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Endogenous Markups, Firm Productivity and International Trade: Testing Some Micro-Level Implications of the Melitz-Ottaviano Model[1]

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September 2008

Abstract

In this paper, we test key micro-level theoretical predictions of Melitz and Ottaviano (MO) (2008), a model of international trade with heterogenous firms and endogenous mark-ups. At the firm-level, the MO model predicts that: 1) firm markups are negatively related to domestic market size; 2) markups are positively related to firm productivity; 3) markups are negatively related to import penetration; 4) markups are positively related to firm export intensity and markups are higher on the export market than on the domestic ones in the presence of trade barriers and/or if competitors on the export market are less efficient than competitors on the domestic market. We estimate micro-level price cost margins (PCMs) using firm-level data extending the techniques developed by Hall (1986, 1988) and extended by Domowitz et al. (1988) and Roeger (1995) for the French manufacturing industry from 1986 to 2004. We find evidence in favor of these theoretical predictions.

Keywords: endogenous markups, export behavior, productivity, firm-level data

JEL Codes: F12, L1, E3, D24

1 Introduction

A recent literature has investigated pricing heterogeneity between firms and its implications for the measurement of total factor productivity (TFP) (see e.g. Foster, Haltiwanger and Syverson, 2008; De Loecker, 2007). An older literature has documented wide TFP dispersion even within precisely defined industries (see e.g. Bartelsman and Doms, 2000). These two facts have obvious implications for the measurement of markups and marginal cost. Yet, one topic that remains relatively understudied is how markups differ between firms within and between industries, i.e. how heterogenous are markups. Indeed, most of the literature has estimated average markups by industry without trying to control for firm-specific factors. This paper studies markup heterogeneity between firms and tries to test recent theoretical predictions using a sample of French manufacturing firms.

On the theoretical side, new models of international trade have introduced firm heterogeneity at the core of the analysis (see e.g. Melitz, 2003 and Bernard et al., 2003; see also the survey by Bernard et al., 2007). These models generally relate export behavior to productivity and "survival of the fit" in the spirit of the selection models of Jovanovic (1982) or Hopenhayn (1992). However, the first generation of models was unable to offer a satisfactory explanation of pricing differences between firms and more precisely markup heterogeneity, as they rested on extreme assumptions about the nature of competition (monopolistic competition à la Dixit-Stiglitz with no implications for markup heterogeneity, or pure Bertrand competition with limited insight on the determinants of firms' markups). A recent paper by Melitz and Ottaviano (2008) proposed a more realistic and yet tractable model relaxing these assumptions and generating a rich set of predictions.

In this paper, we test for some of these theoretical predictions which concern more specifically the determinants of firm-level markups. On that respect, the main findings of the MO model are that: 1) firm markups are negatively related to domestic market size; 2) firm markups are positively

related to firm productivity; 3) firm markups are negatively related to import penetration ratio; 4) firm markups are positively related to firm export intensity and are higher on the export market than on the domestic market in the presence of trade barriers and/or if competitors on the export market are less efficient than competitors on the domestic market. We find evidence in favor of all these theoretical predictions.

We perform this analysis by estimating price cost margins (PCMs) using firm-level data extending the techniques developed by Hall (1986, 1988) and extended by Domowitz et al. (1988) and Roeger (1995) for the French manufacturing industry from 1986 to 2004. We then relate firm PCMs to productivity and export intensity at the firm level, and to market size and import penetration ratio at the industry level.

Section 2 describes a simplified version of the Melitz and Ottaviano (MO) model which highlights its micro-level implications. Section 3 introduces the empirical model which tests for the determinants of firm markups. Section 4 describes our firm-level dataset. In Section 5, we explain how we measure the cost efficiency of the firm using TFP indexes, and we document how this measure is related to a firm export status. Section 6 presents and discusses the results of the empirical model. Section 7 concludes.

2 The Melitz-Ottaviano (MO) framework

Consider a domestic economy endowed with a labor force of size L which produce and consume both a traditional numeraire good sold on a perfectly competitive market and a manufactured good sold on a monopolistic competitive market. Both goods are also produced in the rest of the world (ROW), which for simplicity is assumed to share identical technology and preference compared to the domestic economy. The ROW is endowed with a labor force of size L^* and is homogeneously accessible at the price of a given per unit transport cost.

2.1 Demand

The focus is on the manufacturing industry that is supposed to be active both in the domestic economy and abroad so that factors returns are given. The product of the manufacturing industry is horizontally differentiated in a continuum of varieties indexed by $i \in \Omega$. As the representative consumer (both at home and abroad) is endowed with a linear utility function *à la* Ottaviano, Tabushi and Thisse (2002), the inverted demand for each variety i offered locally (whatever its origin, local or foreign) is given by:

$$p(i) = \alpha - \gamma d(i) - \eta D \qquad (1)$$

whenever demand $d(i)$ is positive.[1] In this equation, $p(i)$ is the *delivered* price of variety i sold on the local market while D is total consumption of all varieties sold on the local market. The parameter $\alpha > 0$ and $\eta > 0$ measure the degree of product differentiation between the manufactured good and the numeraire good: a larger α and a smaller η shift out the inverse demand schedule. The parameter $\gamma > 0$ measures, instead, the degree of product differentiation between the different varieties of the manufactured good: a larger γ makes the inverted demand steeper.

If $\widetilde{\Omega} \subset \Omega$ be those varieties consumed in the domestic economy, then (1) can be inverted to yield the linear market demand system for both these varieties:

$$q(i) \equiv Ld(i) = \frac{\alpha L}{\eta N + \gamma} - \frac{L}{\gamma}p(i) + \frac{\eta L}{\eta N + \gamma}\frac{L}{\gamma}\overline{p}, \forall i \in \widetilde{\Omega} \qquad (2)$$

where N is the (endogenous) measure of consumed varieties in $\widetilde{\Omega}$ and $\overline{p}$ is their average price. The set $\widetilde{\Omega}$ is the largest subset of Ω that satisfies

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[1] Recall that with a linear utility function, contrary to what happens with a CES Utility function à la Dixit-Stiglitz, marginal utilities are bounded for all goods. A consumer may thus not have positive demand for any particular good. We assume that consumers have positive demands for the numeraire good.

$$p(i) \leq \frac{1}{\eta N + \gamma}(\gamma\alpha + \eta N\overline{p}) \equiv p_{max} \tag{3}$$

The price bound, p_{max} represents the price at which demand for a variety is driven to 0.[2] In contrast with the case of CES demand, the price elasticity of demand $\epsilon_i = [(p_{max}/p(i)) - 1]^{-1}$, is not uniquely determined by the degree of product differentiation γ. Given the latter, and all else equal, a lower average price $\overline{p}$ or a larger number of competing varieties N induces a decrease in the price bound p_{max} and an increase in the price elasticity of demand ϵ_i at any given $p(i)$. MO characterize this as a "tougher" competitive environment.

Note also that given the toughness of the competitive environment (i.e given $\overline{p}$ and N), the price elasticity ϵ_i monotonically increases with the price $p(i)$ along the demand curve. This means that, all else equal, firms which charge higher price, will also tend to set lower mark-up.

2.2 Supply

The N varieties consumed by the residents of the domestic economy may be supplied both by domestic firms and by exporters located abroad. The market structure is monopolistic competitive and each variety is supplied by one and only one firm. Within the manufacturing sector, firm heterogeneity is introduced by modeling entry as a research and development process with uncertain outcome. In particular, each entrant has to invent its own variety and a corresponding production process by making an irreversible investment f in terms of labor[3]. The firm does not know, however, its TFP and thus nor its marginal cost of production c as these are randomly determined only

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[2]Note that (1) implies $p_{max} < \alpha$.

[3]To be closer to the empirical implementation which follows, we could alternatively assume that the fixed cost is payed in terms of labor, capital (and intermediate input) and that all firms produce with a Cobb-Douglas technology under constant returns to scale. Introducing capital in the MO model would not change any of its insights as long as capital is immobile internationally and owned by workers, each of them holding a balanced portfolio, so that they are only interested in expected returns (this argument is borrowed to Corcos et al., 2007)

after f has been sunk. Uncertainty is modeled as a draw from a common and known distribution $G(c)$.

The local and foreign markets are segmented. Nevertheless, firms can produce in one market and sell in another by incurring a per-unit trade cost[4]. The overall cost of a delivered unit with cost c from the domestic economy to the foreign market is $\tau^* c$ with $\tau^* > 1$, where $(\tau^* - 1)c$ is the frictional trade cost. Reciprocally, the overall cost of a delivered unit with cost c from the foreign economy to the domestic market is τc with $\tau > 1$. Thus, countries are allowed to differ according to their barriers to imports, τ and τ^* respectively for the domestic and the foreign economy.

Since the entry cost is sunk, only entrants that can cover their marginal cost survive and produce. All other entrants exit without even starting production. Survivors maximize their profits facing the demand function (2). Under monopolistic competition, given the absence of strategic behavior, it is assumed that firms take the average price level $\overline{p}$ and the number of firms N as given. Let $p^*(c)$ and $q^*(c)$ denote the levels of the profit maximizing price and quantity *delivered* for a domestic firm with cost c selling abroad. Since we assume that that markets are segmented and production faces constant returns to scale, firms independently maximize the profit earned from domestic and foreign sales. Let $\pi(c)$ and $\pi^*(c)$ denote the maximized value or profits earned by a firm of cost efficiency c on the domestic and foreign markets respectively. Then, the profit maximizing prices and output levels on each market separately must satisfy

$$\begin{cases} \pi(c) = [p(c) - c]q(c) \quad \text{and} \quad q(c) = \frac{L}{\gamma}[p(c) - c] \\ \pi^*(c) = [p^*(c) - \tau^* c]q^*(c) \quad \text{and} \quad q^*(c) = \frac{L^*}{\gamma}[p^*(c) - \tau^* c] \end{cases}$$

where L^* is the size of the foreign market.

Only firms earning non-negative profits in a market will choose to serve

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[4]In a model with bounded marginal utility, per-unit costs alone are enough to induce selection into export markets. This is the reason why MO prefer not to add fixed export costs (despite their empirical relevance) in order to keep the tractability of their model.

that market. This means that firms which sell both on the domestic market and on the foreign ones (i.e. exporting firms) face a different cutoff rule on each market they are selling to. Let c_D and c_X denote the upper bound exclusive of trade costs, respectively for domestic firms selling at home and for domestic firms selling abroad. Recalling (3), these (endogenous) cost cutoffs must then satisfy:

$$\begin{cases} c_D = sup\{c : \pi(c) > 0\} = p_{max}, \\ c_X = sup\{c : \pi^*(c) > 0\} = \dfrac{p^*_{max}}{\tau^*}, \end{cases} \quad (4)$$

where p^*_{max} is the upper bound price on the foreign market. All else equal, (4) implies that the cost cutoff is higher for domestic firms on the home market than for domestic firms on the export market.

Implications on firm-level performance variables

The cost cutoffs summarized all the effects of market conditions which are relevant for firm performance. In particular, the optimal price and output levels of a domestic firms of cost efficiency c, can be written as:

$$\begin{cases} p(c) = \frac{1}{2}(c_D + c), & q(c) = \frac{L}{2\gamma}(c_D - c) \\ p^*(c) = \frac{\tau^*}{2}(c^*_X + c), & q^*(c) = \frac{L}{2\gamma}\tau^*(c_X - c) \end{cases} \quad (5)$$

respectively in the domestic market and in the foreign ones. They yield the following maximized operating profit levels:

$$\begin{cases} \pi(c) = \frac{L}{4\gamma}(c_D - c)^2 \\ \pi^*(c) = \frac{L}{4\gamma}\tau^2(c_X - c)^2 \end{cases} \quad (6)$$

with markups

$$\begin{cases} \mu(c) = p(c) - c = \frac{1}{2}(c_D - c) \\ \mu^*(c) = p^*(c) - c = \frac{\tau^*}{2}(c_X) - (1 - \frac{\tau^*}{2})c \end{cases} \quad (7)$$

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Eq. (7) has three straightforward implications about the determinants of firm markups.

1) *Firm mark-ups are positively related to firm productivity.* All else equal, firms with lower costs are able to set higher mark-ups as they do not pass all of the cost differential to consumers in the form of lower prices[5].

2) *Firm mark-ups are negatively related to domestic market size* as a larger domestic market size lowers the cost cutoff on the home market c_D. This implication arises because in the presence of trade costs, the *domestic* size of an *open* economy still play an important role in determining the firm performance measure (including mark-up).

3) *All else equal, firms charge higher mark-ups on foreign markets than on domestic markets because of the presence of trade costs.* Indeed, it can easily be shown that, for equal competition toughness and production technology in the domestic and foreign economies[6], Eq. (7) with positive trade cost, $\tau^* > 1$, implies $\mu^*(c) > \mu(c)$.

Because of the presence of barriers to imports in the foreign economy, domestic exporting firms charge higher mark-up on the products they export. This allows them to recover their additional frictional transport cost. In addition, the mark-up premium that a firm sets on its export markets, also depends on its relative efficiency compared to foreign competitors. For instance, suppose that foreign firms are on average more efficient than domestic firms, then two counterbalancing forces will play. On the one hand, the (domestic) exporting firms tend to charge higher mark-ups on their export markets (compared to the domestic market) in order to cover the additional transport costs. On the other hand, they tend to charge lower mark-ups in order to remain competitive relative to the more efficient foreign competitors.

All in all, the average mark-up denoted $\tilde{\mu}(c)$, of a a domestic firm with

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[5]This feature is shared by others models of international trade with heterogeneous such as BJEK (2003) and Asplund and Nocke (2006).

[6]So that $c_X = c_D/\tau^*$

cost c can be written:

$$\tilde{\mu}(c) = (1 - \theta(c)) \, \mu(c) + \theta(c)\mu^*(c) \qquad (8)$$

where $\theta(c)$ is the export intensity (i.e. the value of exports on sales) of a firm of cost c[7].

Accordingly, the MO model yields the following testable implications about $\tilde{\mu}(c)$:

Testable implication (1): The average mark-up of a domestic firm is an increasing function of its productivity level $(1/c)$ and of the degree of its involvement on export markets $(\theta(c))$ and a decreasing function of the size of its domestic market (L).

Testable implication (2): The mark-up premium of an exporting firms relative to its non-exporting counterparts, is an increasing function of the level of trade costs (τ^*) and a decreasing function of the average technology gap between domestic and foreign competitors.

2.3   Equilibrium

To obtain closed form expressions for equilibrium values, MO propose to rely on a specific parametrization for the distribution of cost draws $G(c)$. They assume that productivity draws follow a Pareto distribution with a lower productivity bound $1/c_M$ and shape parameter $k \geq 1$ [8]. This implies a distribution of cost draws c given by

$$G(c) = \left(\frac{c}{c_M} \right)^k, \qquad c \in [0, c_M] \qquad (9)$$

The Pareto distribution is robust to truncation and multiplication. Therefore, the costs for domestic firms that produce for the domestic market or that export (inclusive of trade costs), both follow the same distribution function

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[7]Recall that $\theta(c)$ will take the null value for all firm with cost c below c_x.

[8]Del Gatto, Mion and Ottaviano (2006) provide some empirical support to this specification

of parameter k. Given this distributional assumption, MO are able to derive the equilibrium values both for the short-run (i.e. for given firms location) and for the long-run (for endogenously determined firms location)[9].

In the short run equilibrium, firms only decide whether to produce or not and which markets to supply, bearing in mind that exports incur transport costs. High cost firms decide not to produce but do not relocate. The lowest cost firms produce for both domestic and export markets, and an intermediate group of firms produce only for the domestic market. Given the Pareto distributional assumption, and given that the number of firms located in each economy, $\tilde{N}_{SR}$ and $\tilde{N}_{SR}^*$, is fixed, the fact that only firms with $c < c_D$ ($c < c_D^*$ abroad) choose to produce, implies that the number of firms active in each market is given by:

$$N = \tilde{N}_{SR} \left(\frac{c_D}{c_M} \right)^k + \tilde{N}^*{}_{SR} \frac{1}{\tau^k} \left(\frac{c_D}{c_M^*} \right)^k \tag{10}$$

$$N^* = \tilde{N}^*{}_{SR} \left(\frac{c_D^*}{c_M^*} \right)^k + \tilde{N}^*{}_{SR} \frac{1}{(\tau^*)^k} \left(\frac{c_D^*}{c_M} \right)^k \tag{11}$$

The higher the threshold level of costs, c_D, the larger the number of firms (both domestically located and exporters) that decide to produce. Moreover, the level of transport costs impact the production decisions of firms and shift the relation between N and c_D. For a given level of c_D, a fall in transport costs τ, means more foreign firms selling to the domestic market, an increase in imports and a rise in N [10]. This rise in N implies lowers prices and lower markups for domestically located firms. In the short-run then, trade

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[9]For a full description of the properties of each of these equilibria, we refer the interested reader to the original MO (2008) paper and also to Chen, Imbs and Scott (2006) which provide a nice graphical approach of the differentiated short run and long-run results in the MO framework. Here, we keep the exposition succinct as we simply want to emphasize the key features of the MO model which underpin a relation between the degree of trade openness of a country and its distribution of firm markups.

[10]Actually, a net increase in N arises even through some less efficient domestically producing firms are displaced by foreign exports.

liberalization, through a decrease in τ and an increase in import penetration has standard pro-competitive effect.

In the long-run, entry is unrestricted in both countries. Firms can decide to relocate elsewhere simply by incurring the fixed entry cost f [11]. Letting N_{LR} and N_{LR}^* denote the endogenous long-run equilibrium number of firms located in each country, then 10 and 11 rewrite straightforwardly as

$$N = N_{LR}\left(\frac{c_D}{c_M}\right)^k + N_{LR}^* \frac{1}{\tau^k}\left(\frac{c_D}{c_M^*}\right)^k \tag{12}$$

$$N^* = N_{LR}^*\left(\frac{c_D^*}{c_M^*}\right)^k + N_{LR}^* \frac{1}{(\tau^*)^k}\left(\frac{c_D^*}{c_M}\right)^k \tag{13}$$

Under the Pareto distributional assumption, zero expected profit conditions in both economies pin down closed form solutions for N_{LR} and N_{LR}^*. Recall that $c_X = c_D^*/\tau^*$. From the free entry conditions, one can obtain the following expressions for the cut-off cost levels in the domestic and foreign market respectively:

$$\begin{cases} c_D = \left[\dfrac{\gamma\phi}{L}\dfrac{1-\rho^*}{1-\rho\rho^*}\right]^{(1/(k+2))} \\[4mm] c_X = c_D^*/\tau = \left[\dfrac{\gamma\phi}{L}\dfrac{1-\rho}{1-\rho^*\rho}\right]^{(1/(k+2))} \end{cases} \tag{14}$$

where $\phi \equiv 2(k+1)(k+2)(c_M)^k f$ is a technology index that combines the effects of better distribution of cost draws (lower c_M) and lower entry costs f, and $\rho \equiv \tau^{(-k)}$ is an inverse measure of trade costs (the "freeness" of trade).

Note that because of endogenous entry and exit, there is no longer a direct relationship between c_D and N. Instead the marginal level of costs is pinned

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[11]Recall that we assume no technology difference between the domestic and foreign economy so that both economies share the same cost distribution $G(c)$ with upper bound $c_M = c_M{}^*$ and the same fixed entry cost into manufacturing, f).

down by the distribution of costs (c_M), the level of fixed costs, f, market size (L) and trade costs.

Equations (14) are key to understand how trade liberalization impacts the distribution of firm mark-ups in a given economy. Specifically, they show that trade liberalization has *anti*-competitive effect in the long-run despite its pro-competitive impact in the short-run. To see that, consider an unilateral trade liberalization which reduces the barrier to imports, τ, in the domestic economy while their foreign counterparts, τ^*, remain constant. This asymmetric liberalization leads to an upward shift in marginal costs. In equilibrium, N falls and c_D rises, which implies higher mark-ups. In other words, with exogenous relocation costs, f, the long-run impact of falling trade costs is the exact opposite of the short-run. In the long-run firms respond to increase competition by relocating to more protected markets overseas, as the fall in transport costs makes it more viable to serve the domestic market through exports from there[12].

Only bilateral trade liberalizations, i.e. symmetric decreases in the barriers to imports of the domestic and foreign economies, induce long-run pro-competitive effects. This can easily be shown assuming that trade costs are identical, $\tau^* = \tau$, and analyzing the effects of a decrease in τ (increase in $\rho = \rho^*$). In this case, the equilibrium cut-off condition (14) can be written:

$$
\begin{cases}
c_D = \left[\dfrac{\gamma\phi}{L(1+\rho)} \right]^{(1/(k+2))} \\[2em]
c_X = c_D^*/\tau = \left[\dfrac{\gamma\phi}{L^*(1+\rho)} \right]^{(1/(k+2))}
\end{cases}
\tag{15}
$$

Equations (15) show that bilateral liberalization has a long-run pro-competitive impact in increasing competition in both markets, leading to

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[12]Chen, Imbs and Scott (2006) emphasize that the long-run anti-competitive effects can be reversed in the MO framework only if the fixed entry costs are assumed to decrease with trade liberalization. They show that in this case the overall effect of trade liberalization becomes ambiguous and depends on whether the pro-competitive consequences of lower entry costs offset the anti-competitive impact of relocation to protected market.

proportional changes in cut-offs and hence a decrease in the average firm mark-up both in the domestic and in the foreign economies[13].

All in all, we can derive the following testable implication on the relation between trade liberalization and the distribution of firm markups:

- **Testable implication (3)** : Firm mark-ups are negatively related to the degree of trade openness (through import penetration) only if trade liberalization is bilateral or if relocations have not yet occurred (i.e. in the short-run). Otherwise, firm-level mark-ups should be *positively* impacted by the degree of trade openness.

In the next section, we develop the empirical model that allows us to test for implications (1) to (3).

3   The Empirical Model

The methodology used to estimate markups follows the standard approach proposed by Hall (1986), and revised by Domowitz et al. (1988) and Roeger (1995). Assume a standard production function $Q_{it} = \Theta_{it} F(N_{it}, K_{it}, M_{it})$ where i is the firm index, t a time index, Θ_{it} is the level of productivity, N is labor, K is capital and M is material input. Under imperfect competition in the final good market (but perfect competition in the input markets), Hall (1986) shows that the growth rate of output can be decomposed as:

$$\frac{\Delta Q_{it}}{Q_{it}} = \mu_{it} \left(\alpha_{Nit} \frac{\Delta N_{it}}{N_{it}} + \alpha_{Kit} \frac{\Delta K_{it}}{K_{it}} + \alpha_{Mit} \frac{\Delta M_{it}}{M_{it}} \right) + \vartheta_{it} \qquad (16)$$

where $\alpha_{Jit} = \frac{P_{Jit} J_{it}}{P_{it} Q_{it}}$ $(J = N, K, M)$ is the share of inputs in turnover and $\vartheta_{it} = \frac{\Delta \Theta_{it}}{\Theta_{it}}$ and where $\mu = \frac{p}{c}$ is the markup of price over marginal cost.

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[13]The selection effect through which trade liberalization drives out of the market the least productive firms in both economies is not strong enough to reverse the overall negative impact on mark-ups. Bilateral liberalization has then an unambiguous pro-competitive impact in the long-run.

Assuming constant returns to scale, another way to write it is:

$$\frac{\Delta Q_{it}}{Q_{it}} - \alpha_{Nit}\frac{\Delta N_{it}}{N_{it}} - \alpha_{Mit}\frac{\Delta M_{it}}{M_{it}} - (1 - \alpha_{Nit} - \alpha_{Mit})\frac{\Delta K_{it}}{K_{it}} \quad (17)$$
$$= \beta_{it}\left(\frac{\Delta Q_{it}}{Q_{it}} - \frac{\Delta K_{it}}{K_{it}}\right) + (1 - \beta_{it})\vartheta_{it}$$

where $\beta = \frac{p-c}{p} = 1 - \frac{1}{\mu}$ is the price cost margin or Lerner index.

A common problem in this literature stems from the fact that the choice of inputs is probably correlated with TFP (reminiscent of the production function estimation, see e.g. Marschak and Andrews, 1944). There are various ways to deal with this problem. Most studies use some kind of instrumental variables. A more recent alternative is to use a control function approach (see De Loecker and Warzynski, 2008). In this paper, we follow Roeger (1995) who solves this issue elegantly using the properties of the dual Solow residual under imperfect competition. He derives a similar expression for the price based, or dual, Solow residual:

$$\alpha_{Nit}\frac{\Delta P_{Nit}}{P_{Nit}} + \alpha_{Mit}\frac{\Delta P_{Mit}}{P_{Mit}} + (1 - \alpha_{Nit} - \alpha_{Mit})\frac{\Delta P_{Kit}}{P_{Kit}} - \frac{\Delta P_{it}}{P_{it}} \quad (18)$$
$$= -\beta_{it}\left(\frac{\Delta P_{it}}{P_{it}} - \frac{\Delta P_{Kit}}{P_{Kit}}\right) + (1 - \beta_{it})\vartheta_{it}$$

Then substracting (3) from (2) we get:

$$\left(\frac{\Delta Q_{it}}{Q_{it}} + \frac{\Delta P_{it}}{P_{it}}\right) - \alpha_{Nit}\left(\frac{\Delta N_{it}}{N_{it}} + \frac{\Delta P_{Nit}}{P_{Nit}}\right) - \alpha_{Mit}\left(\frac{\Delta M_{it}}{M_{it}} + \frac{\Delta P_{Mit}}{P_{Mit}}\right)$$
$$- (1 - \alpha_{Nit} - \alpha_{Mit})\left(\frac{\Delta K_{it}}{K_{it}} + \frac{\Delta P_{Kit}}{P_{Kit}}\right)$$
$$= \beta_{it}\left[\left(\frac{\Delta Q_{it}}{Q_{it}} + \frac{\Delta P_{it}}{P_{it}}\right) - \left(\frac{\Delta K_{it}}{K_{it}} + \frac{\Delta P_{Kit}}{P_{Kit}}\right)\right] + u_{it} \quad (19)$$

where P_K is the user cost of capital, defined as:

$$P_{Kit} = R_{it} = P_I\frac{r + \delta_{it}}{1 - t}$$

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where δ_{it} is the firm-specific depreciation rate, P_I is the index of investment goods prices, r is the real interest rate and t is corporate taxation. P_I, r and t are at the country level and time varying.

Rewriting the left hand side as Δy and the right hand side as Δx, one obtains a very simple and flexible equation:

$$\Delta y_{it} = \beta_{it} \Delta x_{it} + u_{it} \tag{20}$$

Most studies in this literature simply assume that β_{it} takes the same value for a subset of firms, typically within a single industry and for a given period. In other words, they estimate an average markup for the subset and period considered. We start our empirical analysis by assuming a constant markup for all firms for a given year, therefore estimating the following Eq:

$$\Delta y_{it} = \beta_t \Delta x_{it} + u_{it} \tag{21}$$

One policy question we might want to answer with this is what was the average response of firms as a consequence of a major competitive shock, like the implementation of the Single Market Program (see Bottasso and Sembenelli, 2001; Warzynski, 2002; Siotis, 2003; or Görg and Warzynski, 2006).

An alternative strategy could be to estimate average markups by industry over the period (β_j), or possibly by year (β_{jt}). Another possibility would be to estimate an average firm-specific markup (see e.g. Dobbelaere and Mairesse, 2008), at the price of losing the time dimension.

To further investigate markup heterogeneity within industry, we also run quantile regressions, and look at the evolution of the markup distribution.

Finally, we adopt yet another strategy. In later sections of the paper, as suggested by the MO model, we allow β_{it} to vary according to some firm-level and time variant characteristics[14]: the exporting status of the firm

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[14]Konings, Van Cayseele and Warzynski (2005) looked at the effect of ownership on markups and found that foreign and private domestic firms had higher markups than state firms. However, most of the other variables used in the analysis were at the sector

(measured by the export intensity at the firm level, $EI_{it} = EXP_{it}/Sales_{it}$) and firm productivity (measured by firm level TFP, TFP_{it}).

We also look at the relationship between the markup and some sector-specific variables, such as the size of the market (measured by the log of the sum of industrial sales and imports, MS_{jt}) and the import penetration ratio (measured at the industry level, $IPR_{jt} = Imports_{jt}/(Sales_{jt} + Imports_{jt} - Exports_{jt})$)

We also control for the business cycle by including various measures of economic activity. First, game theoretical models have provided two contradicting theories of cyclical pricing behavior. According to Green-Porter, PCMs are procyclical because collusion is less sustainable in recessions than in booms; Rotemberg-Saloner argue the opposite. Both models are equally plausible and therefore, ultimately, the answer to this question is an empirical one. We test the effect of the cyclicality by interacting our Δx variable with the growth of real GDP, as a conjectural indicator. Second, we try to detect a "switch of regime" in our period of analysis by comparing price cost margins before and after 1992 (see Görg and Warzynski, 2003; Bellone et al., 2007). We interact Δx with a "post 1992" dummy equal to 1 if $t \geq 1992$ and 0 otherwise.

Our final specification is therefore:

$$
\begin{aligned}
\Delta y_{it} &= \beta_0 \Delta x_{it} + \beta_1 \Delta x_{it} * EI_{it} + \beta_2 \Delta x_{it} * MS_{jt} + \beta_3 \Delta x_{it} * IPR_{jt} \quad (22)\\
&\quad + \beta_4 \Delta x_{it} * TFP_{it} + \beta_5 \Delta x_{it} * \Delta GDP_t + \beta_6 \Delta x_{it} * POST92
\end{aligned}
$$

As discussed in the previous section, a positive coefficient for β_1 could imply either that firms have to recover their transport costs, or that the efficiency of domestic producers on the markets where French firms export is lower on average. Therefore, we try to distinguish between these two sources in our analysis by looking at the role of the average distance where firms export in a specific sector, and the relative efficiency of firms in the sector where they export (the next section explains how we computed these

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level.

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two variables). That is, we run the following regression only for firms that export:

$$
\begin{aligned}
\Delta y_{it} = & \beta_0 \Delta x_{it} + \beta_1 \Delta x_{it} * \log Dist_{jt} + \beta_2 \Delta x_{it} * Eff_{jt} \qquad (23) \\
& + \beta_3 \Delta x_{it} * IPR_{jt} + \beta_4 \Delta x_{it} * TFP_{it} \\
& + \beta_5 \Delta x_{it} * \Delta GDP_t + \beta_6 \Delta x_{it} * POST92
\end{aligned}
$$

4 Data

4.1 Firm-Level Data

We use a firm level dataset collected by the French Ministry of Industry (SESSI), the French Manufacturing Census (known as EAE), constructed from a survey providing information on the financial statements and balance sheets of all manufacturing firms with at least 20 employees. This dataset covers about 23,000 firms by year over the period from 1984 to 2004. Those firms represent only 25% of all manufacturing firms in France but account for 75% of employment and 80% of value added in French manufacturing. The data contains information about nominal gross output, a series of inputs (such as number of employees, intermediates inputs, investments, etc.), and also exports.

[Table 1 about here.]

Table 1 summarizes basic information about the export behaviour of French firms. It displays the number of all manufacturing firms, and the percentage of exporting firms, i.e. the participation rate, by sector at the 2-digit level. It also displays export-to-sales ratios, i.e. export intensities, at both industry and firm levels[15]. The last column presents the size of ex-

---

[15]The export intensity of the industry is calculated by summing sales and exports for all manufacturing firms and then computing the ratio at the industry level. The export intensity at firm level is the result of computing the ratio of export over sales for every firm and then computing the arithmetic average for exporting firms only.

porting relative to non exporting firms. We can see that in all manufacturing sectors, there is a substantial number of firms (73%) engaged in foreign trade, suggesting that exporting and non exporting firms coexist in all types of productive activities[16]. Second, the arithmetic mean of firm export intensity is half that for sector export intensity for all manufacturing, implying that large firms export a larger share of their production[17].

[Table 2 around here]

In order to document further the difference of export behavior between large and small firms, Table 2 below reports mean export intensity and participation rate by size of firms. It is notable that the export-to-sales ratio of small firms is less than half that of larger firms (16.3% versus 34.4%). Moreover, the gap in the participation rates of small and large firms increases with the export-to-sales threshold. Whereas almost all large firms participate in international trade, only 60% of small firms are active in foreign markets. This gap widens as the minimum threshold of export intensity increases. For example, we find that 75% of very large firms export at least 10% of their sales. This ratio is three times larger than that for small firms.

4.2 Sector-Level Data

At the sector level, we obtained data on imports and production at the 4-digit NACE Rev. 1 (or NAF700) from Eurostat Prodcom, Comext and the Structural Business Statistics. We also obtained data on the import price

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[16]We computed the participation rate for manufacturing sectors at the 4 digit level, which yielded more than 286 subsectors. No subsector was exclusively focused on the domestic market, and very few (less than 5) were solely engaged in exporting. We found that for most subsectors (266) the participation rate was higher than 50%.

[17]Note that the broad picture conceals important sectoral differences. The size gap between exporters and non-exporters is particularly pronounced in sectors such as Automobiles, Transportation Machinery, Electrical and electronic components, and Electrical and electronic equipment. By contrast, in Pharmaceuticals where almost all firms (92%) participate in international trade, the average value of firm export intensity approaches sector export intensity.

index, the export price index and the production price index at the 4-digit NACE Rev. 1 or NAF700 from INSEE.

Ideally, to understand the link between markups and exporting activity, we would like to know how costly it is to export goods, and how efficient are firms in the domestic market where firms export. Unfortunately, our database does not provide information about firm-level destination of exports. Therefore, we need to use sector-specific proxies. We use the database from CEPII[18] to construct two indices: the first one measures the average relative efficiency of firms in the country n where French firms from sector j export. This is measured as the relative labor productivy of French firms weighted by the share of the country in total export s_{njt}:

$$Eff_{jt} = \sum_n s_{njt} \log \left(\frac{GDP_F}{GDP_n} \right)$$

The second proxy follows a similar measure for the average distance where French firms from sector j export:

$$Dist_{jt} = \sum_n s_{njt} Dist_{F-n}$$

where $Dist_{F-n}$ is the average distance between Paris and the capital of the country where firms export.

These proxies are obviously rather rough but are a first try to distinguish between the cost and efficiency explanations. There are also other strategic motives that might explain markup differences between countries, such as different marketing strategies, taste differences, different competitive structures, etc...

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[18]Data are available at the 4-digit ISIC level and are then associated to the corresponding NAF700, the Franch equivalent of NACE Rev. 1.

5 Computing TFP and measuring export premia

5.1 Relative TFP Index: Growth-Accounting

The most standard method to construct TFP is based on computation techniques (see e.g. Caves et al., 1982 or Good et al., 1997; for recent applications, see Syverson, 2004 and Hortacsu and Syverson, 2007).

We use the following computation:

$$
\begin{aligned}
\ln TFP_{it} \;=\; & \ln Y_{it} - \overline{\ln Y_t} + \sum_{\tau=2}^{t} \left(\overline{\ln Y_\tau} - \overline{\ln Y_{\tau-1}} \right) \\
& - \sum_{n=1}^{N} \frac{1}{2} \left(s_{nit} - \overline{s}_{nt} \right) \left(\ln X_{nit} - \overline{\ln X}_{nt} \right) \\
& - \sum_{\tau=2}^{t} \sum_{n=1}^{N} \frac{1}{2} \left(\overline{s}_{n\tau} - \overline{s}_{n(\tau-1)} \right) \left(\overline{\ln X}_{n\tau} - \overline{\ln X}_{n(\tau-1)} \right)
\end{aligned}
$$

where Y_{it} denotes real gross output produced by firm i at time t using the set of n inputs X_{it}^n, where input X is alternatively capital stocks (K), labour in terms of hours worked (L) and intermediate inputs (M). s_{nit} is the cost share of input X_{nit} in the total cost (Appendix A provides a full description of the variables). Subscripts τ and n are indices for time and inputs, respectively. Symbols with upper bars correspond to measures for the reference point (the hypothetical firm), computed as the means of the corresponding firm level variables, over all firms in year t. This definition implies that references points $\overline{\ln Y}$ and $\overline{\ln X}$ are the geometric means of the firm's output quantities and input quantities respectively, whereas the cost shares of inputs for representative firms $\overline{s}$ are computed as the arithmetic mean of the cost share of all firms in the dataset.

Aw et al. (2000) and Delgado et al. (2002) also use this methodology in the export-productivity literature. It facilitates comparisons within firm-level panel data sets across industries as it guarantees the transitivity of

any comparison between two firm-year observations in expressing each firm's input and output as deviations from a single reference point. Moreover, the index measures the proportional difference in the TFP of any firm i against the reference firm. This latter is computed once for the whole sample, implying that productivity measures at firm level also embody productivity differences across sectors. Lastly, first-differencing the logarithmic values of TFP measures can be interpreted as gaps in percentage points if they remain small.

5.2 Export Premia

Export premia are defined here as systematic differences in *some* characteristics of exporting firms compared to non-exporting ones, that are over and above mere industry effects, year specific effects or cohort effects. Specifically, we look at a series of variables X_{it}, where subscripts i and t stand for firm i at time t, X is alternatively Output (Y), Labour (L), labour productivity (Y/L), capital intensity and wage per employees (these variables are fully described in Appendix A). We subtract from all X_{it} the industry fixed effect s_j, a year fixed effect d_t and cohort fixed effect v_c in order to obtain $X'_{it} = X_{it} - s_j - d_t - v_c$, where all fixed effect are defined as differences of group means from overall sample mean. Table 3 presents the results for all firms and each size class, together with the mean number of (non-) exporting firms per year. All reported values for firm characteristics are expressed relative to non-exporting firms.[19]

[Table 3 about here.]

For the whole sample of firms, Table 3 reveals a strong export *premium* for the five characteristics: relative to non-exporting firms, exporters produce 2.5 times more, are twice as large, are 40% more labour-productive, are 24%

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[19]Relative values for the export *premium* are computed as the ratio of the mean value of exporting firms ($\overline{X'_E}$) over non-exporting firms ($\overline{X'_{NE}}$), multiplied by a 100.

more capital intensive, and pay their employees 10% more. Moreover, in line with the literature, we find that *export premia* do not disappear in more narrowly defined size-classes of firms. Within each of our four size-classes, the average French exporter displays a labour productivity advantage of around 30%. The TFP advantage is less pronounced but still significant(around 4.2% for the whole sample of firms). The TFP premium does not disseapar for the samples of small and medium size firms. However, it decreases to 1.3% for the sample of large firms. Finally, the TFP premium becomes slightly albeit significantly negative for the sample of large firms.

5.3   More Structural Techniques

To test the robustness of the relationship between the markup and TFP, we also estimated TFP using Olley and Pakes (1996), Levinsohn and Petrin (2003) and Ackerberg, Caves and Frazier (2008). This methodology extracts the residual from the estimation of a production function that controls for the endogeneity of inputs (see Konings and Vandenbussche, 2005, De Loecker, 2007 and Amiti and Konings, 2007 for recent applications to international trade).

6   Results

We start our analysis by looking at the average markup. Figure 1 shows the evolution of the markup. We notice a sharp decline in the average markup, especially after 1992. While this might be interpreted maybe too hastily as a pro-competitive effect of the SMP, this might also be a result of other endogenous factors. This is what we investigate below.

<Insert Figure 1 around here>

The second step is to try to capture the heterogeneity within industry. To do this, we estimate Eq. (15) at each percentile of the distribution for various

subsets (the whole manufacturing industry, and the 14 2-digit undustries) for two different periods: 1990-1995, and 1999-2004. We then take a kernel density of our estimates and look at the evolution of the distribution of our estimates. We observe a general switch to the left of the distribution from 1990-1995 (dashed line) to 1999-2004 (solid line). The next step is to try to understand which factors have contributed to this evolution.

<Insert Figure 2 around here>

We next turn to our main specification when we analyse the effect of firm-specific variables on the markup. Table 4 shows the estimates obtained from the regression of Eq. (17). The results confirm the theoretical predictions from the MO model. First, we see that markups are positively related to total factor productivity. This suggest that more efficient firms are able to extract a rent from being more efficient than their competitors. Column 1 shows the results using our productivity index, while column 2 uses the Olley and Pakes productivity measure. We can see that results are qualitatively similar. Firms' markups are also negatively related to market size. As suggested by the model, there are more firms in larger markets and competition and selection leads to lower prices. Import penetration is also related to lower average markups, as a consequence of more competition, although more productive firms are also more likely to survive. Finally, we see that firms involved in exporting activities have a higher markup as well. There are various ways to interpret this coefficient. First, it means that firms involved in exporting behavior have on average an higher markup than firms that do not export (see also Görg and Warzynski, 2003; and De Loecker and Warzynski, 2008) even controlling for productivity. Second, it also means that the markup on foreign markets is higher than on the domestic market. Indeed, when we only look at the subsample of exporting firms (column 3), the coefficient is still positive, suggesting that exporting intensity (the share of output that is exported) contributes to an increase in the markup as compared to the average domestic markup. The MO model suggests this would be the case if

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there are trade costs that need to be recovered by the firm, or if exporting firms are more efficient than domestic firms on their export markets. We do not find any significant effect of the business cycle on markups. However, when we control for a potential pro-competitive effect of the Single Market Program by adding an interactive dummy Post1992, we find a significant and quite sizeable negative effect, in line with what we observed on Figure 1.

[Table 4 about here.]

We also tried to better understand the link between export intensity and the markup by looking at the effect of the average distance of exports and the average efficiency in the industry in the country where French firms export. We ran our analysis by sector. In most cases, our two variables were not significantly related to the markup. However, in those industries where they were, the relationship was positive, as predicted by the MO model. Only for sector F3, Wood and Paper, do we find a negative relationship with our two variables. This is probably due to the lack of variation in our dataset for this sector, as most French firms in the wood and paper industry only export to neighboring countries.

7   Conclusion

In this paper, we tested important empirical predictions from a recent new international trade model regarding the link between international trade behavior and firms' markups. Our empirical exercise using a rich firm-level panel from French manufacturing over a long period confirmed most of these predictions: markups are higher for more productive firms; markups are lower in larger markets; markups are lower on average in industries with more import penetration; and markups are higher for exporting firms. This last result could be interpreted as the consequence of transportation, costs that need to be recovered, or as a consequence of a competitive advantage of French firms as compared to domestic firms on the export market. Our

preliminary analysis confirms these predictions for some industries. However, more work has to be done in that direction, in particular by improving our variables of sector specific distance and relative efficiency. The availability of information on export destination at the firm level in particular could improve our understanding of the export premium for the markup. We leave the study of these alternative explanations for future work.

References

[1] Bellone, F., Musso, P., Nesta, L. and Warzynski, F., 2008. La dynamique des taux de marge dans les industries manufacturières françaises, OFCE working paper n°2008-6.

[2] Bellone, F., Musso, P., Nesta, L. and Quéré, M., 2008. The U-Shaped Productivity Dynamics of French Exporters, GREDEG working paper n°2008-3.

[3] Bernard, A.B., Eaton, J., Jensen, J.B. and Kortum, S., 2003. Plants and Productivity in International Trade. American Economic Review, 93, 1268-1290.

[4] Bernard, A. B., Redding, S. and Schott, Peter K., 2007. Firms in International Trade, Journal of Economic Perspectives, 21, 105-130.

[5] Blanchard, O. 1986. Market Structure and Macroeconomic Fluctuations: Comments. *Brookings Papers on Economic Activity* 2, 323-328.

[6] Bottasso, A., Sembenelli, A., 2001. Market power, productivity and the EU Single Market Program: Evidence from a panel of Italian firms. *European Economic Review* 45 (1), 167-186.

[7] Caves, D. W., Christensen, L. R. and Diewert, W. E. (1982), 'Multilateral comparisons of output, input, and productivity using superlative index numbers', Economic Journal 92(365), 73–86.

[8] Chen, N., Imbs, J. and Scott, A., The Dynamics of Trade and Competition, Journal of International Economics, forthcoming.

[9] Corcos, G., Del Gatto, M., Mion, G. and Ottaviano, G. (2007), Productivity and Firm Selection: Intra-vs International Trade, CRENOS working paper N°2007-6,June.

[10] Del Gatto, M., Mion, G. and Ottaviano, G. (2006), Trade Integration, Firm Selection and the Cost of Non-Europe, CEPR discussion Paper n° 5730.

[11] De Loecker, J. and Warzynski, F., 2008. Markups and Firm-Level Export Status, mimeo, Aarhus School of Business.

[12] Domowitz, I., Hubbard, R.G., Petersen, B. C., 1988. Market Structure and Cyclical Fluctuations in U.S. Manufacturing. *Review of Economics and Statistics* 70 (1), 55-66.

[13] European Commission (1999), Report on Economic and Structural Reform in the EU, *European Economy, Supplement A*

[14] Good, D. H., Nadiri, M. I. and Sickles, R., 1997. Index Number and Factor Demand Approaches to the Estimation of Productivity, in Pesaran, M. H. and Schmidt, P. (Eds.) Handbook of Applied Econometrics: Microeconometrics, Blackwell, Oxford.

[15] Görg, H. and Warzynski, F., 2003. The Dynamics of Price Cost Margins and Exporting Behaviour: Evidence from the UK. LICOS Discussion Paper # 133.

[16] Hall, R.E., 1986. Market Structure and Macroeconomic Fluctuations. Brookings Papers on Economic Activity 2, 285-322.

[17] Hall, R. E., 1988. The Relation between Price and Marginal Cost in U.S. Industry. Journal of Political Economy 96, 921-947.

[18] Hall, R. E., 1990. Invariance Properties of Solow's Productivity Residual, in Diamond, P. (ed.), Growth, Productivity, Unemployment: Essays to Celebrate Bob Solow's Birthday, Cambridge, MA: MIT Press, 71-112.

[19] Harrison, A.E., 1994. Productivity, imperfect competition and trade reform. Journal of International Economics 36 (1-2), 53-73.

[20] Hopenhayn, H. A., 1992. Entry, Exit, and firm Dynamics in Long Run Equilibrium Econometrica 60, 1127-1150.

[21] Hortacsu, A. and Syverson, C., 2007. Cementing Relationships: Vertical Integration, Foreclosure, Productivity, and Prices. Journal of Political Economy 115, 250-301.

[22] Jovanovic, B., 1982. Selection and the Evolution of Industry. Econometrica 50, 649-670.

[23] Krishna, P. and Mitra, D., 1998. Trade liberalization, market discipline and productivity growth: new evidence from India. Journal of Development Economics 56 (2), 447-462.

[24] Levinsohn, J., 1993. Testing the imports-as-market-discipline hypothesis. Journal of International Economics 35 (1-2), 1-22.

[25] Melitz, M. J. (2003), 'The impact of trade on intra-industry reallocations and aggregate industry productivity', Econometrica 71(6), 1695–1725.

[26] Melitz, M. J. and Ottaviano, G. I. P. (2008), 'Market size, trade, and productivity', Review of Economic studies, 75, 295-316.

[27] Oliveira Martins, J., Scarpetta, S., Pilat, D. 1996. Mark-Up Ratios in Manufacturing Industries. OECD Economics Department Working Paper n°162.

[28] Roeger, W., 1995. Can Imperfect Competition Explain the Difference between Primal and Dual Productivity Measures? Estimates for U.S. Manufacturing. Journal of Political Economy 103(2), 316-330.

[29] Siotis, G., 2003. Competitive pressure and economic integration: An illustration from Spain, 1983-1996. International Journal of Industrial Organization, 21, 1435-1459.

[30] Syverson, C., 2004. Market Structure and Productivity: A Concrete Example. Journal of Political Economy 112, 1181-1222.

A   Main Variables Used in the Dataset

All nominal output and inputs variables are available at firm level. Industry level data are used for price indexes, worked hours and depreciation rates.

Output. Our Output variable is Gross output deflated using sectoral price indexes published by INSEE (French System of National Accounts).

Labour. We compute our Labour variable by multiplying the number of effective workers (i.e. number of employees plus number of outsourced workers minus workers taken from other firms) by average worked hours. The annual series for worked hours are available at the 2-digit industry level and provided by *GGDC Groningen Growth Development Center*). This choice was made because there are no data in the EAE survey on hours worked. Note also that between 1999 and 2000 there was a substantial drop in number of worked hours occurs due to the specific "French 35 hour working week policy" (On average, worked hours fell from 38.39 in 1999 to 36.87 in 2000).

Capital input Capital stocks are computed from investment and book value of tangible assets (we rely on book value reported at the end of the accounting exercise), following the traditional PIM

$$K_t = (1 - \delta_{t-1}) \, K_{t-1} + I_t \tag{A-1}$$

where δ_t is the depreciation rate and I_t is real investment (deflated nominal investment). Both investment price indexes and depreciation rates are available at the 2-digit industrial classification from the INSEE data series.

Intermediate inputs. Intermediate inputs are defined as purchases of materials and merchandise, transport and travel, and miscellaneous expenses. They are deflated using sectoral price indexes for intermediate inputs published by INSEE (French System of National Accounts).

Input cost shares. With w, c and m respectively representing wage rate, user cost of capital and price index for intermediate inputs $CT_{kt} = w_{kt}L_{kt} + c_{It}K_{kt} + m_{It}M_{kt}$ represents the total cost of production of firm k at time t. Labour, capital and intermediate inputs cost shares are then

respectively given by

$$s_{Lkt} = \frac{w_{kt}L_{kt}}{CT_{kt}} \; ; \; s_{Kkt} = \frac{c_{It}K_{kt}}{CT_{kt}} \; ; \; s_{Mkt} = \frac{m_{It}M_{kt}}{CT_{kt}} \qquad \text{(A-2)}$$

To compute labour cost share, we rely on the variable "labour compensation" in the EAE survey. This value includes total wages paid to salaries, plus income tax withholding, and is used to approximate the theoretical variable $w_{kt}L_{kt}$. To compute the intermediate inputs cost share, we use variables for intermediate goods consumption in the EAE survey and the price index for intermediate inputs in industry I provided by INSEE.

We compute the user cost of capital using Hall's (1988) methodology where the user cost of capital (i.e. the rental of capital) in the presence of a proportional tax on business income and of a fiscal depreciation formula, is given by[20]

$$c_{It} = (r_t + \delta_{It} - \pi_t^e) \; \left(\frac{1 - \tau_t z_I}{1 - \tau_t} \right) \; p_{IKt} \qquad \text{(A-3)}$$

where τ_t is the business income tax in period t and Z_I denotes the present value of the depreciation deduction on one nominal unit investment in industry I. Complex depreciation formula can be employed for tax purposes in France. To simplify, we chose to rely on the following depreciation formula $z_I = \sum_{t=1}^{n} \frac{(1-\bar{\delta}_I)^{t-1}\delta}{(1+\bar{r})^{t-1}}$ where $\bar{\delta}_I$ is a mean of the industrial deprecation rates for the period 1984-2002 and $\bar{r}$ is a mean of the nominal interest rate for the period 1990-2002.

---

[20]In this equation, we abstract from tax credit allowance
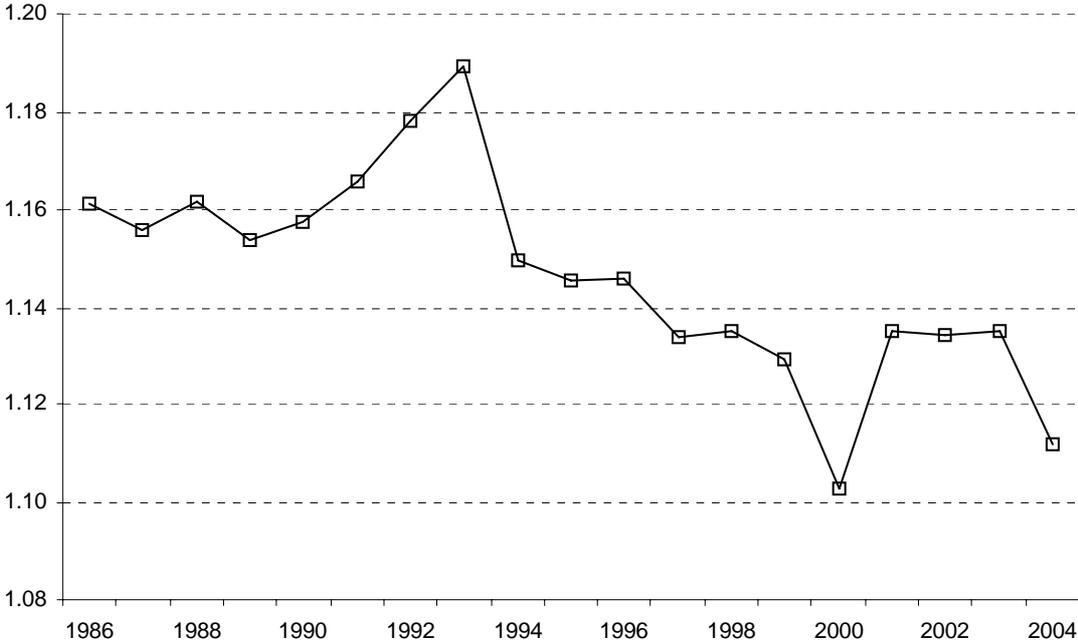
Figure 1: Evolution of the average markup

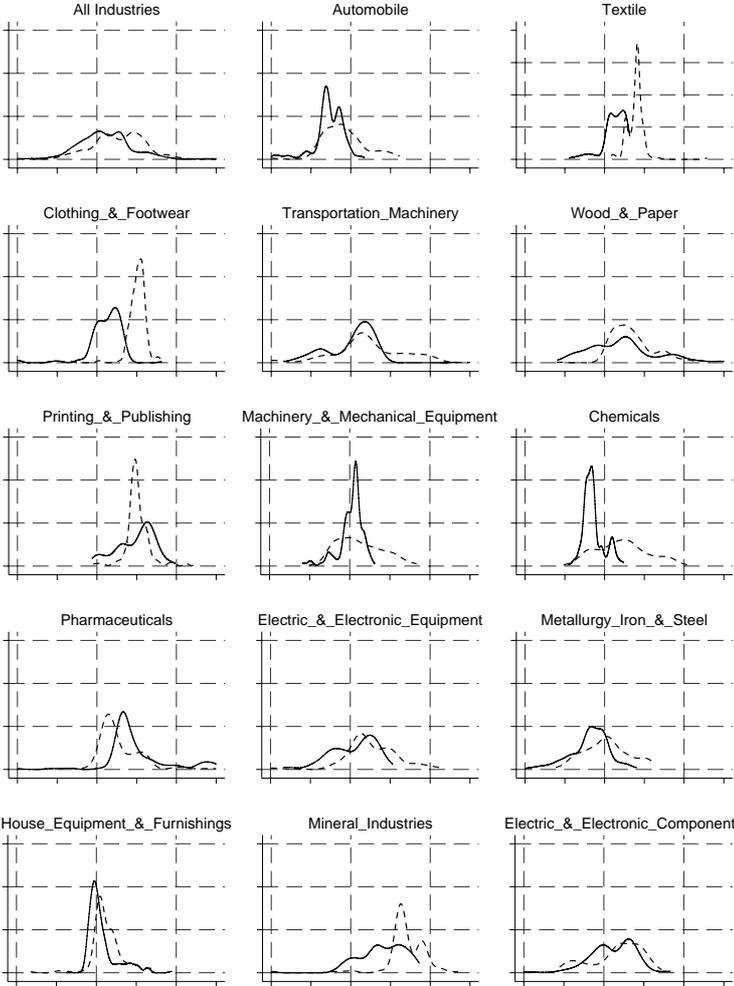Figure 2: Evolution of the distribution of the markup

Table 1: Descriptive Statistics of the Sample (Year 2002)

	Nb. firms	PR^a	Firm EI^b (%)	Sector EI^c (%)	Relative Size^d (%)
All Manufacturing	20,726	72.8	23.1	41.2	287
Clothing	1,212	69.9	24.8	33.3	186
Printing and publishing	1,667	62.6	8.2	7.1	143
Pharmaceuticals	513	92.0	30.4	33.1	245
House equipment and furnishings	1,303	82.7	24.2	30.7	303
Automobile	559	76.4	24.4	50.6	812
Transportation machinery	307	77.2	34.5	57.7	678
Machinery and mechanical equipment	3,764	70.4	23.6	36.8	264
Electrical and Electronic equipment	1,131	74.6	30.3	48.1	374
Mineral industries	1,189	51.8	21.9	21.0	334
Textile	1,129	80.6	29.4	35.7	176
Wood and paper	1,276	68.6	19.0	28.9	252
Chemicals	2,177	83.8	25.4	37.9	221
Metallurgy. Iron and Steel	3,602	71.7	19.4	32.3	270
Electric and Electronic components	897	78.1	27.3	49.1	448

^{a}PR: Participation Rate
^{b}Firm EI: Arithmetic Mean of Export Intensity of firms
^{c}Sector EI: Export Intensity of sector
^{d}Relative size: size of exporters relative to non exporters

Table 2: Firm Export Behaviour, by Size Classes

| Size class | Obs.(%) | EI[a] | PR[a], According to EI[a] Threshold | | | | | |
			$> 0\%$	$\geq 5\%$	$\geq 10\%$	$\geq 15\%$	$\geq 35\%$	$\geq 50\%$
All	100.0	20.5	71.5	47.1	37.0	30.3	15.6	9.3
20-49	57.0	16.3	62.8	36.2	26.8	21.1	9.9	5.8
50-249	34.1	22.3	80.4	56.7	45.5	37.6	19.4	11.8
250-499	4.9	30.1	91.5	76.0	65.5	56.8	33.1	20.2
≥ 500	3.9	34.4	95.6	84.2	75.8	68.1	43.5	26.3

[a]See previous table footnotes.

Table 3: The Export Premium, by Size Classes

| | All firms | Number of employees | | | |
		20-49	50-249	250-499	≥500
Mean Number of Non Exp. Firms	6,215	4,622	1,462	92	38
Mean Number of Exp. Firms	15,614	7,810	5,986	984	834
Output (Y)	257.2	143.8	153.0	134.8	182.4
Labour (L)	198.6	103.7	115.0	102.4	*102.0*
Labour Productivity (Y/L)	140.4	138.9	134.2	131.7	127.3
Capital Intensity (K/L)	124.5	115.4	120.6	115.5	*101.1*
Wage per employee	110.3	110.1	111.0	105.5	*101.9*
TFP	104,2	104,4	104,5	101,3	98,1

100 = Non exporting firms.

All differences significant at 1% level, except values reported in *italics*.

All values are net from industry, year and cohort specific effects.

Table 4: Estimation Results

Dep. var. Δy_{it}	Column (1) Using computed TFP		Column (2) Using OP TFP		Column (3) Using OP TFP (only exporting firms)	
	Coeff.	Std. error	Coeff.	Std. error	Coeff.	Std. error
Δx_{it}	0.165***	(0.005)	0.109***	(0.005)	0.109***	(0.005)
$\Delta x_{it} * EI_{it}$	0.018***	(0.003)	0.030***	(0.003)	0.023***	(0.003)
$\Delta x_{it} * Market\ size_{jt}$	-0.034***	(0.003)	-0.021***	(0.003)	-0.021***	(0.004)
$\Delta x_{it} * IPR_{jt}$	-0.014***	(0.004)	-0.053***	(0.004)	-0.052***	(0.005)
$\Delta x_{it} * \log TFP_{it}$	0.259***	(0.004)	0.078***	(0.002)	0.087***	(0.003)
$\Delta x_{it} * \Delta GDP_t$	0.019	(0.018)	-0.011	(0.012)	-0.011	(0.014)
$\Delta x_{it} * Post1992$	-0.038***	(0.004)	-0.014***	(0.004)	-0.016***	(0.005)
Nr. obs	90,018		88,676		71,471	

Note: ***/**/* indicates statistical significance at 1%/5%/10% respectively

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