.7	5.5
	19244	4441	2021	660	3870	8252

Table A.2**.** Descriptive statistics across type of firms

	Non-exporters	Entrants	Exiters	Switchers	Exporters
Export ratio	0	8.9	9.0	9.1	34.7
Export ratio (only exports > 0)	0	13.96	18.9	16.5	34.7
(Observations with export > 0)	(0)	(1463)	(366)	(2430)	(9400)
Size (number of employees)	41.6	169.9	144.9	170.9	398.5
Total observations	5132	2305	768	4422	9400

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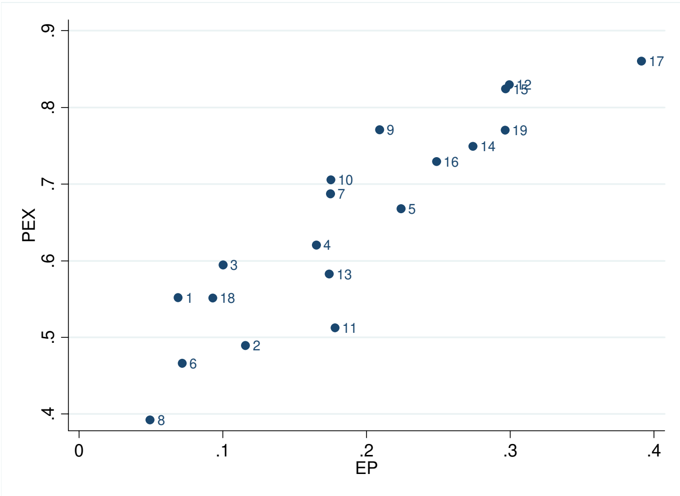
Figure 1

PEX and EP



1	Meat related products	11	Non-metal mineral products
2	Food and tobacco	12	Basic metal products
3	Beverages	13	Fabricated metal products
4	Textiles and clothing	14	Industrial and agricultural equipment
5	Leather, fur and footwear	15	Office mach., data proc., precision instr. and similar
6	Timber	16	Electric materials and accessories
7	Paper	17	Vehicles and accessories
8	Printing and publishing	18	Furniture
9	Chemicals	19	Miscellaneous
10	Plastic and rubber products		

Table 1
Cost Function, Cost Shares and Margin Equation
(Joint estimate by GMM)

	Coefficients	**t-statistics**
β_0	-1.276	-0.2
β_1	0.909	16.9
β_2	-0.102	-0.1
β_3	3.474	2.0
β_4	0.001	0.1
β_5	-0.005	-1.2
β_6	0.012	2.9
β_7	-0.221	-1.4
β_8	0.038	0.5
β_9	-0.094	-0.8
β_{10}	-0.029	-2.9
Mov1	5.912	2.2
Mov2	-7.604	-2.4
$\boldsymbol{\mu_s}$	**0.121**	**2.9**
D	**0.021**	**11.8**
Average Margin	**0.165**	**4.2**

Sargan test	13.7 (16)
Industrial dummies F-test (cost)	27.5 (19,17582)
Industrial dummies F-test (margin)	147.5 (13,17588)
Observations	17601
Years	1992-2005

- t-statistics are robust to heterocedasticity.
- In the Sargan test and industrial dummies F-test, the degrees of freedom are in parenthesis.

Table 2

Correlation between performance measures and the openness degree (export)

	PEX		EP	
	Average	Variance	Average	Variance
Marginal cost	-0.419 (0.07)	-0.176 (0.47)	-0.455 (0.05)	-0.252 (0.29)
Price	-0.437 (0.06)	-0.029 (0.90)	-0.484 (0.04)	-0.147 (0.55)
Markup	-0.044 (0.86)	-0.297 (0.22)	-0.087 (0.72)	-0.162 (0.50)
Size	0.437 (0.06)	0.411 (0.08)	0.477 (0.04)	0.407 (0.08)
Productivity (TFP)	0.624 (0.00)	-0.155 (0.53)	0.490 (0.03)	-0.062 (0.80)

Note: Standard deviations in parenthesis.

Table 3

Correlation between performance measures and the openness degree (import)

	PIM		IP	
	Average	Variance	Average	Variance
Marginal cost	-0.513 (0.02)	-0.106 (0.67)	-0.613 (0.01)	-0.102 (0.68)
Price	-0.505 (0.03)	0.014 (0.95)	-0.647 (0.00)	0.049 (0.84)
Markup	0.020 (0.93)	-0.245 (0.31)	-0.125 (0.61)	-0.184 (0.45)
Size	0.506 (0.03)	0.313 (0.13)	0.535 (0.02)	0.359 (0.13)
Productivity (TFP)	0.719 (0.00)	0.037 (0.88)	0.716 (0.00)	0.004 (0.98)

Note: Standard deviations in parenthesis.