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Departamento de Estadística y Econometría
Universidad Carlos III de Madrid
Calle Madrid, 126
28903 Getafe (Spain)
Fax (34-91) 624-9849

FIRMS´PRODUCTIVITY AND THE EXPORT MARKET: A NONPARAMETRIC APPROACH.

Miguel A. Delgado, José C. Fariñas and Sonia Ruano.*

Abstract

This paper examines total factor productivity differences between exporting and non-exporting firms. These differences are documented on the basis of a sample of Spanish manufacturing firms over the period 1991-1996 drawn from the ESEE. The paper also examines two complementary explanations for the superior productivity of exporting firms: 1) the market selection hypothesis, and 2) the learning hypothesis. Nonparametric tests are implemented for testing these hypothesis. Results indicate clearly higher levels of productivity for exporting firms than for non-exporting firms. Evidence favours the hypothesis of self-selection of more efficient firms into the export market. However there is little evidence that these efficiency gains are supportive of the learning-by-exporting hypothesis.

Keywords: Total Factor Productivity; Exports; Stochastic Dominance; Nonparametric tests.

*Delgado, Departamento de Estadística y Econometría, Universidad Carlos III de Madrid, C/ Madrid 126, 28903 Getafe (Madrid), Spain, e-mail: delgado@est-econ.uc3m.es; Fariñas, Universidad Complutense de Madrid and PIE-FEP; Ruano, Universidad Carlos III de Madrid and PIE-FEP. We are grateful to Rebeca de Juan, Ana Martín, Daniel Miles and Mark J. Roberts for their useful comments and suggestions. This research has been partially funded by the project CICYT SEC97-1368 and DGES PB95-0292.

1. Introduction

The link between efficiency and exports is one of the many features on which the literature on productivity growth has focused on. A widespread and robust finding supported by this literature is that there are significant differences in productivity across firms, and also that these differences persist overtime (see Griliches and Regev, 1995 and many others; for a review article see Tybout, 1997). One of the firms' characteristics that contribute to this observed heterogeneity is the entry of firms in the export market. Studies by Aw and Hwang (1995), Bernard and Jensen (1995), Jensen and Wagner (1997), Aw, Chen and Roberts (1997), Clerides, Lach and Tybout (1998) and Aw, Chung and Roberts (1999), for different countries and time periods, provide evidence on the fact that export-oriented firms are closer to the efficiency frontier than non-exporters.

The purpose of this paper is two fold. First, we begin by measuring total factor productivity differences between exporting and non-exporting firms. The paper documents these productivity differences on the basis of a micro-panel sample of Spanish manufacturing firms over the period 1990-1996: the *Encuesta sobre Estrategias Empresariales (ESEE)*. Second, the firm level panel structure of the information permits to examine the relative merits of two different and complementary explanations for superior productivity of exporting firms. The first explanation emphasises that export markets select the most efficient firms. The mechanism that underlies this selection process is based on the hypothesis that export markets are more competitive and therefore that the most efficient firms become exporters. The second explanation suggests that entry into the export market imply a learning process that improves firms' productivity. The paper explores and tests for these two different, but non mutually exclusive explanations, comparing productivity levels as well as productivity growth for groups of firms with different trajectories between the export and domestic markets.

The literature on the relationship between exporting and firm performance that is particularly interested on testing the relative merits of both the selection and the learning hypothesis is relatively recent. Studies along these lines include Clerides, Lach and Tybout (1998), Aw, Chen and Roberts (1997), Bernard and Wagner (1997), Bernard and Jensen (1999), and Aw, Chung and Roberts (1999). Our contribution to this literature can be summarised as follows. First, the empirical analysis is based on the complete distribution of productivity levels for exporting and non-exporting firms. Second, we design testing procedures based on the concept of stochastic dominance to compare cumulative distribution functions for different groups of firms. Third, we use non-parametric tests for ranking differences between productivity distributions.

The rest of the paper is organised as follows. Section 2 summarises the analytical arguments available in the literature to explain the observed link between productivity and exports. Section 3 presents the testing procedures that have been used. Section 4 presents the index used for measuring total factor productivity and discusses some related measurement issues. Section 5 reports the main empirical results. Conclusions are placed in section 6.

2. Productivity differentials and exports

The analytical literature on productivity provides a set of possible explanations for the observed link between productivity and exports. Before discussing our approach to the measuring of productivity differences between exporting and non-exporting firms and testing procedures, we review the main theoretical arguments which explain these productivity differences.

The first argument comes from the development literature and relies on the idea of international competition. The mechanism that underlies the link between exports and productivity is that the intensity of product market competition in export markets is greater than in domestic markets, and therefore afford fewer opportunities for inefficient firms. There are increasing returns to entrepreneurial effort after firms' exposure to international competition. Within this development literature linking export-orientation to productivity, is also the argument of increasing returns to scale as the source for the greater efficiency of exporting firms. If entry in the export market allows firms to expand production and take advantage from scale economies, then their productivity will increase more (see Aw and Hwang, 1995, for furthers details on these arguments).

Empirical studies on trade reform (see Feenstra 1997 for a survey), confirm the existence of a positive relationship between competition and productivity. This empirical literature obtains two different sets of findings. First, corrected measures of total factor productivity for changes in mark-ups, leads to a positive and substantial effect of trade reform on productivity. Second, productivity growth tends to be associated to declining mark-ups due to increased trade-exposure, this relation being stronger for manufacturing industries. Therefore, both findings link differences in productivity between exporting and non-exporting firms to the greater competitive pressure of foreign markets compared to domestic ones. More productive firms will be more likely to export, and therefore their productivity will be greater than those only selling in the domestic market.

The previous argument applies mainly to situations where the intensity of product competition for the domestic market differs significantly from the level competition in foreign markets. This difference may stem from barriers to entry in domestic markets. However, when the competitive pressure is similar for both markets, as may be the case for non-developing countries and many tradable good industries, the exact source of the increased competition is not clear.

The second approach to the explanation of superior productivity of exporting firms comes from models of industry dynamics by Jovanovic (1982), Hopenhayn (1992) and Ericson and Pakes (1995). Two recent papers establishing a link between these models and productivity differences between exporting and non-exporting firms are Aw, Chen and Roberts (1997) and Aw, Chung and Roberts (1999). This second approach emphasises the notion of sunk cost to explain productivity differences between exporters and domestic-oriented firms.

In Hopenhayn (1992) selection model, each firm output is a function of factors of production and a random variable, which can be interpreted as a persistent productivity shock uncorrelated across firms. One of the features of the model is the presumption that firms have an initial distribution of efficiency levels that they do not know before entering the industry. Potential entrants have to incur in sunk entry costs. More efficient firms stay in business. Less efficient firms learn about their relative inefficiency and choose to exit. Hopenhayn's learning model shows that there is a critical level of productivity that defines the rule for the firm to stay or to exit from business. This rule influences firms' decisions about entry and exit, and consequently will involve simultaneous offsetting flows of entering and exiting firms.

Models of industry dynamics have some consequences for the analysis of productivity differences between exporting and non-exporting firms. These models predict higher productivity levels for exporting firms because sunk entry costs for entering into the export market are higher relative to firms selling in the domestic market. Therefore the critical level of productivity to decide to enter into the export market is higher too.

To explain why exporters are more efficient than non-exporters we have outlined two arguments: 1) firms participating in international markets are exposed to more intensive competition; and 2) exporters have higher sunk entry costs than domestic firms. Both explanations are consistent with the idea that export markets select the most efficient firms among the set of potential entrants into the export market. A third different approach, but not mutually exclusive with respect to the two previous ones, is based on the idea of exporting as a learning mechanism that allows firms to improve their productivity.

The management literature describing the firm's internationalisation process has emphasised the argument of exporting as a learning process. Either the approach that describes the internationalisation process as a sequence of stages for the firm (the Uppsala model) or the approach focussing the export activity as an innovation for the firm, both agree on the idea of exporting as a learning sequence for the firm (see Andersen, 1993 and Leonidou and Katsikeas, 1996, for reviews of this literature). Export activity could be viewed as a learning process that is gained through experience in the market, wherein firms gradually become familiar with overseas markets and operations. Similarly, the internationalisation decision can be considered as an innovation for the firm, which modify management practices and attitudes in a step by step process.

There is a recent literature focussing on the relationship between exporting and firm performance, and interested on testing the relative merits of both the selection and the learning hypothesis. This literature, which includes Clerides, Lach and Tybout (1998), Aw, Chen and Roberts (1997) Bernard and Jensen (1999) and Aw, Chung and Roberts (1999) explore and test for the two explanations by comparing different performance measures for groups of firms with different trajectories between the export and domestic market. In the next section we describe a testing procedure to examine productivity differentials taking into consideration different firm's transitions between the domestic and the export market.

3. Testing procedure

This section develops a procedure for comparing the productivity distributions of exporting and non-exporting firms. The panel structure of the sample of firms allows a classification of firms according to their export activity and to different trajectories between the export and the domestic market over the period. We design different test in order to explore whether or not transitions from domestic to export markets are consistent with certain firms' productivity differences. In particular, test of the selection hypothesis is based on the comparison of cumulative distribution functions of productivity *level* for firms that have undergone different transition patterns between the domestic and the export market. On the other hand, test of the learning hypothesis relies on comparisons of productivity *growth* distribution for firms with different trajectories between the domestic and the export market[1].

We need to test the existence of differences between groups of firms in terms of their cumulative distribution functions and to establish a ranking for the compared distributions. For this purpose we rely on the concept of stochastic dominance. Let X and Y denote random variables with respective cumulative distribution functions F(.) and G(.), then X stochastically dominates Y if $F(z)-G(z)\leq 0$ for all $z\in Z$, where $P(X\in Z, Y\in Z)=1$, and z represents either the firms' productivity levels or firms' productivity growth.

The theoretical arguments summarised in section 2 suggest the following three hypotheses to test, which we now formulate using the concept of stochastic dominance:

i) If productivity differences reflect selection and/or learning forces at work in export markets, the productivity distribution of exporting firms should stochastically dominate the productivity distribution of non-exporting firms;

ii) The hypothesis of selection implies that differences between exporting and non-exporting firms precede their entry in the export market. Therefore, in the period prior to their entry, the productivity distribution of non-exporting becoming exporters should stochastically dominate the productivity distribution of non-exporters;

[1] See next section for the definition of the productivity index that has been used to measure productivity.

iii) Learning-by-exporting implies that differences between exporting and non-exporting firms increase after the entry of exporters in the export market, and therefore the productivity growth distributions of exporting firms should stochastically dominate the distribution of non-exporting firms.

Therefore, the three hypotheses we are interested in consist of a two-sample problem that can be formalised as follows. Let $X_1,.., X_m$, be a random sample of size m, which corresponds to a group of firms, from the cumulative distribution function F(.), and let $Y_1,..., Y_n$, denote a random sample of size n, which corresponds to a different group of firms, from cumulative distribution function G(.). Then, X stochastically dominates Y if two complementary conditions are statistically satisfied

i) The two distribution functions are not identical, i.e. we want to test whether the null hypothesis H_0: $F(z) = G(z)$ all $z \in Z$ can be rejected (two-sided test);

ii) The sign of the difference between the compared distributions is as expected, i.e. we want to test the null hypothesis H_0: $F(z) \leq G(z)$ all $z \in Z$ (one-sided test).

The null hypothesis in (i) can be also written as

$$H_0\text{: } \sup_{z \in Z} \left| F(z) - G(z) \right| = 0,$$

and the statistic proposed by Smirnov (1939) to test this hypothesis is

$$\hat{\delta}_N = \sqrt{\frac{n.m}{N}} \sup_{z \in Z} \left| \hat{F}(z) - \hat{G}(z) \right|,$$

where $\hat{F}$ and $\hat{G}$ are the empirical distribution functions corresponding to F and G, respectively, and N=n+m[2].

Similarly, the null hypothesis in (ii) can be also written as

$$H_0\text{:}\ \sup_{z \in Z}\big(F(z)-G(z)\big) \leq 0$$

which can be tested using the Smirnov (1939) statistic for the two-sample problem[3]; that is

$$\hat{\eta}_N = \sqrt{\frac{n.m}{N}} \sup_{z \in Z}\big(\hat{F}(z)-\hat{G}(z)\big).$$

4. Productivity measurement and data

The measurement of firm productivity

Total factor productivity at firm level is measured by a multilateral productivity index. The advantage of this kind of measures is that the parameters of the production function are not required to compute productivity. The index we use is based in the multilateral productivity index proposed by Good (1985). The expression of this index at time t, for firm f is:

$$\begin{aligned} \ln \lambda^{*}_{ft} = \quad & \ln y_{ft} - \overline{\ln y_t} - \frac{1}{2}\sum_{n=1}^{N}(\varpi_{nft} + \overline{\varpi}_{tn})(\ln x_{nft} - \overline{\ln x_{nt}}) + \\ & \sum_{s=2}^{t}\left[\overline{\ln y_s} - \overline{\ln y_{s-1}} - \frac{1}{2}\sum_{n=1}^{N}(\overline{\varpi}_s + \overline{\varpi}_{s-1})(\overline{\ln x_{ns}} - \overline{\ln x_{ns-1}})\right]. \end{aligned}$$

[2]Kolmogorov (1933) showed that the limiting distribution of this statistic is given by $\lim_{N\to\infty} P\{\hat{\delta}_N > \upsilon\} = -2\sum_{k=1}^{\infty}(-1)^k \exp(-2k^2\upsilon^2)$.

[3] Smirnov (1939) showed that the limiting distribution of this statistic is given by $\lim_{N\to\infty} P\{\hat{\eta}_N > \upsilon\} = \exp(-2\upsilon^2)$.

where y_{ft} is the output level of the firm f at time t, ω_{nft} and x_{nft} are , respectively, the cost share and the quantity of input n corresponding to firm f at time t; N denotes the total number of inputs[4] and the bars denote the average value over the relevant variable (e.g., $\overline{\varpi_{tn}}$ indicates the average of the cost share of input n across all firms at time t). This index provides a measure of the proportional difference in total factor productivity for firm f at time t relative to the average firm in the base time period. We construct the productivity index for each industry.

To clarify the meaning of the productivity index, we interpret the terms on the right hand side. The first set of terms compares every firm with the average firm in terms of output, cost shares and inputs at time t. Thus, transitiveness of comparisons among observations corresponding to the same cross-section is satisfied given that all deviations are expressed from a common reference. The later term describes the change in productivity over time for the average firm. In other words, firms' productivities are expressed in relative terms to the same reference, the average firm in the base year, to preserve transitiveness on the comparisons among observations in different years[5].

The index we use in this paper is adapted from the above index to a sample that includes observations of two groups of firms, small and large, for which the data set we use different sampling proportions. Denoting the two size groups of firms by τ, the expression of total factor productivity index at time t, for the firm f is:

$$\begin{aligned}\ln \lambda^*_{ft} = \; & \ln y_{ft} - \overline{\ln y_\tau} - \frac{1}{2}\sum_{n=1}^{N}(\varpi_{nft} + \overline{\varpi_{n\tau}})(\ln x_{nft} - \overline{\ln x_{n\tau}}) + \\ & \overline{\ln y_\tau} - \overline{\ln y} - \frac{1}{2}\sum_{n=1}^{N}(\overline{\varpi_{n\tau}} + \overline{\varpi_n})(\overline{\ln x_{n\tau}} - \overline{\ln x_n}).\end{aligned}$$

[4]For the construction of the index, we consider three inputs: labour, capital and materials. For more details see appendix.

[5] For more details about total factor productivity indexes see Good, Nadiri and Sickless (1996).

According to this expression firm-level total factor productivity is expressed as the sum of two components. The first component measures productivity differences between the firm and the average firm of the size-group that firm belongs to. The second component measures productivity differences between the average firm of its size-group and a common reference firm constructed as the arithmetic mean over the entire sample of firms. Notice that firms taken as references do not vary over time to preserve transitiveness of intertemporal comparisons, and furthermore a different reference firm has been considered for each industry[6]. Then, this index provides a measure of the proportional difference of total factor productivity for firm f at time t relative to the average firm of the same size-group and industry over the entire period. Taking into account the characteristics of the data set, the productivity index is constructed separately by industry and then we pool the industries to examine productivity differences.

Data and measurement issues

The data set considered in this study is drawn from the *Encuesta Sobre Estrategias Empresariales (ESEE)*, an annual survey referred to a representative sample of Spanish manufacturing firms over the period 1990-1996. In 1990, the base year, 2188 firms participated in the survey according to a selective sampling scheme that implies different rates of participation depending on the size firm category. All firms with more than 200 employees (large firms) were asked to participate, and the rate of participation reached around 70% of the population of firms within the size category. Firms that employed between 10 and 200 employees (small firms) were chosen according to a random sampling scheme, and the rate of participation was around 5% of the number of firms in the population.

[6]Firms have been grouped in eighteen industries corresponding to NACE-CLIO R-25 classification.

We are interested in comparing the cumulative distribution functions of productivity levels and productivity growth that correspond to different groups of firms that experience different trajectories between the domestic and of the export market. Particularly, we want to classify firms according to two different criteria. According to the first one, firms are classified in two groups: exporters and non-exporters[7]; and according to the second, the two categories correspond to non-exporters and to firms entering the export market. Let D denote a dummy variable that categorise firms into groups, then the conditional cumulative distribution function of the random variable z, $F(z|t,D)$, evaluated at any of the two possible values of D is the cumulative distribution function of z, which may represent either the productivity level of firm f at time t or the productivity growth of firm f between t and t+k, for the corresponding group of firms.

The estimations of both cumulative distribution have been obtained from gaussian kernel density estimators as:

$$\hat{F}(z|t,D) = \int_{-\infty}^{z} \hat{f}(x|t,D)dx$$

The smoothing parameter for the kernel estimate is: $h = 0.9An^{-1/5}$, where $A = min(s_n, riq)/1.34$, s_n denotes the standard deviation and riq the interquartile range (according to the recommendation in Silverman, 1986).

The selective sampling scheme used in the ESEE data set, implies that the cumulative distribution function for different groups of the whole population (exporters and non-exporters and so on) cannot be directly estimated. However the characteristics of the data set permit to estimate the following conditional cumulative distribution

[7] We consider exporting firms those that export at least one year over the period 1990-1996 and non-exporting firms those that do not export any of the years during the period.

function: $F(z|t,D,\tau)$, where τ is a dummy variable that represents the size category of the firm. The conditional cumulative distribution functions of the whole population is related to the conditional cumulative distribution functions of the two size groups as follows

$$\begin{aligned} F(z|t,D) = \quad & P(\tau = 0 \mid t,D) \times F(z|t,D,\tau = 0) \\ & + P(\tau = 1 \mid t,D) \times F(z|t,D,\tau = 1) \end{aligned}$$

where P(.) represents the conditional probability of being either a small or a large firm, given t and D. For example, if D is a dummy variable taking the value 1 when the firm exports and 0 otherwise, the expression of the estimator of the cumulative distribution function of productivity (z) for exporting firms (D=1) at time t is given by the following equation

$$\begin{aligned} \hat{F}(z|t,D = 1) = \quad & \hat{P}(\tau = 0 \mid t,D = 1) \times \hat{F}(z|t,D = 1,\tau = 0) \\ & + \hat{P}(\tau = 1 \mid t,D = 1) \times \hat{F}(z|t,D = 1,\tau = 1) \end{aligned}$$

where $\hat{F}$ and $\hat{P}$ represent the estimates of F and P, respectively. A similar expression can be written for the non-exporting firms (D=0). The probabilities have been calculated from the information provided by the *ESEE* for the base year (1990), and we assume the same probabilities for the rest of the period[8].

5. Empirical results

The data set contains annual information at the firm level, including data on firm export activity. We have 11,916 observations corresponding to an average number of 1,702 firms over the period 1990-1996.

[8]Estimated conditional probabilities are P(τ=0|t,D=0)=0,993 and P(τ=0|t,D=1)=0,924.

This section is organised as follows. Firstly, we begin by examining differences in total factor productivity between exporting and non-exporting firms. Secondly, we document whether the magnitude of the productivity advantage for exporting firms is dependent or not on the export intensity of firms. Finally, we explore the sources of observed differences between exporting and non-exporting firms, comparing the base group of firms that never entered the export market and the group of firms in transition from the domestic to the export market. We explore whether their transitions are consistent to certain patterns of productivity differences. Non-parametric tests described in previous sections are carried out to explore the relationship between exports and productivity as well as the hypotheses of market selection and learning.

Exports and productivity

Firms are classified in two groups according to the following criteria. Exporting firms are defined as the group of firms exporting at least once over the period 1990-1996. The total number of observations that corresponds to this category is 8,048, which represents a 67,5% of the total number of observations in the sample. Non-exporting firms are defined as firms that do not export during the entire period. The number of observations that corresponds to this group is 3,868, which represents 32,5% of the total number of observations. We call this sample I.

Let D denote a dummy variable taking the value 1 when the firm exports and 0 when the firm is a non-exporter, as we have already defined. To test if the productivity of exporting firms stochastically dominates the productivity distribution of non-exporting firms we have to compare, for each time period,

$$F(z|t,D=1) \quad vs. \quad F(z|t,D=0), \qquad t=1991,\ldots,1996$$

where z is the productivity level ($\ln \lambda^{*}_{ft}$), using the two-sided and one-sided tests defined in section 3.

Figure 1 reports kernel estimators of the cumulative distribution functions of productivity for exporting and non-exporting firms. The position of the distribution for exporting firms is to the right to the distribution of non-exporting firms. The positions of both distributions indicate higher levels of productivity for exporters relative to non-exporters.

Table 1 summarises productivity differences between exporting and non-exporting firms for the quartiles of both distributions. All quartiles of the productivity distributions are higher for exporting firms relative to non-exporting firms. In particular, the median productivity of exporting firms is 6% higher than the productivity of non-exporting firms. The productivity differences are greater at the lower part of the distribution (9% in favour of exporting firms at the lower quartile), and smaller at the upper part (5% in favour of exporting firms at the upper quartile). Moreover, the dispersion of the distribution of exporting firms, measured by the interquartile range, is lower than for non-exporting firms.

Table 2 presents the hypotheses test statistics. First, the null hypothesis of equality of both distributions can be rejected at the 0.01 level for all years. Second, the null hypothesis of stochastic dominance of exporting firms can not be rejected at any reasonable significance level.

Export intensity and productivity

Our previous findings indicate higher levels of productivity for exporting firms relative to non-exporting firms. Now, we want to explore if there is also a positive link between productivity and export intensity. Therefore, we examine if the magnitude of the productivity advantage for exporting firms is dependent on the export intensity of firms. For this purpose, we have classified firms into three groups according to their export intensity distribution: 1) high export intensity for firms over the upper quartile of the distribution; 2) medium export intensity for firms in between the lower and the upper quartiles; and 3) low export intensity for firms under the lower quartile.

Figure 2 presents the productivity distributions of the three groups employing kernel density estimates. We distinguish between small and large firms due to the selective sampling scheme used in our database. For small and large firms, kernel density estimators describe the distributions of firms' total factor productivity according to their export intensity. For large firms differences are very narrow, and they seem to operate in the opposite direction to what we would expect. Table 3 reports that large firms with low export intensity have a median productivity 1% and 2% greater than medium and high intensity firms. For small exporting firms, there is a positive relationship between productivity and export intensity for small firms. The density distribution shifts to the right when export intensity increases. Descriptive statistics for the three distributions reported in Table 3, suggest that the magnitude of productivity differentials is smaller than for the aggregate distributions of exporters and non-exporters.

Market selection and learning by exporting

We turn now to the exam of two different sources for productivity differences between exporting and non-exporting firms. First, we explore if the higher productivity of exporters reflect selection forces at work: export markets being more competitive and selecting the most efficient firms. To test the market selection hypothesis we classify firms in two groups. The first group corresponds to firms entering the export market and the second group corresponds to firms that never entered the export market. Both groups are selected from the sample of firms that we observe in 1991 and 1996, which amount to a total number of 518 firms. Entering firms amount to 162 firms, and are identified to those units that do not export in 1991 but export in 1996. Firms that never enter the export market amount to a total number of 356 firms. We call this sample II.

Let D denote a dummy variable taking the value of 1 when the firm was not an exporter in 1991 but exports in 1996, and 0 when the firm never entered the export market. To examine the market selection hypothesis we test if the high productivity we observe among firms that export precede their entry into the export market. More formally, we want to test at the period prior to their entry if the productivity distribution of entering firms in the export market stochastically dominate the productivity distribution of non-exporters, so we have to compare

$$F(z|t=1991,D=1) \quad vs. \quad F(z|\ t=1991,D=0),$$

where z represents the productivity level, and two-sided and one-sided tests are applied.

Figure 3 reports kernel estimators of the cumulative distribution functions of productivity for non-exporters and entering exporters. Both distributions are drawn for 1991, before entry, and 1996, after entry. The position of the distribution for entering firms is always to the right to the position of non-exporters, indicating that firms that eventually enter the export market were more efficient than non-exporters in the period prior to their entry. Table 4 reports test statistics on this market selection hypothesis. First, we are able to reject the null hypothesis of equality of both distributions for 1991, the year before entry, at the 0.16 level. Second, the null hypothesis of stochastic dominance of exporting firms cannot be rejected at any reasonable significance level.

A different view has been put forward to explain the positive relationship between exports and productivity. This view implies that entry in the export market provides to firm benefits that result in higher productivity. This improvement may be associated to learning (for example, the knowledge that exporters acquire in international markets) although the exact channels that generates this process is difficult to establish.

To test the learning hypothesis we examine whether productivity growth for entering firms into the export market is greater than for non-exporters. Again, let D denote a dummy variable taking the value of 1 for entering firms and 0 for non-exporters. We compare productivity growth distributions for both groups of firms

$$F(z|D=1) \quad vs. \quad F(z|D=0),$$

where z represents productivity growth during the period 1991-1996. Firm-level productivity growth between years t and t+k is given by $\ln\lambda^*_{ft+k} - \ln\lambda^*_{ft}$.

Figure 4 reports kernel estimators of the cumulative distributions of productivity growth for entering firms and for non-exporters. The position of the distribution of entering firms is to the right to the distribution of non-exporters, except for the upper tail of the distribution. This indicates that almost for all levels of *z*, productivity growth of entering firms is greater than productivity growth for non-exporters. Table 4 (fourth row) reports test statistics that indicate that we cannot reject the equality of both distributions, although the null hypothesis of stochastic dominance of entering firms in the export market cannot be rejected. A possible explanation for non-rejecting the equality of both distributions may be that the period of time during which we are allowing firms to learn from export markets is too short to appreciate its effect on productivity growth. To test the sensibility of results to this argument, we repeat the hypothesis testing procedure with sample I, which includes entering firms into the export market before 1991 and therefore with longer learning processes at work. Table 4 (third row) reports the results. We are not still able to reject the null hypothesis of equality, so we do not find any significant difference between sample II and I.

6. Conclusions

This paper has examined total factor productivity differences between exporting and non-exporting firms. These differences are examined using a sample of Spanish manufacturing firms over the period 1991-1996 drawn from the ESEE. The paper also examines two complementary explanations for the superior productivity of exporting firms: 1) the market selection hypothesis, and 2) the learning hypothesis.

Results can be summarised as follows. First, our data suggests clearly higher levels of productivity for exporting firms relative to non-exporters. Second, firms that export a small fraction of their sales have a similar productivity as firms with a high propensity to export. This fact is stronger for large firms than for small firms. Third, with respect to the market selection hypothesis, results indicate hat firms that eventually enter the export market were more efficient than non-exporters in the period prior to their entry. Fourth, post-entry productivity improvement is similar for non-exporters and for entering firms in the export market. Evidence is not very much in favour of the learning hypothesis.

Data Appendix:

Using firms' manufacturing data drawn from the Encuesta sobre Estrategias Empresariales (ESEE). We construct the index of total factor productivity (TFP) for each firm according to the following variable definitions:

Output: measured by annual gross production of goods and services expressed in real terms using individual price index for each firm drawn from the *ESEE*.

Labour input: measured by the number of effective yearly hours of work, which is equal to normal yearly hours plus overtime yearly hours minus non-working yearly hours. The cost of labour is measured by the sum of wages, social security contributions, and other labour costs paid by the firm.

Materials: measured by the cost of intermediate inputs; it includes raw materials purchases, energy and fuel costs and other services paid by the firm. It is expressed in real terms using individual price indexes of intermediate inputs for each firm drawn from the *ESEE*.

Stock of capital: it is calculated following Martín Marcos and Suárez (1997), who use the perpetual inventory formula: $k_t^* = I_t + k_{t-1}^*(1-d_t)\frac{P_t}{P_{t-1}}$, where I_t represents investment in equipment, d_t are depreciation rates obtained from Martin Marcos (1990) and P_t corresponds to price indexes for equipment published by the Instituto Nacional de Estadistica. The user cost of capital is measured by the cost of long-term external debt of the firm plus depreciation rates (d_t) minus the variation of the price index for capital goods.

References

Anderson, O. (1993) "On the internalization process of firms: a critical analysis", *Journal of International Business Studies*, pp. 209-231.

Aw, Bee Yan and A. Hwang (1995), "Productivity and the export market: A firm-level analysis", *Journal of Development Economics,* 47, pp. 313-332.

Aw, Bee Yan, Xiaomin Chen, and Mark J. Roberts (1997), "Firm level evidence on productivity differentials, turnover, and exports in Taiwanese manufacturing", *NBER Working Paper No. 6235.*

Aw, Bee Yan, Sukkyun Chung and Mark J. Roberts (1999), "Productivity and turnover in the export market: Micro evidence from Taiwan and South Korea" forthcoming in *The World Bank Economic Review.*

Bernard, Andrew B. and J. Bradford Jensen (1995), "Exporters, jobs and wages in U.S. manufacturing, 1976-1987", *The Brooking Papers on Economic Activity: Microeconomics 1995*, pp. 67-112.

Bernard, Andrew and J. Bradford Jensen, (1999), "Exceptional exporter performance: cause, effect or both?", *Journal of International Economics*, 47, pp. 1-25.

Clerides, Sofronis K. Saul Lach and James R. Tybout (1998), "Is learning-by-exporting important? Micro-dynamic evidence from Colombia, Mexico and Morocco", *Quarterly Journal of Economics*, vol. CXIII, August, pp. 903-947.

Ericson, Richard. and Ariel Pakes (1995), "Markov-perfect industry dynamics: A framework for empirical work", *Review of Economic Studies*, 62, pp. 53-82.

Feenstra, Robert (1997),"Estimating the effects of trade policy ", *Handbook of International Economics , III,* 18, Elsevier Science B.V.

Good, David H. (1985), " The effect of deregulation on the productive efficiency and cost structure of the airline industry", PH.D. dissertation, University of Pennsylvania.

Good, David M. Ishaq Nadiri and Robin Sickless (1996), "Index number and factor demand approaches to the estimation of productivity", NBER Working Paper 5790.

Griliches, Z. and H. Regev (1995),"Firm productivity in Israeli industry 1979-1988", *Journal of Econometrics* 65, pp. 175-203.

Hopenhayn, Hugo (1992), "Entry, Exit, and firm dynamics in long run equilibrium", *Econometrica*, 60, September, pp. 1127-1150.

Jensen, J. Bradford and J. Wagner (1997), "Exports and success in German manufacturing", *Weltwirtschaftliches Archiv*, vol 133 (1), pp. 134-157.

Jovanovic, Boyan (1982), "Selection and the evolution of industry", *Econometrica*, 50, pp. 649-670.

Leonidou, L. C. and Katsikeas, C. (1996), "The export development process: an integrative review of empirical models", *Journal of International Business Studies*, pp. 517-551.

Kolmogorov, A.N. (1933), "Sulla determinazione empirica di une legge di distribuzione", *Giorn. dell'Istit. Degli att.*, Vol 4, pp. 83-91.

Martín Marcos, Ana (1990), "Estimación del stock de capital para los sectores de la EI", Documento Interno nº 4. *Programa de Investigaciones Económicas. Fundación Empresa Pública.*

Martín, Ana and Cristina Suárez (1997), "El stock de capital para las empresas de la Encuesta Sobre Estrategias Empresariales". Documento Interno nº 13. *Programa de Investigaciones Económicas. Fundación Empresa Pública.*

Silverman, B.W. (1986), *Density estimation for statistics and data analysis*, Chapman and Hall.

Smirnov, N.V. (1939), "On the estimation of the discrepancy between empirical curves of distribution for two independent samples", *Bull. Math. Univ. Moscow*, vol. 2, nº 2, pp.3-14.

Tybout, James R. (1997), "Heterogeneity and productivity growth: assessing the evidence", Mark J. Roberts and James R. (eds.), *Industrial evolution in developing countries*, Oxford University Press.

Table 1

Productivity distributions of exporting and non-exporting firms: Descriptive statistics

	Exporting firms	Non-exporting firms
Lower quartile	-0.18	-0.27
Median	-0.08	-0.14
Upper quartile	0.03	-0.02
Interquartile range	0.22	0.25

Table 2

Hypotheses test statistics

	Equality of distributions		Stochastic dominance of entering firms	
	Statistic	p-value	Statistic	p-value
1990	1.85	0.00	0.04	0.99
1991	2.79	0.00	0.16	0.95
1992	2.54	0.00	0.00	0.99
1993	3.13	0.00	0.06	0.99
1994	3.49	0.00	0.01	0.99
1995	3.53	0.00	0.00	0.99
1996	3.49	0.00	0.03	0.99

Table 3

Productivity and export intensity: descriptive statistics of the distributions

	Small firms			Large firms		
	Low intensity	Medium intensity	High intensity	Low intensity	Medium intensity	High Intensity
Lower quartile	-0.25	-0.20	-0.17	-0.12	-0.12	-0.15
Median	-0.13	-0.09	-0.07	-0.02	-0.03	-0.04
Lower quartile	-0.00	0.03	0.04	0.08	0.07	0.06
Interquartile range	0.24	0.23	0.21	0.19	0.18	0.20

Note: Exporting firms have been classified according to the quartiles of the export intensity distribution: high intensity for firms over the upper quartile of distribution; medium intensity for firms between the lower and the upper quartiles and low intensity for firms under the lower quartile.

Table 4
Hypotheses test statistics

	Equality of Distributions		Stochastic dominance of entering exporters	
	Statistic	p-value	Statistic	p-value
Selection hypothesis				
Ex-ante productivity differences (1991)	1.12	0.16	0.02	0.99
Ex-post productivity differences (1996)	1.33	0.06	0.00	0.99
Learning Hypothesis				
Sample I	0.70	0.71	0.09	0.98
Sample II	0.48	0.97	0.19	0.93

Note: Exporting firms in Sample I includes entering firms in the export market before and after 1991. Sample II includes firms that enter the export market after 1991. Productivity growth corresponds to the period 1991-1996

Figure 1

Total Factor Productivity: exporting and non-exporting firms.
(Kernel cumulative distribution estimators)

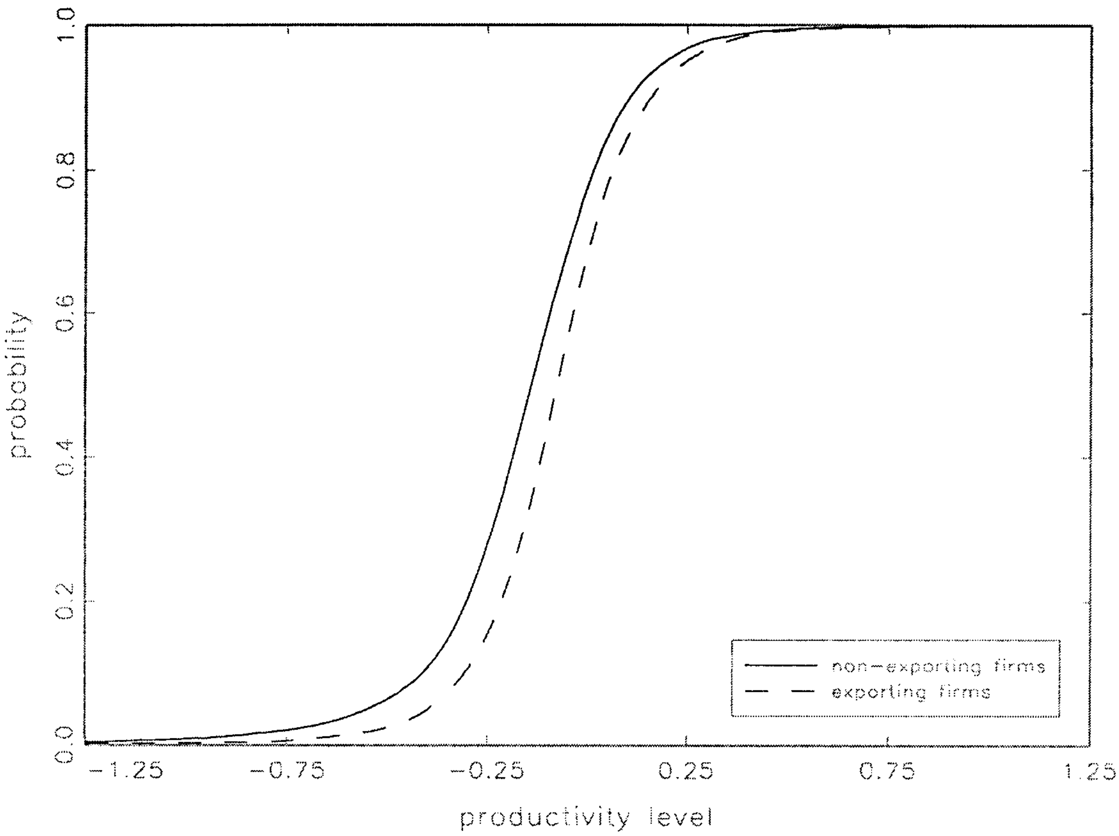


Figure 2

Total Factor Productivity and export intensity.
(Kernel density estimators)

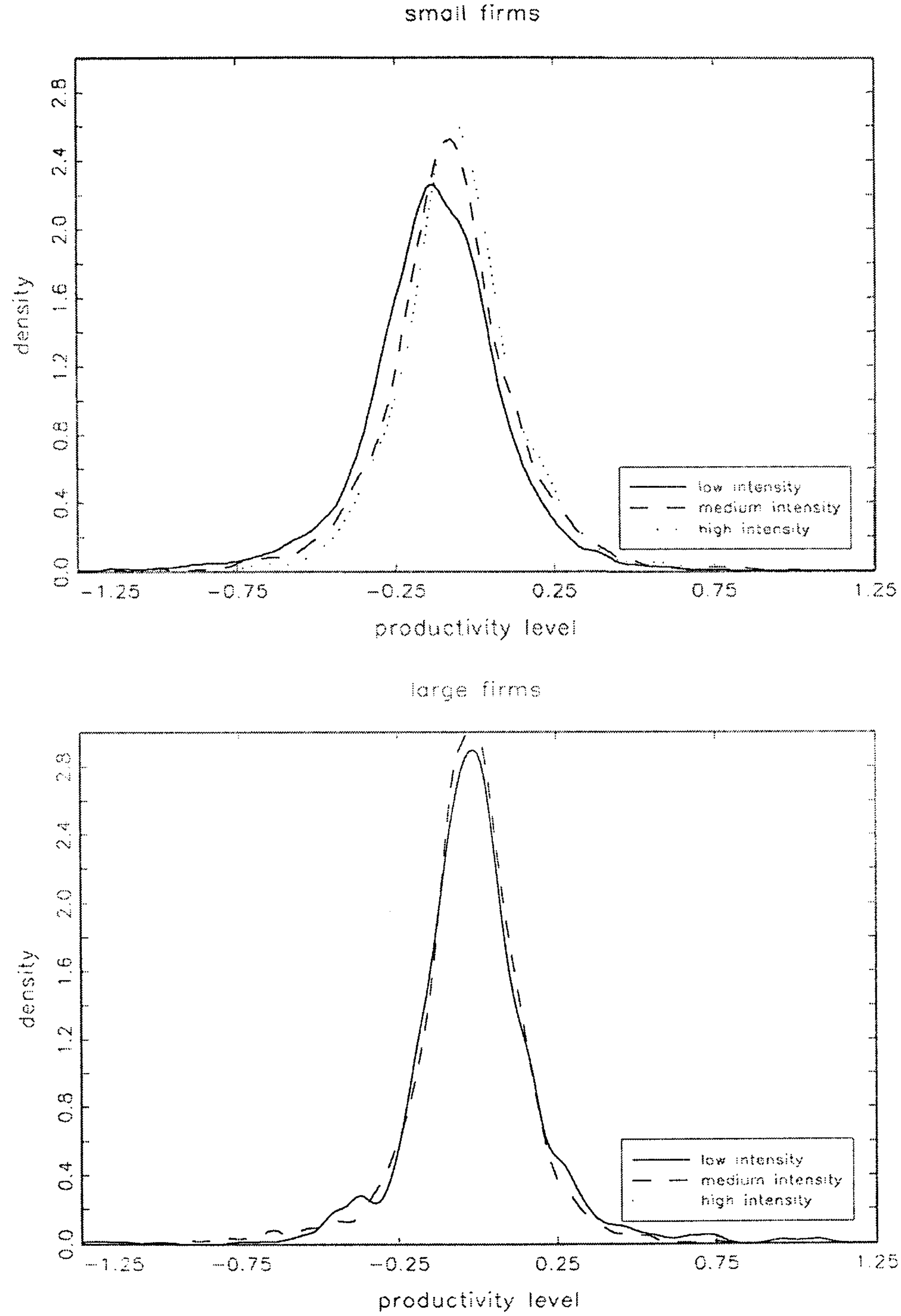
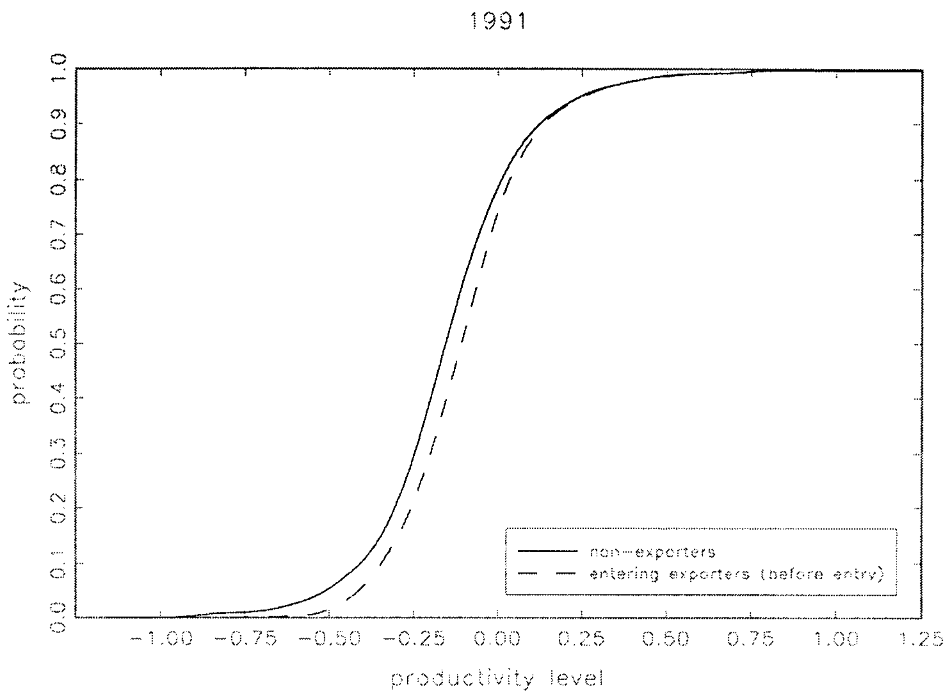


Figure 3

Productivity levels and exports: selection hypothesis
(Kernel cumulative distribution estimators)



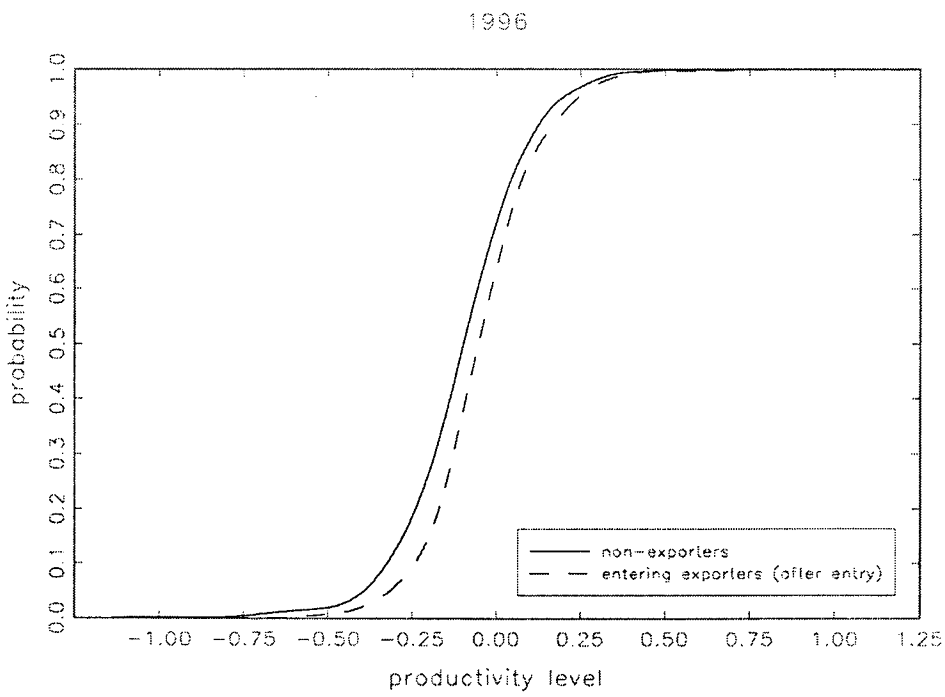


Figure 4

Productivity growth and exports: learning hypothesis
(Kernel cumulative distribution estimators)