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

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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. As implied by the model, we find that, all else equal: 1) firm markups are positively related to firm productivity; 2) firm markups are negatively related to domestic market size; 3) firm markups are negatively related to bilateral trade liberalization (through import penetration); 4) firm markups are positively related to firm export intensity. We interpret this result as indicative that, behind productivity heterogeneity, quality differentiation across firm may explain why exporting firm are able to charge higher mark-ups on export markets compared to the domestic market despite freight cost absorption. This result points out to the need to augment theoretical models in the line of Melitz and Ottavianno (2008) with quality differentiation across firms and across markets in order to tackle appropriately mark-ups patterns at the firm level.

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) and the existence of wide TFP dispersion even within precisely defined industries (see e.g. Syverson, 2010). Yet, one related topic that remains relatively under-studied is how markups differ between firms within and between industries, i.e. how heterogenous are markups. 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 economic modelling (see e.g. Melitz, 2003 and Bernard, Eaton, Jensen and Kortum, 2003, BEJK henceforth; see also the survey by Bernard, Redding and Schott., 2007). These models have been quite successful explaining some patterns relating export behavior to productivity. 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, MO henceforth) 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. 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. In line with the MO model, we find that 1) firm markups are positively related to firm productivity; 2) firm markups are negatively related to domestic market size; 3) firm markups are negatively impacted by bilateral trade liberalization; 4) firm markups are positively related to firm export intensity1.

Our paper can be related to several recent theoretical and empirical developments regarding firms’ pricing decisions and differences between markets. First, various authors have stressed the importance of quality sorting, i.e. exporting firms are more likely to produce high quality goods (e.g. Johnson, 2009; Hallak and Sivadasan, 2009) and might also price discriminate and charge higher markups in richer markets where consumers’ willingness to pay is higher. Manova and Zhang (2009) provide empirical evidence of this hypothesis. In our analysis, we focus on the markup as our variable of interest and try to determine which factors are related to higher markups.

Second, more closely related to our work, Chen et al. (2009) conduct a similar analysis using sectoral data for seven EU countries, focusing on the impact of import competition. Our approach is complementary to theirs, as we estimate (rather than compute) markups using firm-level data, test additional implications from the MO model while focusing on one large European country.

The paper is organized as follows. Section 2 describes a simplified version of the 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.

1Görg and Warzynski (2003) and De Loecker and Warzynski (2009) also find that markups of exporting firms are higher than those of domestic firms. Our analysis also tests other theoretical implications of the MO model, in particular the link between the markup, market size and productivity.
The MO framework of analysis is one of 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 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.

In the global economy, the product of the manufacturing industry is horizontally differentiated in a continuum of varieties indexed by $i \in \Omega$. In each country, the representative consumer is endowed with a linear utility function a la Ottaviano, Tabushi and Thisse (2002), so that the inverted demand for each variety $i$ offered locally is given by:

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

where $p(i)$ is the delivered price of variety $i$ sold on the local market and $D$ is total consumption of all varieties sold on the local market. The parameters $\alpha > 0$ and $\eta > 0$ measure the degree of product differentiation between the manufactured good and the numeraire good while the parameter $\gamma > 0$ measures, instead, the degree of product differentiation between the different varieties of the manufactured good.

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

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

where $N$ is the (endogenous) measure of consumed varieties in $\tilde{\Omega}$ and $\bar{p}$ is their average price. The set $\tilde{\Omega}$ is the largest subset of $\Omega$ that satisfies
\begin{equation}
    p(i) \leq \frac{1}{\eta N + \gamma}(\gamma \alpha + \eta N \bar{p}) \equiv p_{\text{max}}
\end{equation}

where the price bound, \(p_{\text{max}}\) represents the price at which demand for a variety is driven to 0. All else equal, a lower average price \(\bar{p}\) or a larger number of competing varieties \(N\) induces a decrease in the price bound \(p_{\text{max}}\) and an increase in the price elasticity of demand \(\epsilon_i\) at any given \(p(i)\). MO characterize this as a "tougher" competitive environment. On the other hand, for a given toughness of the competitive environment (i.e. for given \(\bar{p}\) and \(N\)), the price elasticity \(\epsilon_i\) monotonically increases with the price \(p(i)\) along the demand curve. This means that, all else equal, less productive firms which charge higher price, and will also tend to set lower mark-up.

The \(N\) varieties consumed by the residents of the domestic economy can be supplied both by domestic firms and by exporters located abroad, both of them operating on monopolistic competitive markets. To enter the market, a firm has to invent its own variety and a corresponding production process by making an irreversible investment \(f\) in terms of labor\(^2\). The firm does not know neither its marginal cost of production \(c\) until having incurred the sunk entry cost \(f\). The firm efficiency is a random draw from a common and known distribution \(G(c)\).

The local and foreign markets are segmented in the sense that firms can produce in one market and sell in another by incurring a per-unit trade cost modeled as an iceberg transport cost. Specifically, the overall cost of a delivered unit with cost \(c\) from the domestic economy to the foreign market is \(\tau^* c\) with \(\tau^* > 1\) while the overall cost of a delivered unit with cost \(c\) from the foreign economy to the domestic market is \(\tau c\) with \(\tau > 1\).

\(^2\)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. Corcos et al. (2007) argue that 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.
Since markets are segmented and production faces constant returns to scale, firms independently maximize the profit earned from domestic and foreign sales. Then, the profit maximizing prices and output levels on each market separately must satisfy

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

where \( L^* \) is the size of the foreign market and \( p^*(c) \) and \( q^*(c) \) denote respectively the levels of the profit maximizing price and quantity delivered for a domestic firm with cost \( c \) selling abroad.

Only firms earning non-negative profits in a market will choose to serve that market. This means that firms selling 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 costs exclusive of trade costs, respectively for firms selling at home and selling abroad. Recalling (3), these (endogenous) cost cutoffs must then satisfy:

\[
\begin{align*}
c_D &= \sup\{c : \pi(c) > 0\} = p_{\max}, \\
c_X &= \sup\{c : \pi^*(c) > 0\} = \frac{p_{\max}^*}{\tau^*},
\end{align*}
\]

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.

### 2.1 Implications on firm-level performance variables

The optimal delivered price and output levels of a domestic firm of cost efficiency \( c \), can be written as:

\[
\begin{align*}
p(c) &= \frac{1}{2}(c_D + c), \quad q(c) = \frac{L}{\gamma}(c_D - c) \\
p^*(c) &= \frac{\tau^*}{2}(c_X + c), \quad q^*(c) = \frac{L^*}{\gamma}\tau^*(c_X - c)
\end{align*}
\]
respectively in the domestic market and in the foreign ones. They yield
the following maximized operating profit levels:

\[
\begin{align*}
\pi(c) &= \frac{L}{4\gamma}(c_D - c)^2 \\
\pi^*(c) &= \frac{L}{4\gamma^2}(c_X - c)^2
\end{align*}
\]

(6)

with markups

\[
\begin{align*}
\mu(c) &= p(c) - c = \frac{1}{2}(c_D - c) \\
\mu^*(c) &= p^*(c) - \tau^*c = \frac{1}{2}(c_D - c) + \frac{1}{2}(c_X - c_d) - \frac{(\tau^* - 1)}{2}(c + c_x)
\end{align*}
\]

(7)

Eq. (7) has three straightforward implications about the determinants of
firm markups. It tells us that, all else equal:

1) **Firm mark-ups are positively related to firm productivity.** Specifically,
firms with lower costs \(c\) 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.

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 \(c_D\).

3) **Exporting firms charge lower mark-ups on foreign markets than on
their domestic market because of freight costs absorption.**

4) **Firms charge lower markups on the foreign market when the average
efficiency of their competitors is higher on the foreign market than on the
domestic market.**

While implication (1) emphasizes a common feature shared by all the
models with heterogeneous firms and endogenous mark-ups, as for instance
BEJK(2003) or Asplund and Nockle (2006), implications (2), (3) and (4)
are less intuitive and deserve some specific comments, especially in the MO
framework.

First, implication (2) 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). This specific feature of
the MO model is what makes this model original, especially compared to
the BEJK model in which the distribution of mark-ups remains invariant to country characteristics and to geographic barriers.

On the other hand, implication (3) arises because in the presence of barriers to imports in the foreign economy, exporting firms both set higher delivered prices and charge lower mark-ups on foreign markets compared to the domestic market, in order to recover their additional frictional transport costs. It is noticeable that this feature of the MO model is also shared by the BJEK model.

However, in the MO framework, the mark-up a firm actually sets on its export markets, also depends on the relative toughness of competition and production technology in the domestic economy compared to the foreign one, as indicated by implication 4). This means that, if domestic firms are on average more efficient than firms on the foreign market, then two counterbalancing forces will play. On the one hand, the (domestic) exporting firms will tend to charge lower mark-ups on their export markets (compared to the domestic market) because of freight costs absorption. On the other hand, they will tend to charge higher mark-ups on their export markets because of the positive efficiency gap between their domestic and foreign competitors.

The MO paper only discusses implications for the absolute markup \((p - c)\), while our econometric analysis is concerned with the estimation of a "relative" markup, or the Lerner index, \((p - c)/p\). It is straightforward to show that the relative markups do not depend directly on trade costs, i.e.:

\[
\frac{p - c}{p} = \frac{c_D - c}{c_D + c}
\]

\[
\frac{p^* - c}{p^*} = \frac{c_X - c}{c_X + c} = \frac{(c_D - c) + (c - c_D)}{(c_D + c) + (c - c_D)}
\]

Now, going back to our absolute markup, our data set does not allow us to distinguish directly between (3) and (4), as we will explain in more details below. Basically, this is due to the fact that transportation costs are
included in the global intermediate inputs bill for each firm included in our data source, so that, we are not able to differentiate the production costs the firm incurs in order to deliver a given quantity of output respectively to the domestic and to the foreign markets. In other words, we are not able to estimate separately the mark-up a firm charges on its domestic market and the mark-up it charges on its export markets. Instead, we are only able to estimate an average mark-up for each domestic firm.

Let \( \tilde{\mu}(c) \) denotes the average mark-up for a domestic firm with cost \( c \). By definition, this average mark-up is equal to:

\[
\tilde{\mu}(c) = (1 - \theta(c)) \mu(c) + \theta(c)\mu^*(c)
\] 

where \( \theta(c) \) is the share of sales sold on foreign markets, also termed export intensity, of a firm of cost \( c \).

As we can only estimate \( \tilde{\mu}(c) \), and not directly \( \mu(c) \) and \( \mu^*(c) \), we must derive from the MO model some further testable implications in terms of the average firm mark-up.

Let us first consider the case of equal toughness of competition and production technology between the domestic and the foreign economies. In this case, equation Eq.(8) can be rewritten:

\[
\tilde{\mu}(c) = \mu(c) - \frac{1}{2} \theta(c)(\tau^* - 1)c = \frac{1}{2} [c_D - c - \theta(c)(\tau^* - 1)c]
\] 

which yield the following testable implications:

**Testable implication (1):** All else equal, the average mark-up of a domestic firm is an increasing function of its productivity level \( (1/c) \), a decreasing function of the size of the domestic market (which lowers the level of the cost cut off \( c_D \)).

**Testable implication (2):** Conditional on exporting, the average mark-up of a domestic (exporting) firm is a decreasing function of the level of trade costs \( (\tau^*) \) and of the degree of its involvement into export markets \( (\theta(c)) \).

\( ^3 \theta(c) \) will take the null value for all firm with cost \( c \) below \( c_x \).

8
Let us then consider the case of asymmetric domestic and foreign economies. More specifically, let us consider that domestic producers are on average less productive than their foreign competitors, so that competition is comparatively tougher on the foreign markets from the point of view of the domestic producers. In this case, all else equal, the average mark-up of a domestic firm is still an unambiguous increasing function of its productivity level \((1/c)\) and an unambiguous decreasing function of the size of the domestic market and of the level of trade costs. On the other hand, it is no longer possible to tell without ambiguity whether this average mark-up will be an increasing or a decreasing function of the firm export intensity. Yet, one should still be able to identify some unambiguous positive relationship between the "efficiency gap" between the domestic and the foreign economy and the average mark-up. More specifically, we should be able to observe that:

**Testable implication (3):** All else equal, the average mark-up of an exporting firm is an increasing (decreasing) function of the positive (negative) "efficiency gap" between the domestic and the foreign economies.

### 2.2 Equilibrium

To obtain closed form expressions for equilibrium values, MO 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 \(k \geq 1\). 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)\(^4\). Specifically, they obtain the following expressions for the cut-off cost levels in the domestic and foreign market respectively:

\(^4\)For a full description of the properties of each of these equilibria, we refer the reader to the original MO (2008) paper and also to Chen, Imbs and Scott (2009) 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.
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).

Equations (10) show how trade liberalization impacts the distribution of firm mark-ups in a given economy. Specifically, they show that an unilateral trade liberalization has anti-competitive effect in the long-run despite its pro-competitive impact in the short-run. To see that, consider a reduction in the barriers to imports, $\tau$ in the domestic economy while their foreign counterparts, $\tau^*$, 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 increased 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$^5$.

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 $\tau$ (increase in $\rho = \rho^*$). In this case, the equilibrium cut-off condition (10) can be rewritten:

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$^5$Chen, Imbs and Scott (2009) 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.
Equations (11) show that bilateral liberalization has a long-run pro-competitive impact in increasing competition in both markets, leading to proportional changes in cut-offs and hence a decrease in the average firm mark-up both in the domestic and in the foreign economies\(^6\).

We can then 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) when trade liberalization is bilateral or if relocations have not yet occurred (i.e. in the short-run). Otherwise, firm-level mark-ups are 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, \( \Theta_{it} \) 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

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\(^6\)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.
(1986) shows that the growth rate of output can be decomposed as:

$$\frac{\Delta Q_{it}}{Q_{it}} = \mu_{it} \left( \alpha_{Nit} \frac{\Delta N_{it}}{N_{it}} + \alpha_{Kit} \frac{\Delta K_{it}}{K_{it}} + \alpha_{Mit} \frac{\Delta M_{it}}{M_{it}} \right) + \vartheta_{it} \quad (12)$$

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

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

$$\frac{\Delta Q_{it}}{Q_{it}} - \alpha_{Nit} \frac{\Delta N_{it}}{N_{it}} - \alpha_{Mit} \frac{\Delta M_{it}}{M_{it}} - (1 - \alpha_{Nit} - \alpha_{Mit}) \frac{\Delta K_{it}}{K_{it}} = \beta_{it} \left( \frac{\Delta P_{Nit}}{P_{Nit}} - \frac{\Delta K_{it}}{K_{it}} \right) + (1 - \beta_{it}) \vartheta_{it} \quad (13)$$

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, 2009). 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:

$$\alpha_{Nit} \frac{\Delta P_{Nit}}{P_{Nit}} + \alpha_{Mit} \frac{\Delta P_{Mit}}{P_{Mit}} + (1 - \alpha_{Nit} - \alpha_{Mit}) \frac{\Delta P_{Kit}}{P_{Kit}} - \frac{\Delta P_{it}}{P_{it}} = \beta_{it} \left( \frac{\Delta P_{it}}{P_{it}} - \frac{\Delta P_{Kit}}{P_{Kit}} \right) + (1 - \beta_{it}) \vartheta_{it} \quad (14)$$

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

$$\left( \frac{\Delta Q_{it}}{Q_{it}} + \frac{\Delta P_{it}}{P_{it}} \right) - \alpha_{Nit} \left( \frac{\Delta N_{it}}{N_{it}} + \frac{\Delta P_{Nit}}{P_{Nit}} \right) - \alpha_{Mit} \left( \frac{\Delta M_{it}}{M_{it}} + \frac{\Delta P_{Mit}}{P_{Mit}} \right) - (1 - \alpha_{Nit} - \alpha_{Mit}) \left( \frac{\Delta K_{it}}{K_{it}} + \frac{\Delta P_{Kit}}{P_{Kit}} \right)$$

$$= \beta_{it} \left[ \left( \frac{\Delta Q_{it}}{Q_{it}} + \frac{\Delta P_{it}}{P_{it}} \right) - \left( \frac{\Delta K_{it}}{K_{it}} + \frac{\Delta P_{Kit}}{P_{Kit}} \right) \right] + u_{it} \quad (15)$$
where $P_K$ is the user cost of capital, defined as:

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

where $\delta_{it}$ 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 $\Delta y$ and the right hand side as $\Delta x$, one obtains a very simple and flexible equation:

$$\Delta y_{it} = \beta_{it} \Delta x_{it} + u_{it} \quad (16)$$

Most studies in this literature simply assume that $\beta_{it}$ 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\(^7\).

We start our empirical analysis by assuming a constant markup for all firms for a given year, therefore estimating the following Eq:

$$\Delta y_{it} = \beta_{it} \Delta x_{it} + u_{it} \quad (17)$$

We then relax this assumption and allow $\beta_{it}$ to vary according to some firm-level and time variant characteristics, as suggested by the MO model\(^8\): the exporting status of the firm (measured by the export intensity at the firm level, $EI_{it} = EXP_{it}/Sales_{it}$) and firm productivity (measured by firm level TFP, $TFP_{it}$).

\(^7\)An alternative strategy could be to estimate average markups by industry over the period ($\beta_j$), or possibly by year ($\beta_{jt}$). Another possibility would be to estimate an average firm-specific markup (see e.g. Dobelaere 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.

\(^8\)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 level.
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, \( IPR_{jt} = \frac{Imports_{jt}}{Sales_{jt} + Imports_{jt} - Exports_{jt}} \)).

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 \( \Delta x \) 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. We interact \( \Delta x \) with a “post 1992” dummy equal to 1 if \( t \geq 1992 \) and 0 otherwise.

Our final specification is therefore:

\[
\Delta y_{it} = \beta_0 \Delta x_{it} + \beta_1 \Delta x_{it} \ast E_{it} + \beta_2 \Delta x_{it} \ast MS_{jt} + \beta_3 \Delta x_{it} \ast IPR_{jt}\]
\[
+ \beta_4 \Delta x_{it} \ast TFP_{it} + \beta_5 \Delta x_{it} \ast \Delta GDP_t + \beta_6 \Delta x_{it} \ast POST92
\]

As discussed in the previous section, a positive coefficient for \( \beta_1 \) could imply or that the efficiency of domestic producers on the markets where French firms export is lower on average, while the sign is expected to be negative if firms have to cover transport costs. We also 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 two variables). That is, we run the following regression only for firms that export:
\[\Delta y_{it} = \beta_0 \Delta x_{it} + \beta_1^{\text{Dist}} \Delta x_{it} \ast \log \text{Dist}_{jt} + \beta_1^{\text{Eff}} \Delta x_{it} \ast \text{Eff}_{jt} \]
\[+ \beta_2 \Delta x_{it} \ast \text{MS}_{jt} + \beta_3 \Delta x_{it} \ast \text{IPR}_{jt} + \beta_4 \Delta x_{it} \ast \text{TFP}_{it} \]
\[+ \beta_5 \Delta x_{it} \ast \Delta \text{GDP}_t + \beta_6 \Delta x_{it} \ast \text{POST92} \]

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 including number of employees, intermediates inputs, and investments in capital goods, and also exports.

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\(^9\). The last column presents the size of exporting 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.

\(^9\)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.
suggesting that exporting and non exporting firms coexist in all types of productive activities\textsuperscript{10}. 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\textsuperscript{11}.

\[\text{Table 2 around here}\]

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

\textsuperscript{10}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%.

\textsuperscript{11}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.
Ideally, to understand the link between markups and exporting activity, we would like to know 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\textsuperscript{12} to construct an index measuring the average relative efficiency of firms in the country $n$ where French firms from sector $j$ export. This is measured as the relative labor productivity of French firms weighted by the share of the country in total export $s_{njt}$:

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

This is obviously a rather rough proxy. There are also other strategic motives that might explain markup differences between countries, such as different marketing strategies, product mix, taste differences, competitive structures, etc...

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).

\textsuperscript{12}Data are available at the 4-digit ISIC level and are then associated to the corresponding NAF700, the French equivalent of NACE Rev. 1.
We use the following computation:

\[
\ln TFP_{it} = \ln Y_{it} - \ln Y_t + \sum_{\tau=2}^{t} \left( \ln Y_{\tau} - \ln Y_{\tau-1} \right) - \sum_{n=1}^{N} \frac{1}{2} \left( s_{nit} - \bar{s}_{nt} \right) \left( \ln X_{nit} - \ln X_{nt} \right) - \sum_{\tau=2}^{t} \sum_{n=1}^{N} \frac{1}{2} \left( \bar{s}_{n\tau} - \bar{s}_{n(\tau-1)} \right) \left( \ln X_{n\tau} - \ln X_{n(\tau-1)} \right)
\]

where \( Y_{it} \) denotes real gross output produced by firm \( i \) at time \( t \) using the set of \( n \) inputs \( X_{nit} \), 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 \( \tau \) 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 \( \bar{Y} \) and \( \bar{X} \) are the geometric means of the firm’s output quantities and input quantities respectively, whereas the cost shares of inputs for representative firms \( \bar{s} \) 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.\footnote{Relative values for the export premium are computed as the ratio of the mean value of exporting firms ($\bar{X}_E^t$) over non-exporting firms ($\bar{X}_{NE}^t$), multiplied by a 100.}

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% 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 disappear 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 industries) 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 firm markups are positively related to total factor productivity. This suggests 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 domestic 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 largely committed to export 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 a higher markup than firms that do not export (see also Görg and Warzynski, 2003; and De Loecker and Warzynski, 2009) 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 firms on the domestic market are on average more efficient than firms on the export markets.

As an attempt to better understand the link between export intensity and the markup, we also looked at the effect of 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 significant, the relationship was positive, as predicted by the MO model: when the average
efficiency of French firms is larger than the average efficiency of domestic firms on the export markets, the markup is also larger\textsuperscript{14}.

This result however is not very convincing, probably due to the lack of quality of our proxy. This suggests that we are missing important product and destination level characteristics in our analysis if we want to control for the possibility that firms sell different products in export markets and/or possibly price discriminate across markets, as recent papers have indicated. Only access to better data would allow us to better understand this exporter premium.

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.

\textsuperscript{14}Results are available from the authors.
References


A Data Appendix

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 \(\delta_t\) 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 \(CT_{kt} = w_{kt}L_{kt} + c_{kt}K_{kt} + m_{kt}M_{kt}\) represents the total cost of production of firm \(k\) at time \(t\). Labour, capital and intermediate inputs cost shares are then
respectively given by

\[ s_{Lkt} = \frac{w_{kt} L_{kt}}{C T_{kt}}; \quad s_{Kkt} = \frac{c_{It} K_{kt}}{C T_{kt}}; \quad s_{Mkt} = \frac{m_{It} M_{kt}}{C T_{kt}} \]  (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\(^{15} \)

\[ c_{It} = (r_t + \delta_{It} - \pi_t^e) \left( \frac{1 - \tau_t z_I}{1 - \bar{r}} \right) p_{IKt} \]  (A-3)

where \( \tau_t \) 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

\[ z_I = \sum_{t=1}^{n} \frac{(1-\delta)(1-t\delta)}{(1+\bar{r})^{t-1}} \] where \( \bar{\delta} \) is a mean of the industrial depreciation rates for the period 1984-2002 and \( \bar{r} \) is a mean of the nominal interest rate for the period 1990-2002.

\(^{15}\)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)

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

\(^a\)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

<table>
<thead>
<tr>
<th>Size class</th>
<th>Obs.(%)</th>
<th>EI&lt;sup&gt;a&lt;/sup&gt;</th>
<th>&gt; 0%</th>
<th>≥ 5%</th>
<th>≥10%</th>
<th>≥15%</th>
<th>≥35%</th>
<th>≥50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>100.0</td>
<td>20.5</td>
<td>71.5</td>
<td>47.1</td>
<td>37.0</td>
<td>30.3</td>
<td>15.6</td>
<td>9.3</td>
</tr>
<tr>
<td>20-49</td>
<td>57.0</td>
<td>16.3</td>
<td>62.8</td>
<td>36.2</td>
<td>26.8</td>
<td>21.1</td>
<td>9.9</td>
<td>5.8</td>
</tr>
<tr>
<td>50-249</td>
<td>34.1</td>
<td>22.3</td>
<td>80.4</td>
<td>56.7</td>
<td>45.5</td>
<td>37.6</td>
<td>19.4</td>
<td>11.8</td>
</tr>
<tr>
<td>250-499</td>
<td>4.9</td>
<td>30.1</td>
<td>91.5</td>
<td>76.0</td>
<td>65.5</td>
<td>56.8</td>
<td>33.1</td>
<td>20.2</td>
</tr>
<tr>
<td>≥500</td>
<td>3.9</td>
<td>34.4</td>
<td>95.6</td>
<td>84.2</td>
<td>75.8</td>
<td>68.1</td>
<td>43.5</td>
<td>26.3</td>
</tr>
</tbody>
</table>

<sup>a</sup>See previous table footnotes.
Table 3: The Export Premium, by Size Classes

<table>
<thead>
<tr>
<th></th>
<th>All firms</th>
<th>20-49</th>
<th>50-249</th>
<th>250-499</th>
<th>≥500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Number of Non Exp. Firms</td>
<td>6,215</td>
<td>4,622</td>
<td>1,462</td>
<td>92</td>
<td>38</td>
</tr>
<tr>
<td>Mean Number of Exp. Firms</td>
<td>15,614</td>
<td>7,810</td>
<td>5,986</td>
<td>984</td>
<td>834</td>
</tr>
<tr>
<td>Output (Y)</td>
<td>257.2</td>
<td>143.8</td>
<td>153.0</td>
<td>134.8</td>
<td>182.4</td>
</tr>
<tr>
<td>Labour (L)</td>
<td>198.6</td>
<td>103.7</td>
<td>115.0</td>
<td>102.4</td>
<td>102.0</td>
</tr>
<tr>
<td>Labour Productivity (Y/L)</td>
<td>140.4</td>
<td>138.9</td>
<td>134.2</td>
<td>131.7</td>
<td>127.3</td>
</tr>
<tr>
<td>Capital Intensity (K/L)</td>
<td>124.5</td>
<td>115.4</td>
<td>120.6</td>
<td>115.5</td>
<td>101.1</td>
</tr>
<tr>
<td>Wage per employee</td>
<td>110.3</td>
<td>110.1</td>
<td>111.0</td>
<td>105.5</td>
<td>101.9</td>
</tr>
<tr>
<td>TFP</td>
<td>104.2</td>
<td>104.4</td>
<td>104.5</td>
<td>101.3</td>
<td>98.1</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Dep. var. $\Delta y_{it}$</th>
<th>Coeff.</th>
<th>Std. error</th>
<th>Coeff.</th>
<th>Std. error</th>
<th>Coeff.</th>
<th>Std. error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta x_{it}$</td>
<td>0.165***</td>
<td>(0.005)</td>
<td>0.109***</td>
<td>(0.005)</td>
<td>0.109***</td>
<td>(0.005)</td>
</tr>
<tr>
<td>$\Delta x_{it} \times EI_{it}$</td>
<td>0.013***</td>
<td>(0.003)</td>
<td>0.030***</td>
<td>(0.003)</td>
<td>0.023***</td>
<td>(0.003)</td>
</tr>
<tr>
<td>$\Delta x_{it} \times Market\ size_{jt}$</td>
<td>-0.034***</td>
<td>(0.003)</td>
<td>-0.021***</td>
<td>(0.003)</td>
<td>-0.021***</td>
<td>(0.004)</td>
</tr>
<tr>
<td>$\Delta x_{it} \times IPR_{jt}$</td>
<td>-0.014***</td>
<td>(0.004)</td>
<td>-0.053***</td>
<td>(0.004)</td>
<td>-0.052***</td>
<td>(0.005)</td>
</tr>
<tr>
<td>$\Delta x_{it} \times \log TFP_{it}$</td>
<td>0.259***</td>
<td>(0.004)</td>
<td>0.078***</td>
<td>(0.002)</td>
<td>0.087***</td>
<td>(0.003)</td>
</tr>
<tr>
<td>$\Delta x_{it} \times \Delta GDP_{t}$</td>
<td>0.019</td>
<td>(0.018)</td>
<td>-0.011</td>
<td>(0.012)</td>
<td>-0.011</td>
<td>(0.014)</td>
</tr>
<tr>
<td>$\Delta x_{it} \times Post_{1992}$</td>
<td>-0.038***</td>
<td>(0.004)</td>
<td>-0.014***</td>
<td>(0.004)</td>
<td>-0.016***</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Nr. obs</td>
<td>90,018</td>
<td>88,676</td>
<td>71,471</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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