Exporting and performance: evidence from Chilean plants

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Abstract. Recent empirical evidence documents the superior characteristics of exporters relative to non-exporters. Three explanations for this phenomenon have been proposed: self-selection; learning-by-exporting; and conscious self-selection. We test these three hypotheses using plant-level data from Chile. We find that plants that enter international markets show superior initial performance compared with non-exporters, consistent with self-selection; we observe increases in productivity after plants begin to export, which is consistent with learning-by-exporting. We also find strong evidence supporting the idea that self-selection is a conscious process by which plants increase productivity with the purpose of becoming exporters. JEL classification: F14; O54; D21

Exportations et performance: résultats pour des établissements chiliens. Certains résultats récents montrent empiriquement que les exportateurs ont une performance supérieure à celle des non exportateurs. On a proposé trois explications de ce phénomène : auto sélection, apprentissage par l'exportation, et auto sélection consciente. On met ces trois hypothèses au test à l'aide de données chiliennes. On découvre que les établissements qui entrent sur les marchés internationaux ont une performance initiale meilleure que celles des non exportateurs, ce qui supporte l'hypothèse d'auto sélection; on observe aussi que leur productivité s'accroît après qu'ils ont commencé à exporter, ce qui supporte l'hypothèse d'apprentissage; enfin on obtient des résultats qui montrent que ce processus d'auto sélection est conscient : les établissements accroissent leur productivité dans le but de devenir exportateurs.

We would like to thank two anomynous referees and seminar participants at Purdue University, the Midwest International Economics Conference held at Indiana University (Fall 2003), and the 58th International Atlantic Economic Conference at Chicago (2004) for very helpful comments. Thanks also to Amil Petrin for letting us use his Stata programs to estimate production functions. All remaining errors are ours. Email: rialopez@indiana.edu

1. Introduction

A growing body of empirical evidence has documented the superior characteristics of exporters relative to non-exporters. Researchers have found that exporters are larger, more productive, more capital-intensive, and pay higher wages than firms that produce solely for the domestic market, even in narrowly defined industries.[1] Some scholars have interpreted these findings as evidence that exporting improves productivity. The most common explanation, known as *learning-by-exporting*, is that exporters acquire information from foreign customers, who may suggest ways to improve the manufacturing process, product design, and the quality of the good (Westphal, Rhee, and Pursell 1984; World Bank 1993; Grossman and Helpman 1991; Keesing and Lall 1992). Another possibility is that exports allow firms to increase the scale of production so that, in the presence of economies of scale, productivity is improved. Other researchers, however, have argued that the positive correlation between export participation and performance may be due to the fact that only the more productive firms can afford the higher costs of exporting. Thus, firms *self-select* into export markets.

Previous studies have found that plant productivity increases before entry to export markets but it does not seem to increase much, if at all, after entry (e.g., Bernard and Jensen 1999; Clerides, Lach, and Tybout 1998; Aw, Chung, and Roberts 2000). Thus, there is strong evidence of self-selection and only modest support for the learning-by-exporting hypothesis.[2] However, not much work has been done to explain the sources of productivity growth before entry to export markets. One possible explanation is that firms increase their productivity with the purpose of becoming exporters. It could be the case that productivity depends on the decision to export, and that the higher returns available in world markets induce firms to increase their productivity before they attempt to enter them (López 2004). Thus, a *conscious self-selection* process would exist. In this context, a decrease in trade costs (e.g. transport costs) induces some firms to adopt new technologies, which increases productivity (Yeaple 2005).

The contribution of this paper is to test, for the first time, all three hypotheses – self-selection, learning-by-exporting, and conscious self-selection – using a single data set. In particular, we are interested in the answers to three questions: Do good firms become exporters? Does export participation increase productivity? Are export markets an incentive to increase productivity? In other words, we explicitly consider the possibility that productivity is endogenous with

1 See Aw and Batra (1998), and Aw, Chung, and Roberts (2000) for Taiwanese and Korean firms; Bernard and Jensen (1999, 2004) for U.S. firms; Bernard and Wagner (1997) for German firms; Clerides, Lach, and Tybout (1998) for Colombia, Mexico, and Morocco.

2 There are, however, some papers that do find increases in productivity after firms begin to export: Kray (1999) for Chinese firms; Bigsten et al. (2000), and Van Biesebroeck (2003) for African firms; Castellani (2002) for Italian firms; and Baldwin and Gu (2003) for Canadian plants.

respect to the decision to export. The importance of these questions for policy is clear. If exports were a source of productivity growth in developing countries, then policymakers should design policies to increase domestic firm access to world markets.

Using plant-level data from the Chilean manufacturing sector, we analyse the differences in performance between exporters and non-exporters, controlling for plant characteristics, and, in contrast to previous studies, explicitly taking into account the role of foreign ownership. If foreign-owned plants are more productive and more export oriented than domestic firms, we may erroneously conclude that exporters are more productive than non-exporters if we do not control for foreign ownership.

The main results are as follows. First, we find that firms that enter international markets show superior initial performance compared with non-exporters; in other words, we discover evidence consistent with self-selection. Second, we observe increases in productivity after firms begin to export, which is consistent with learning-by-exporting. Third, we find that previous investments increase the probability of beginning to export. Thus, if firms invest to become exporters, then this is strong evidence supporting the idea that self-selection is a conscious process by which firms increase productivity with the explicit purpose of becoming exporters. In summary, our results are consistent with the idea that increasing access to export markets boosts productivity in developing countries.

2. Data set and basic patterns

The empirical analysis is based on the Annual National Industrial Survey (ENIA) carried out by the National Institute of Statistics of Chile (INE) for the years 1990 through 1996. This survey covers the universe of Chilean manufacturing plants with 10 or more workers and includes almost 5,000 plants per year; therefore, we have about 35,000 plant-year observations. A plant is not necessarily a firm, since they may have several plants; however, a significant percentage of plants in the survey are actually single-plant firms.[3] The INE updates the survey annually by incorporating plants that started operating during the year and excluding those plants that stopped operating for any reason. Each plant has a unique identification number, allowing us to follow the plants over time. The unbalanced nature of the data set permits us to identify the plants that are entering and those that are exiting each year.

In table 1 we present some basic information about the panel. The total number of plants that operated for at least one year between 1990 and 1996 was 7,132. The percentage of plants that stayed in operation throughout the entire period was 44.1%, while the percentage of plants that appeared in the

3 Pavcnik (2002) points out that, although for a different period, more than 90% of Chilean manufacturing firms had only one plant.

TABLE 1
Plants in the panel and years of exporting

	Plants in the panel		Years of exporting	
Number of years	Number of Plants	Percentage	Number of plants	Percentage
7	3,142	44.1	396	5.6
6	614	8.6	184	2.6
5	534	7.5	164	2.3
4	523	7.3	174	2.4
3	552	7.7	218	3.1
2	675	9.5	282	4.0
1	1,092	15.3	511	7.2
0	–	–	5,203	73.0
Total	7,132	100.0	7,132	100.0

NOTES: Plants in the panel: The number (and percentage) of plants that stayed in the panel for a total of 7, 6, 5, etc. years. Years of exporting: The number (and percentage) of plants that exported for a total of 7, 6, 5, etc. years.

sample for only one year was 15.3%. In terms of export activity, we observe that the percentage of plants exporting throughout the entire period was 5.6%, while the percentage of plants that exported between 1 and 6 years was 21.5%.

For each plant, the ENIA collects data on production, value added, sales, employment and wages (production and non-production), exports, investment, depreciation, energy usage, foreign licences, and other plant characteristics. The ENIA also classifies plants according to the 4-digit ISIC (Rev. 2) code, which allows us to identify the specific industry in which the plant operates. Using 4-digit level price deflators, we expressed all the variables in constant prices of 1996. Capital stocks were constructed using the perpetual inventory method for each plant.

Some descriptive statistics are summarized in table 2. The data set contains information for an average of 4,934 plants per year, with 20.6% being exporters, and 79.4% non-exporters. Domestic plants accounted for 95.6% of the plants, while plants with at least 10% of foreign ownership accounted for only 4.4%. In the great majority of plants with foreign ownership, foreigners had control of the plant (i.e., they owned more than 50% of the plant's assets). The percentage of plants with foreign ownership was higher for exporters than non-exporters: 13.5% for exporters and only 2.4% for non-exporters. In terms of size, 64.6% were classified as small plants (10–49 workers), 22.6% were medium plants (50–149 workers), and only 12.9% were considered large (150 or more workers). With respect to the type of business, most of the plants were classified in one of three categories: limited partnerships (47.9%), corporations (30.6%), and proprietorship (17.8%).

In figure 1 we show the importance of exporters in the manufacturing industry in terms of employment, value added, and capital. Although exporters represent only about 20% of the plants, their importance is much larger. In

TABLE 2
Descriptive statistics, averages, 1990–96

	Number	Percentages
A. TOTAL NUMBER OF PLANTS	4,934	100.0
B. EXPORT ORIENTATION		
1. Exporters	1,017	20.6
- Foreign ownership	137	13.5
- Domestic	880	86.5
2. Domestic market only	3,917	79.4
- Foreign ownership	94	2.4
- Domestic	3,823	97.6
C. OWNERSHIP		
1. Domestic (<10% of foreign ownership)	4,716	95.6
2. Foreign Owned (>= 10% of ownership)	218	4.4
>= 50% of ownership	185	84.9
D. SIZE		
1. Small (10–49 Workers)	3,185	64.6
2. Medium (50–149 Workers)	1,114	22.6
3. Large (>= 150 Workers)	635	12.9
E. TYPE OF BUSINESS		
1. Proprietorship	881	17.8
2. Limited partnership	2,362	47.9
3. General partnership	64	1.3
4. Corporation	1,511	30.6
5. Cooperative	50	1.0
6. Public	64	1.3
7. Other	4	0.1

SOURCE: Annual National Industrial Survey, National Institute of Statistics, Chile

terms of employment, the share of exporters grew from 40% to more than 50% over the period 1990–96. The evidence is similar with regard to value-added and capital stock. The share of exporters in value-added has increased from 56% to 62%, and the share in capital stock shows an increase from 63% to 73% over this period.

Similar to the evidence for other countries, exporter plants have superior characteristics to non-exporters. Once we control for size (number of workers) and foreign capital participation,[4] exporters are 19% more productive in terms of total factor productivity (TFP)[5] and 60% larger, in terms of sales and value added, than non-exporters. There are also significant differences in wages paid by both groups of plants: the wage differential is approximately 20%. Interestingly, exporters pay relatively more to skilled workers – the average wages of non-production workers differ by almost 30%, while for production

4 In other words, we estimate the following equation: $\ln(y_{it}) = \alpha + \beta X_{it} + \delta' Z + \delta_s + \delta_t + e_{it}$, where y_{it} is the variable we are interested in (e.g., productivity), X_{it} is a dummy equal to 1 if plant i exported at t. Z is a vector of plant characteristics (size and foreign ownership), and δ_s and δ_t are sector and year dummy variables. The parameter β gives the differences between exporters and non-exporters.

5 See the appendix for an explanation on how TFP is computed.

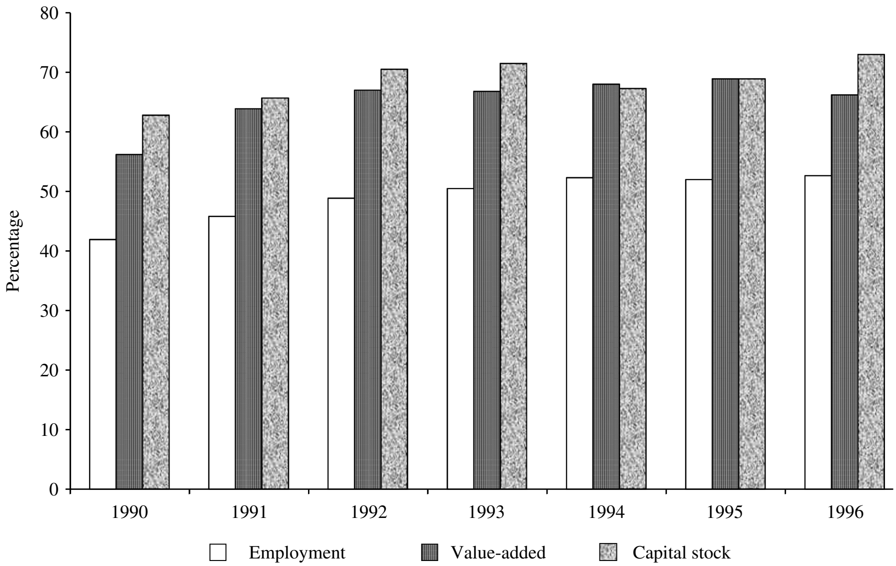

FIGURE 1 Share of exporters in the Chilean manufacturing industry

workers, the difference is about 15%. Another important difference between exporters and non-exporters concerns capital per worker: exporters are about 60% more capital intensive than non-exporters.

Given that we are interested in knowing if the export markets are or are not a source of productivity growth for plants involved in exporting, we can gain a preliminary idea by looking at the productivity trajectories of plants with different export market participation patterns. With that purpose we purge plant productivity, TFP, of industry (at the 3-digit ISIC level) and time effects. In other words, we estimate the following equation:

$$\ln\ TFP_{it} = \delta_s + \delta_t + e_{it},$$

where TFP_{it} is the total factor productivity of plant i at time t, while δ_s and δ_t are vectors of sector and year dummy variables. We use the residual, e_{it}, to examine the paths of productivity for plants that enter, exit, or stay in the export markets.

We distinguish two types of entrants: entrants-stay are those plants not exporting in the previous years, start exporting at $t = 0$, and continue exporting until the end of the period; entrants-exit are those that enter at $t = 0$ but stop exporting in some year after entry. Quitters are those plants that previously exported, but leave international markets at $t = 0$. Considering the seven-year period available and to maintain the same group of firms and the same years of comparison, entry years correspond to 1991, 1992, 1993, and 1994, while exit years correspond to 1992, 1993, 1994, and 1995. The period of comparison is two years before entry (exit) up to two years after entry (exit). Non-exporters are plants not exporting in every year of the period 1990 to 1996, and permanent exporters are plants exporting in every year of this period.

Figure 2 shows the evolution of the term $e_{it} + 1$ for entrants and quitters.[6] Results for exporters and non-exporters are presented separately in figure 3 because there is no natural $t = 0$ for them. As we can see in these two figures, entrants-stay are more productive than non-exporters before they start exporting. Moreover, there appears to be an increase in TFP, though very small, before entry. After entry, productivity does not seem to increase further in these plants. Quitters also appear more productive than non-exporters, but their productivity declines before exit. Permanent exporters tend to be the most productive among all plants. It seems, however, that the gap between permanent exporters and non-exporters narrowed between 1990 and 1996.

This preliminary evidence suggests that firms that enter the export markets are already more productive than non-exporters before they enter. However, they also seem to be slightly less productive than permanent exporters, which suggests that there might be some productivity improvements after entry, but longer than the ex post entry periods examined in the figure. More formal evidence is presented in the following sections.

3. The self-selection hypothesis

The self-selection hypothesis suggests that a positive relationship between firm performance and exports originates because only the most productive firms are capable of entering international markets. It is argued that firms must incur sunk costs to enter the export markets, and that the level of competition abroad is higher than in the domestic market. In this context, exporting will be profitable only for the most productive firms. Under this hypothesis, initial performance would be important to explain why some firms export and others sell only to the domestic market.

To investigate the self-selection hypothesis we study how initial plant characteristics affect the probability of beginning to export. We pool pairs of years for firms not exporting in the first year and look at how the probability of beginning to export in the second year is affected by plant characteristics in the first year of the pair. In other words, we estimate the following equation:

$$\Pr\,(X_{i,t} = 1 | X_{i,t-1} = 0) = F(\beta' \Omega_{i,t-1} + \delta_s + \delta_t + e_{it}), \qquad (1)$$

where $X_{i,t}$ is a dummy variable equal to one if plant i exported at time t. $\Omega_{i,t-1}$ is a vector of plant characteristics at $t - 1$, which previous literature suggests affect the probability of exporting; these variables are TFP, plant size, foreign ownership, a dummy equal to one if the firm spends on foreign licences, the

6 We add one to avoid having trajectories below the horizontal axis. In this way, graphs are much easier to read.

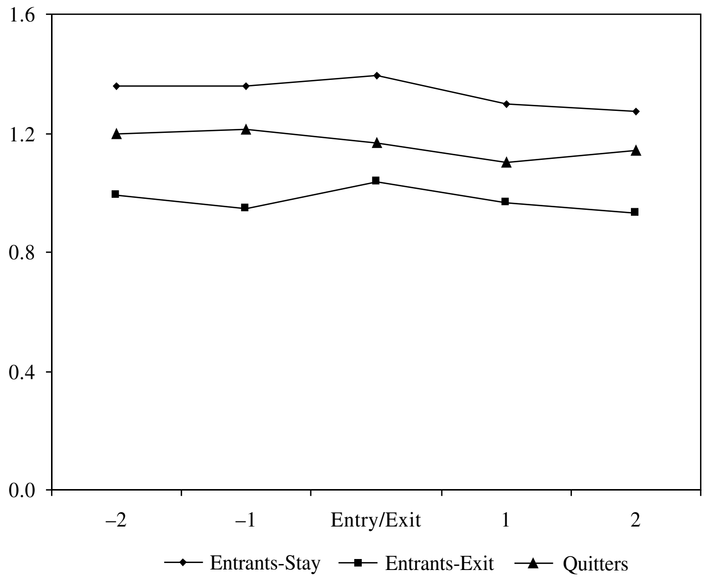

FIGURE 2 Path of TFP for entrants and quitters

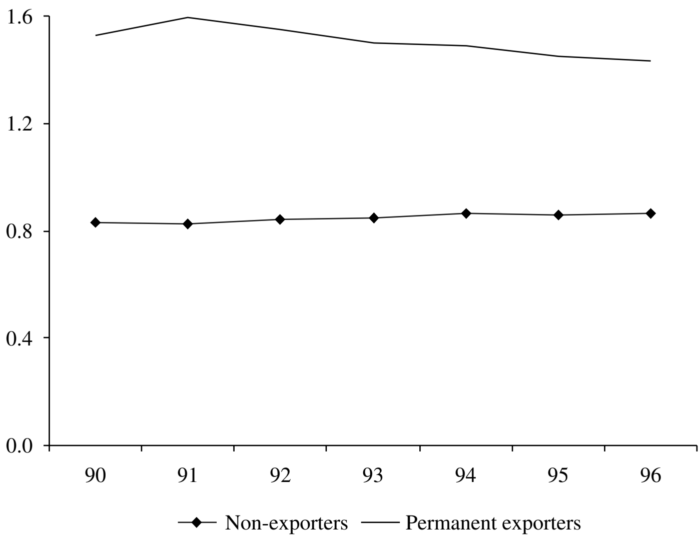

FIGURE 3 Path of TFP for permanent exporters and non-exporters

ratio of skilled to total labour, and plant age. Plant size is included as two dummy variables for medium and large plants. The dummy for foreign licences, which refers to expenditures on foreign technical assistance and

TABLE 3
The probability of beginning to export

	(1)	(2)	(3)
ln (TFP)$_{t-1}$	0.009	0.007	0.007
	(4.77)***	(3.89)***	(3.19)***
Medium$_{t-1}$	0.053	0.044	0.039
	(12.56)***	(10.95)***	(8.96)***
Large$_{t-1}$	0.103	0.080	0.065
	(12.68)***	(10.55)***	(8.00)***
Foreign capital$_{t-1}$	0.036	0.031	0.02
	(4.08)***	(3.67)***	(2.32)**
Foreign licences$_{t-1}$	0.019	0.017	0.014
	(2.57)***	(2.33)**	(1.76)*
(Skilled/total labor)$_{t-1}$	0.027	0.022	0.019
	(2.90)***	(2.35)**	(1.91)*
Age$_{t-1}$	−0.001	−0.001	−0.001
	(4.14)***	(4.01)***	(3.12)***
ln (Investment)$_{t-1}$		0.002	0.002
		(6.71)***	(4.15)***
ln (Investment)$_{t-2}$			0.001
			(1.97)**
Number of observations	18,595	18,595	14,378
Pseudo R-squared	0.102	0.109	0.106

NOTES: Numbers are the marginal effects of probit estimation. Absolute values of robust z-statistics in parentheses. Standard errors were adjusted for repeated observations on plants.***, **, *: significant at 1%, 5%, and 10%, respectively. Medium = 1 for plants with 50 to 149 workers; Large = 1 for plants with 150 or more workers; Foreign capital = 1 for plants with positive % of foreign ownership. Sector and year dummy variables were included but not reported.

licences, is used as a proxy for technological innovation. Finally, age is the number of years the plant has been present in the survey since 1979 (the first year the survey is available).[7] δ_s and δ_t are sector and year dummy variables; β is the vector of parameters that reflect the impact of changes in Ω on X.

In table 3, column 1, we show the results of estimating (1) with a probit model. The estimates, which correspond to the marginal effects, show that those plants that initially are more productive, larger, foreign owned, have a higher share of skilled workers, and spend on foreign licences are more likely to enter the export markets. A 1% increase in productivity increases the probability of beginning to export to almost 1%. Medium and large plants are 5 and 10% more likely to start exporting than small plants, respectively. The coefficient on foreign ownership is also important and significant: being part of a multinational increases the probability of entering the international markets to 3.6%. Interestingly, younger firms are more likely to begin to export (the estimate for age is negative), which suggests that exporters may be plants that started operations with the international markets in mind.

7 Although the survey has been available since 1979, data on exports are collected only from 1990.

These findings imply that it is the 'better' firms that are becoming exporters. In the spirit of self-selection, this means that prior to exporting, a firm must acquire certain characteristics in terms of size, human capital, and productivity in order to sell its goods abroad. These results, however, do not necessarily determine a unique causal relationship between performance and exports. It may be argued that as a result of technological transfers or economies of scale, firm performance can improve upon entrance into international markets. This phenomenon is analysed in the next section.

4. The learning-by-exporting hypothesis

The learning-by-exporting hypothesis suggests that a positive correlation between performance and exporting derives from improvements in productivity as a result of the absorption of knowledge and new technologies once firms are involved in the exporting business. For this hypothesis to be valid, plants should improve their performance, especially in terms of productivity, once they enter international markets. Note, however, that this could also reflect other factors, such as differences in product mix between exporters and non-exporters, or different mark ups in the domestic and the international markets. In this section, we analyse learning-by-exporting effects, taking into account explicitly how long the plant has been exporting. It may be argued that exporting patterns are important for shedding light on the nature of learning effects. One theoretical possibility is that exporting generates only a one-time improvement in plant productivity. Thus, it can be expected that only more recent exporters should exhibit higher productivity than other plants. On the other hand, if there is a continuous process of learning, long-time exporters may have permanently higher productivity levels than other plants.

Although the period under study is relatively short, there are several exporting patterns in our sample. We classify plants into five categories. First, given that we are interested in the effect on productivity for plants that have entered the export markets, we define as entrants-stay those plants that initially do not export but at some point begin exporting and continue to export throughout the end of the sample period. Second, we identify firms that have been exporting during the whole period to analyse whether permanent exporters experience greater productivity gains. The third category contains plants that initially export but stop exporting at some year: quitters. The fourth category contains those plants that change export status more than once: switchers. Our base category comprises those that never export during the period under study. In this empirical exercise, we are particularly interested in testing whether permanent exporters or plants entering international markets experience higher levels of productivity than other plants.

In table 4, we present our results for total factor productivity. The dependent variable is plant TFP (measured in log) at the final year the plant is observed. We consider as possible final years a plant is observed the years

TABLE 4
Final productivity levels and export experience

	(1)	(2)	(3)
Entrant-stay	0.402	0.170	
	(4.91)***	(3.28)***	
Late entrant-stay			0.134
			(2.48)**
Early entrant-stay			0.194
			(3.35)***
Permanent	0.452	0.074	0.075
	(5.40)***	(1.30)	(1.31)
Quitter	0.164	−0.010	−0.010
	(1.84)*	(0.19)	(0.18)
Switcher	0.181	0.053	0.053
	(2.51)**	(0.65)	(0.66)
Initial TFP		0.506	0.506
		(16.97)***	(16.99)***
Medium		0.046	0.046
		(1.02)	(1.02)
Large		0.218	0.217
		(2.74)***	(2.74)***
Foreign capital		0.125	0.125
		(1.63)	(1.64)
Age		0.003	0.002
		(0.48)	(0.46)
Final year = 1995	−0.234	−0.155	−0.155
	(5.47)***	(3.41)***	(3.43)***
Final year = 1996	−0.300	−0.173	−0.172
	(4.05)***	(2.88)***	(2.86)***
Initial year = 1991	−0.108	−0.106	−0.106
	(2.61)**	(3.02)***	(3.02)***
Initial year = 1992	−0.047	−0.303	−0.303
	(0.86)	(4.62)***	(4.69)***
Constant	7.925	4.093	4.097
	(368.57)***	(18.88)***	(18.91)***
Number of observations	3,473	3,473	3,473
R-squared	0.46	0.58	0.58

NOTES: Absolute values of robust t-statistics in parentheses. ***, **, *: significant at 1% 5%, and 10%, respectively. Medium = 1 for plants with 50 to 149 workers; Large = 1 for plants with 150 or more workers; Foreign capital = 1 for plants with positive % of foreign. Sector dummy variables were included but not reported. All plant variables are measured at the initial year. TFP is measured in logs.

1994, 1995, and 1996. To test for learning effects, we include as regressors four dummy variables representing the different exporting patterns previously defined. To control for other factors that may explain differences in productivity across plants, we include as covariates the initial values of TFP,[8] two dummy variables for size (medium and large plants), a dummy variable for

8 Initial year is the first year a plant is observed in the sample. We include plants initially observed in 1990, 1991, and 1992. In all our regressions, to control for temporal differences in TFP, we include both initial- and final-year dummy variables.

plants with foreign capital participation, and plant age. For each regression, we expect the parameter associated to entrants and permanent to be positive. Moreover, in the case that productivity gains are more prevalent for plants recently entering foreign markets, we should find a larger parameter for entrants.

We sequentially estimate this equation. In column 1 we include only the four dummy variables representing the plant exporting patterns, industry-specific effects, and final- and initial-year-specific effects. In column 2 we include as additional regressors the other plant-specific variables. In column 3, to test whether learning effects are concentrated in plants entering in the most recent years, we divide our sample of entrants in two different groups: those that entered at the beginning of the period (1990 to 1993), and those that entered at the end of the period (1994 to 1996). We call these groups 'early entrants' and 'late entrants,' respectively. If recent entrants experience larger productivity gains, the parameter associated with these plants should be positive and higher than the parameter for plants entering in previous years.

The results show that not controlling for initial plant characteristics could generate misleading results regarding the evidence of learning-by-exporting. As shown in column 1, consistent with the hypothesis of learning, all exporters display higher productivity than non-exporters. This is valid not only for plants exporting permanently and entering international markets, but also for quitters and plants changing their export status more than once (switchers). Moreover, the coefficient for permanent exporters is higher and statistically significant different from the coefficient for non-exporters. The evidence in column 2, however, shows that once we control for initial differences in plants characteristics (size, productivity, foreign capital, and age), there are no further differences between permanent exporters and non-exporters. The only evidence consistent with learning-by-exporting is that entrants are 17% more productive than non-exporters, and they are also more productive than the other plants. Then, the exporting pattern of a plant has a differential impact on its productivity only for entering firms. These results are not driven by a self-selection phenomenon. Plants entering international markets achieve a higher productivity level even after we control for initial differences in productivity.

In column 3 we distinguish between recent entrants and plants that started to export at the beginning of the period. Although it may be expected that more recent exporters experience larger productivity gains, the evidence is not consistent with this hypothesis. According to the F-test, late entrants are not more productive than early entrants.

In summary, we have found evidence favouring the hypothesis of learning-by-exporting only for plants entering international markets. Permanent exporters are more productive than non-exporters, but this is attributable to initial productivity differences, not to productivity gains associated to exporting. Thus, productivity gains for entering plants are likely to be short run.

5. Conscious self-selection

According to the self-selection hypothesis, more productive firms become exporters. There is no reasonable explanation, however, for why some firms may become more productive to begin with. Researchers have not attempted to explain the source of productivity growth before entry. Theoretical papers, such as Melitz (2003) and Bernard et al. (2003), assume exogenous productivity and show that only the more productive firms can enter international markets affording fixed and/or variable trade costs. In such a context, trade policy may affect productivity by reallocating production from low-productivity firms to high-productivity firms. However, there is no effect on firm-level productivity.

López (2004) has recently proposed the idea that self-selection in developing countries may be a *conscious* process by which firms increase their productivity with the explicit purpose of becoming exporters. The reason is that in such countries the goods that are produced for export markets, in particular those exported to developed countries, are usually of a higher quality than the analogous goods produced for the domestic market.[9] Therefore, firms that want to focus on world markets have to buy new technologies and invest in new capital in order to produce an export (i.e., better) version of the good. The introduction of new technology increases the value of the output produced by exporters, thereby increasing measured productivity relative to non-exporter firms, which continue to produce low-quality goods for domestic markets. López (2004) develops a simple model in which profit-maximizing forward-looking firms invest in a new technology with the intent of becoming exporters, and the adoption of the technology requires mastery and learning that only initially more productive firms can accomplish. Therefore, he argues, there is indeed self-selection, which involves a conscious decision to increase productivity.[10]

Important theoretical support for the idea that entry to export markets is not an exogenous process is also developed by Yeaple (2005). He introduces a model with ex ante homogeneous firms that invest in two technologies that differ in terms of the unit costs of production. The existence of workers with different skills implies that some firms adopt the low-cost technology and others the high-cost technology. Thus, contrary to other models, heterogeneity appears because firms make different decisions with respect to technologies. In this framework, when the economy is opened, only the firms that use the low-cost technology will export. In this context, a fall in trade costs may induce some firms to switch from the high-cost technology to the low-cost technology, which is reflected in an increase in measured productivity at the firm level.

9 For example, wine consumed in Chile is very homogeneous and of low quality, whereas exported wine is of high quality (in order to meet higher quality requirements of consumers in developed countries).

10 This idea is consistent with the empirical literature that finds a positive link between exports and innovation. See, for example, Wakelin (1998).

To analyse this hypothesis we study the behaviour of plants that make the transition from producing exclusively for the domestic market to producing for the export market, compared with non-exporters. If this hypothesis is correct, we should observe that plants that make the transition make investments to incorporate new technologies that allow them to produce a higher-quality good. If there is a conscious process of self-selection, then plants that become exporters in the future should start to invest in physical capital before entry into the export markets. Thus, we estimate equation (1) again, including investment. The results are presented in column 2 of table 3. We see that investment enters significantly and with a positive sign. An increase of 1% in investment increases the probability of beginning to export by 0.2%. Given that entry to exporting may require a stream of investments, we also include the investment variable lagged two periods. The results, in column 3 of the same table, show that investment from two periods previously increases the probability of exporting, although its effects is much lower: an increase of 1% in investment two years ago increases the probability of entry by 0.1%.

In summary the evidence shown in this section strongly supports the idea that firms make conscious efforts to increase their productivity when they focus on the export markets. Plants seem to invest in capital either to increase the quality of the goods they produce or to reduce costs of production, with the purpose of becoming exporters. In other words, productivity increases do not seem to be completely exogenous, which implies that better access to export markets may be a source of productivity growth for firms in developing countries. It is important to notice, however, that alternative explanations cannot be completely ruled out. It is quite possible that firms invest simply to succeed in the domestic market and then, subsequently, they enter the export markets.

6. Conclusions

This paper has focused on the significant differences in plant characteristics between exporters and non-exporters. There is much recent empirical work that attempts to discover the best explanation for the positive relationship between exports and performance. We have shown that Chilean data are consistent with evidence for other economies: exporters outperform non-exporters in productivity.

From an empirical point of view, we carry out empirical tests in line with previous studies on whether learning-by-exporting or self-selection can explain this positive relationship between exports and firm characteristics. We depart, however, from these studies in two main significant ways. First, we identify exporters with different patterns of exporting, and we let the data tell us whether this makes a difference in terms of potential learning effects. Our results suggest the existence of learning-by-exporting for entrants but not for those that export continuously.

Second, though our estimates support the hypothesis of self-selection, we provide evidence that self-selection may be an active and conscious process carried out by firms. Our interpretation of these findings about self-selection is important. If firms actively target international markets, then there would be some policy role to facilitate this process, since the higher returns available in the export markets may be an incentive to increase productivity. This is especially relevant for developing countries, for which some firms may be constrained in their investment decisions, owing to deficiencies in capital markets.

An important caveat to our analysis, like the recent literature, concerns learning-by-exporting. We cannot rule out the possibility that some learning effects are missing from our estimates. It may be argued that the existence of externalities from exporters to domestic firms, or indeed from consolidated exporters to firms that initially do not export, generates a downward bias on the effect of exports on firm performance. It is traditionally argued that learning effects arise as exporters absorb technologies from external clients. However, we should expect significant gains in productivity when compared with non-exporters if and only if the absorption of new technologies is perfectly appropriable by exporters. It may be, however, that these new technologies are transferred to other firms that also can increase their productivity. Thus, it should be difficult to find significant differences between non-exporters and firms that become exporters. The same idea has been suggested by Westphal (2002), who argues that the lack of evidence of learning-by-exporting may be explained by a continuous diffusion of newly acquired technology from exporters to non-exporters in such a way that both groups follow similar productivity trajectories. Another possibility is that contact between a firm and a foreign client may occur well before any flow of export is revealed in the data (Tybout 2003). Thus, we believe that a great deal of work is required to clearly analyse the significance of learning-by-exporting effects.

Appendix: Computation of TFP

To compute TFP we estimate a Cobb-Douglas production function separately for each industry. Specifically, for each 3-digit sector we estimate the following equation:

$$y_{it} = \beta_0 + \beta_1 k_{it} + \beta_2 l_{it}^S + \beta_3 l_{it}^U + \varepsilon_{it}, \tag{A1}$$

where y_{it} is the log of value added of plant i at time t; k_{it} is the log of plant's capital stock; and l_{it}^S and l_{it}^U are the logs of skilled and unskilled labour, respectively. TFP is defined as

$$TFP = \exp(y_{it} - \widehat{\beta}_1 k_{it} - \widehat{\beta}_2 l_{it}^S - \widehat{\beta}_3 l_{it}^U).$$

If ε_{it} is uncorrelated with the right-hand-side variables in equation (A1), then the production function could be estimated using OLS. However, although productivity is not observed by the econometrician, it may be observed by the firm; thus, ε_{it} is likely to be correlated with the regressors. Following Olley and Pakes (1996) and Levinsohn and Petrin (2003a,2003b) we explicitly consider this endogeneity problem by writing $\varepsilon_{it} = \omega_{it} + \eta_{it}$, where ω_{it} is the transmitted productivity component and η_{it} is an error term that is uncorrelated with input choices and, assuming that $m_{it} = m_{it}(k_{it}, \omega_{it})$, where m_{it} is the intermediate input. Levinsohn and Petrin (2003a) show that this relationship is monotonically increasing in ω_{it}, so the intermediate input function can be inverted to obtain: $\omega_{it} = \omega_{it}(k_{it}, m_{it})$. Then, equation (A1) becomes

$$y_{it} = \beta_2 l_{it}^S + \beta_3 l_{it}^U + \phi(k_{it}, m_{it}) + \eta_{it}, \tag{A2}$$

where $\phi(k_{it}, m_{it}) = \beta_0 + \beta_1 k_{it} + \omega_{it}(k_{it}, m_{it})$. Equation (A2) can be estimated using the procedures discussed in Petrin, Poi, and Levinsohn (2004). As in Levinsohn and Petrin (2003a), we use consumption of electricity as the intermediate input that allows the identification of the elasticity of capital.

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