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The role of investments in export growth

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Abstract In an increasingly globalised world, exporting plays a central role for economic growth and poverty reduction, particularly in small open economies. In this study, we test the hypothesis that a rise in investment favours entry into export markets and increases exports among firms that are already exporting. We address causal links through impact evaluation techniques for observational data. We examine the binary case and also continuous analysis of investment as treatment. We analyse a panel of Uruguayan manufacturing firms in the period 1997–2008, and we find evidence that investments "cause" exports and export orientation, and this provides a rationale for carefully designing investment promotion policies rather than focusing on other export support policies.

Keywords Exports · Investments · Firm-level data · Treatment effect models

JEL Classifications F1 · D21 · C21

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1 Introduction

In an increasingly globalised world, exporting plays a central role in economic growth and poverty reduction, particularly in small open economies. Access to world markets is generally considered to be one of the necessary conditions for sustained economic growth and poverty reduction in developing countries. Much has been written on the nexus between international market access and growth at the aggregate level and on export-led growth strategies, for example about China and the Asian Tiger countries. By contrast, we have little systematic evidence at the micro-level about how firms in developing countries actually connect with foreign customers and suppliers or about the factors that may help them do so.

Exporting constitutes the most popular, quickest and easiest way for many small firms to internationalise (Leonidou et al. 2007). Indeed, in the case of small and medium enterprises (SMEs) exporting can be key for their survival, growth and long-term viability, since exporting is a less resource-laden approach than alternative foreign market entry or expansion modes such as joint venture arrangements or undertaking manufacturing operations overseas.

Furthermore, exporting is an internationalisation strategy, which can be used by SMEs to sell in foreign markets and benefit from scale economies. Firms' survival and expansion are strongly dependent on a better understanding of the determinants that influence their export performance (Sousa et al. 2008).

There is a growing body of literature on export behaviour among heterogeneous firms.[1] This empirically analyses firm- and plant-level data and finds that, on average, exporting producers are more productive than non-exporters. A general finding is that this reflects a self-selection effect whereby firms that are more productive tend to enter the export market, but in some cases it may also reflect a direct effect of exporting on future productivity gains. A further possibility is that there is a spurious component to the correlation reflecting the fact that some firms undertake investments that lead to both higher productivity and a greater propensity to export.

Recently, several authors have begun to measure the potential role of the firms' own investments in R&D or technology adoption as a potentially important component of the productivity–export link. Bernard et al. (1995), Bernard and Jensen (1997), Hallward-Driemeier et al. (2002), Baldwin and Gu (2004), Aw et al. (2008), Bustos (2011), Lileeva and Trefler (2010) find evidence from micro-data sets that exporting is also correlated with firm investment in R&D or the adoption of new technology that can also raise productivity.

Similarly, Atkeson and Burstein (2007), Ederington and McCalman (2008), Costantini and Melitz (2008), Lileeva and Trefler (2010) and Aw et al. (2008, 2011) study the impact of firm-level innovation on productivity evolution and exporting over time. In addition, studies by Yeaple (2005) and Bustos (2011) highlight the link between firm-level exports and decisions about hiring skilled workers.

Lileeva and Trefler (2010) and Bustos (2011) find that access to a new market makes investment in improving the production process or product quality worthwhile and predict that such upgrading in the exporting country will happen prior to exports actually taking place; this is in line with the work of Costantini and Melitz (2008). Alvarez and Lopez (2005) show that future exporters tend to have higher investment outlays, and Iacovone and Smarzynska Javorcik (2012) find quality upgrading taking place in preparation for entry into export markets, with the price premium emerging 1 year before a variety starts being exported.

However, total physical firm-level investments and changes in export behaviour have been less studied. Investments in physical assets may help firms to expand capacity and obtain scale economies. Nonetheless, credit constraints can hamper or even prevent exporting. The reason is that exporting involves extra costs (e.g. to acquire information about a foreign market, to adapt products to foreign legal rules or local tastes, to produce instruction manuals in a foreign language and to set up a distribution network) that often have to be paid up front and that to a large extent are sunk costs. Firms need sufficient liquidity to pay these costs, and constraints in the credit market may be binding (Wagner 2014a). Furthermore, it tends to take considerably more time to complete an export order (and to collect payment after shipping) than it does to complete a domestic order, and this increases exporters' working capital requirements. Besides these liquidity requirements, export activities are riskier as there are exchange rate fluctuations and the danger that it may not be possible to enforce contracts as easily in a foreign country. Therefore, whether or not a firm is financially constrained can be considered an important factor in the decision to export.[2]

Recently, economists have started to incorporate these arguments into theoretical models of heterogeneous firms and to test the implications of these models econometrically with firm-level data. Chaney (2013), Muûls (2015) and Manova (2013) introduce credit constraints into Melitz's (2003) seminal model of heterogeneous firms and trade to discuss the role of these frictions in the export decision. These models imply that firms are more likely to be exporters and to export more if they are less credit-constrained.

From a policy point of view, in order to improve export performance it is important to ease access to funding.

Rho and Rodrigue (2012) present and estimate a dynamic model of investment and export decisions with heterogeneous firms for Indonesian manufacturing plants. They study the impact of investments in physical capital on firm-level entry, growth and duration in export markets. These authors find that new exporters invest at higher rates that non-exporters and incumbent firms. New investments allow young exporters to survive longer in export markets while

[1] For a review, see Wagner (2012).

[2] For a recent survey on credit constraints and exports, see Wagner (2014b).

reducing their vulnerability to productivity or demand shocks across markets. These authors argue that differences in export behaviour can account for differences in performance in both domestic and export markets across heterogeneous producers and over time. The policy implication is that costly investment may deter firms from entering or maintaining their presence in export markets.

The objective of this study is to test the hypothesis that a rise in investment favours entry into export markets and increases exports among firms that were already exporting. We try to answer the question of what role investments play in entry into foreign markets and export performance. We describe the behaviour of different types of firms (new entrants into export markets, permanent exporters, switchers, and non-exporting firms). We analyse the full sample of firms and also the behaviour of SMEs. Our research has an important policy dimension, but we also make a methodological contribution to the literature by addressing endogeneity issues that arise when we attempt to estimate the impact of asset growth on firm exports.

It is well established in today's world that exporters are larger and more productive than non-exporters (e.g. Bernard et al. 1995; Wagner 2007; ISGEP 2008) and that most of this difference can be attributed to the best performers self-selecting into foreign markets (e.g. Bernard and Jensen 1999). While the ex post impact of export entry on firms' growth has been extensively investigated (e.g. Clerides et al. 1998; Wagner 2002; Girma et al. 2004), less attention has been paid to the effect of ex ante firms' growth on the probability of becoming exporters. Since a firm's growth is affected by unobservable factors such as managerial choices and profit opportunities, it is difficult to identify its causal effect on export entry. In addition, firms' investments and employment policies are likely to reflect their strategy with regard to future expansion in foreign markets, and therefore, reverse causality impedes the correct identification of the impact of ex ante firms' growth on exports (Lileeva and Trefler 2010).

To address the identification issue, we analyse causal links through impact evaluation techniques for observational data. We examine the binary case as well as continuous treatment analysis for investment as treatment. The analysis is conducted for a panel of Uruguayan manufacturing firms for the period 1997–2008.

To the best of our knowledge, this is the first study of a middle-income Latin American economy, and the relatively long time span of our data makes it possible to better characterise new entrants and export performance. Moreover, our data appear to be richer, and they include information to estimate total factor productivity, data on R&D and worker training, which provide better controls for confounding factors. We find evidence that investments "cause" exports and a rise in exports, which provides a rationale for carefully designing investment promotion policies rather than focusing on other export support policies. The results are of interest to development and trade economists in general, and to policymakers and stakeholders/entrepreneurs in Uruguay and other countries experimenting with stimuli for investment, innovations and exports.

2 Empirical strategy

2.1 Methodology

2.1.1 Binary treatment effects

We use a matching and difference-in-differences methodology,[3] which makes it possible to study the causal effect of investments (the treatment) on firms that enter export markets and export performance relative to firms that exclusively serve the domestic market. Thus, our aim is to evaluate the causal effect of investment on entry into export markets and export performance—**Y**, where **Y** represents the outcome (starting to export and export performance).

Thus, our treatment is firms' investments, and we consider different treatment definitions: (a) growth in investments, and we generate a dummy equal to one for firms that increase their investments and zero otherwise (ginv), (b) defined as a variable equal to one if the firm undertakes investment and zero otherwise (dinv),[4] (c) due to the high dispersion in investment across sectors we define a variable that takes the value one if the firm undertakes investments higher than the industry average, and zero otherwise (di). Finally, we

[3] Blundell and Costa Dias (2000) present a review of the microeconomic evaluation literature.

[4] We note that 40 % of the firms observed do not undertake investments.

define different cut-points for the increase in investments and for the ratio of investments of the firm in relation to average investments in the sector, as we explain below.

We perform the analysis for these definitions of the treatment and for various outcome variables: entry into export markets and export performance (export propensity and the value of exports).

The effect of investments is the estimated difference-in-difference of the outcome variable (export behaviour) between the firms treated (firms that invest) and the control groups (firms that do not invest).

Let Y_{it} be the outcome—entry into exports, export propensity or the value of exports—for firm i in industry j at time t.

Let investments be (DI) where $DI_{it} \in \{0, 1\}$ denotes an indicator (dummy variable) of whether firm I has received the treatment and $Y^1_{i,t+s}$ is the outcome at t + s, after the treatment. Also the outcome of firm i had it not received the treatment is denoted by $Y^0_{i,t+s}$. The causal effect of the treatment for firm i in period $(t + s)$ is defined as: $Y^1_{i,t+s} - Y^0_{i,t+s}$

The fundamental problem of causal inference is that the quantity $Y^0_{i,t+s}$, referred to as the counterfactual, is unobservable. Causal inference relies on the construction of the counterfactual, which is the outcome that firms would have experienced on average had they not undertaken investments. The counterfactual is estimated by the corresponding average value of firms that did not invest. An important issue in the construction of the counterfactual is the selection of a valid control group, and to this end we make use of matching techniques.

The basic idea of matching is to select from the group of firms belonging to the control group those in which the distribution of the variables $\mathbf{X}_{it}$ affecting the outcome is as similar as possible to the distribution in the firms belonging to the treated group. The matching procedure consists of linking each treated individual with the same values of $\mathbf{X}_{it}$. We adopt the "propensity score matching" method. To this end, we first identify the probability of undertaking investments (the "propensity score") for all firms, irrespective of whether they belong to the treated or control group, by means of a logit model. A firm k belonging to the control group, which is "closest" in terms of its "propensity score" to a firm belonging to the treated group, is then selected as a match for the latter. There are several matching techniques, and in this work we use the "kernel" matching method, which penalises distant observations.

A matching procedure is preferable to randomly or arbitrarily choosing the comparison group because it is less likely to suffer from selection bias through firms with markedly different characteristics being picked. As Blundell and Costa Dias (2000) point out, a combination of matching and difference-in-difference is likely to improve the quality of non-experimental evaluation studies. The difference-in-difference approach is a two-step procedure. Firstly, the difference between the average output variable before and after the treatment is estimated for firms belonging to the treated group, conditional on a set of covariates ($\mathbf{X}_{it}$). However, this difference cannot be attributed only to the treatment since after the firm has received it, the outcome variable might be affected by other macroeconomic factors such as policies aimed at stabilising the economy, the real exchange rate and so on. To deal with this, the difference obtained at the first stage is further differenced with respect to the before and after difference for the control group. Therefore, the difference-in-difference estimator should remove the effects of common shocks and hence provide a more accurate description of the impact of investment on export activities.

To estimate the propensity score (i.e. the probability of investing), we use the following covariates: lagged total factor productivity, lagged capital intensity, lagged size of the firm measured as the number of workers, lagged markups and average wages, a dummy for R&D and a dummy for training activities. In all cases, we tested that the balancing properties were met. Also we note that to analyse entry into export markets we retain for the analysis switchers into export markets and non-exporting firms, and we drop permanent exporters. On the other hand, to analyse export propensity and the value of exports we consider the full sample (domestic firms, switchers and permanent exporters).

2.1.2 *Continuous treatment effects*

Recently, researchers have developed a generalisation of Rosenbaum and Rubin's (1983) propensity score for continuous treatment effects. The advantage of using the generalised propensity score is that it reduces the bias caused by non-random treatment assignment as in the binary treatment case. Joffe and Rosenbaum (1999) and Imbens (2000) have proposed two possible extensions to the standard propensity score for ordinal and categorical treatments, respectively, and propensity score techniques for continuous treatment effect were proposed by Hirano and Imbens (2004). This methodology has been applied in the empirical literature on exports and firm performance by Fryges and Wagner (2008, 2010), and it is reviewed in a recent paper on these new methods in this field by Wagner (2015).

Similarly to binary propensity score matching, generalised propensity score (gps) matching evaluates the expected amount of treatment that a firm receives given the covariates. Therefore, the estimation of the impact of the treatment is based on comparing firms with similar propensity scores. Furthermore, as in the binary treatment, adjusting for the generalised propensity score (gps) removes the biases associated with differences in the covariates. Thus, we can estimate the marginal treatment effect of a specific treatment level on the outcome variable of firms that have received that specific treatment level compared to firms that have received a different one (counterfactual), but both groups with similar characteristics. This methodology improves the intervention effect evaluation: for instance, if there is an economic trend present at the same time as the treatment this technique avoids positive or negative trends causing an overvaluation or undervaluation, respectively, of the treatment effect.

Bia and Mattei (2008) and Cerulli (2014) introduce a practical implementation of the generalised propensity score methodology; they assume a flexible parametric approach to model the conditional distribution of the treatment given the covariates.

For the sake of simplicity, we assume a linear model for the treatment—also quadratic, cubic and higher-order response models are supported by the program—as follows:

$$t|X_i \approx F(\beta_0 + \beta_1' X_i, \sigma^2),$$

where t stands for the treatment and X_i are the covariates.

In order to estimate the causal effect for continuous treatment, firstly we have to estimate the conditional expectation of the outcome, $E[Y|T = t, R = r] = E[Y(t)|r(t, X)] = \beta(t, r)$, estimated as a function of a specific level of treatment (t) and of a specific value of the generalised propensity score denoted by $R = r$.

It should be noted that $\beta(t, r)$ does not have a causal interpretation. To have a causal interpretation, the conditional expectation has to be averaged over the marginal distribution $r(t, X)$: $\mu(t) = E[E(Y(t)|r(t, X))]$, where $\mu(t)$ is the outcome at each level of the treatment in which we are interested.

Thus, we can obtain an estimate of the entire dose–response function as a average weighted by each different propensity score, i.e. $\hat{r}(t, X_i)$, estimated in accordance with each specific level of treatment, t. After averaging the dose–response function over the propensity score function for each level of treatment, we can also compute the derivatives of $\hat{\mu}(t)$, which can be defined as the marginal causal effect of a variation in the treatment Δt on the outcome variable (Y), thus obtaining the treatment effect function.

2.2 Data

Our analysis is based on an unbalanced panel of Uruguayan manufacturing firms covering the period 1997–2008. The panel data were constructed using information from the IV Economic Census (1997) and the annual Economic Activity Surveys from 1998 up to 2008, carried out by the National Institute of Statistics of Uruguay (INE). The annual surveys include all firms in the formal sector with 50 or more employees and a random sample of those with 5 to 49 employees. These data are strictly confidential but not exclusive. They can be used by researchers on a contractual basis with the National Institute of Statistics. The code used for this work is available from the author upon request.

The panel contains annual data on sales (domestic and exports), value added, capital, intermediate inputs, energy, and other expenditures, which were deflated using detailed price indices (base year 1997).[5] It also includes data on employment, R&D activities and worker training, among other variables. Additionally, we use data from the "product sheets" (available from

[5] For sales and materials, we computed firm-specific deflators as the weighted average of the four-digit ISIC revision 3 price indices corresponding to all items produced/used as inputs each year by the firm.

the same surveys), which contain the value of each firm's sales in domestic and foreign markets.

We have 1444 different firms present at least in one period, with an average of 672 firms per year and a total of 8063 firm-year observations.[6] Firms are classified into three categories, according to their export status over the period of analysis: (1) non-exporter: firms that never export during the sample period (830 firms which amounts to 57.60 % of total firms and 45 % of observations), (2) permanent exporters: firms that export in all the years of our sample period (315 firms amounting to 21.83 % of total firms and 26 % of observations), and (3) switchers: firms that switched into export markets one or more times over the sample period (296 firms amounting to 20.54 % of total firms and 29 % of observations). From the first group of firms—non-exporting firms—a subset is selected as a control group by means of propensity score matching.

In Table 1, we present descriptive statistics for the firms in our panel, averaged over the sample period. It can be seen that exporting firms, particularly permanent exporters, are larger in terms of output, capital, and labour than non-exporting firms. They are also more capital intensive, invest more, have a larger share of skilled workers, have a higher propensity to use imported intermediates and undertake R&D and training of workers activities. Permanent exporters are the best performing firms. They have the highest total factor productivity (TFP),[7] gross output, value added, investments, and share of skilled workers.

Furthermore, permanent exporters and switchers use a higher share of imported inputs, are older, and have a higher share of firms that engage in R&D activities and worker training.

In Fig. 1, we present the kernel densities for TFP, employment, capital/employment ratio and labour productivity. It can be seen that permanent exporters and firms entering foreign markets—switchers—have higher TFP, employment, capital intensity and labour productivity than non-exporting firms.

We also split the subsample and analyse the features of switchers that change their export status more than once, and firms that break into foreign markets and keep exporting (we call this group of firms "once-time switchers"). From Table 2, we can compare some characteristics of all the switchers and once-time switchers. Once-time switchers have similar features to general switchers but have slightly fewer workers and investment in machinery and equipment but a greater share of firms undertaking R&D.

It is worth noting that 39.75 % of the observations do not register investments over the whole sample period and 60.25 % do invest.

Finally, in Table 2 we present some statistics for SMEs defined as those with 50 or less workers, which amounts to 57 % of the observations of the total sample (4599 observations for SMEs and of 8063 observations for the full sample). Comparing the full sample (big and SMEs) with SMEs only, we find that the latter have lower output and value added, lower investments, a smaller share of professionals and technicians, and are younger firms. They show lower expenditures on R&D and worker training. Moreover, the percentage of firms that undertake these activities is lower than in the full sample. We also find that in this subsample only 47 % of the firm-year observations register investments, while this figure was 60 % in the full sample. Finally, we can see that among SMEs, permanent exporters (followed by switchers into exports) perform better than non-exporting firms and show a similar hierarchy to the full sample.

3 Results

3.1 Binary treatment effects

As explained above, we estimate the propensity score (i.e. the probability of receiving the treatment) using as covariates lagged total factor productivity, lagged capital intensity, lagged size of the firm measure as the number of workers, lagged markups and average wages, a dummy for R&D, a dummy for training activities and industry and time dummies. As outcome variables, we analyse switching into export markets and export performance. To analyse switching into export markets we consider only non-exporting firms and switching firms, and to analyse export propensity

[6] We discarded firms that were only present in the Economic Census and also those with no data available from the product sheets.

[7] TFP was estimated using various techniques: Olley and Pakes (1996), Levinsohn and Petrin (2003) and Ackerberg et al. (2006). We find correlations higher than 0.95 for the various measures of TFP. In "Appendix", we present some different estimations of TFP and also the correlation matrix.

Table 1 Descriptive statistics, averages for the whole sample over 1997–2008

	All	Permanent exporters	Switchers into exports	Once-time switchers	Non-exporters
Total factor					
Productivity (in logarithm)	9.965	10.236	10.097	10.170	9.702
	(0.989)	(1.09)	(0.903)	(110.569)	(120.808)
Output[a]	74.049	188.026	50.411	50.994	21.608
	(244.942)	(416.643)	(96.382)	(77.094)	(84.072)
Value added[a]	32.786	76.463	25.174	25.393	11.748
	(144.718)	(245.166)	(63.195)	(23.207)	(23.441)
Investment in machinery and equipment[a]	12.865	33.89	8.755	8.249	3.029
	(103.532)	(196.177)	(19.975)	(71.097)	(65.298)
No. of workers	81.668	164.943	72.396	67.578	38.147
	(151.849)	(251.577)	(76.376)	(0.077)	(0.042)
Share of P&T[b]	0.024	0.041	0.03	0.036	0.011
	(0.061)	(0.079)	(0.063)	(0.876)	(1.766)
Capital intensity	10.303	11.06	10.689	10.519	9.56
	(1.735)	(1.45)	(1.49)	(0.196)	(0.911)
Export propensity	0.16	0.505	0.084	0.079	0
	(0.296)	(0.344)	(0.196)	(0.355)	0
Share of imported inputs in total inputs	0.261	0.419	0.353	0.305	0.103
	(0.355)	(0.382)	(0.37)	(0.807)	(0.247)
Price–cost margin	−0.071	−0.237	0.098	0.213	−0.083
	(10.687)	(19.161)	(2.484)	(17.077)	(5.761)
Age	27.289	30.484	30.594	29.267	23.228
	(17.16)	(18.173)	(17.277)	(0.262)	(15.525)
Expenditures on R&D[a]	0.052	0.117	0.041	0.052	0.019
	(0.329)	(0.417)	(0.351)	(1.508)	(0.22)
R&D (share of firms)	0.124	0.224	0.144	0.185	0.051
	(1.498)	(2.041)	(1.604)	(0.126)	(0.853)
Expenditures on worker training[a]	0.389	0.773	0.443	0.043	0.125
	(0.471)	(0.496)	(0.494)	(0.499)	(0.341)
Training (share of firms)	0.331	0.564	0.42	0.332	0.135
	(0.317)	(0.455)	(0.22)	(0.329)	(0.26)

SDs in parentheses

[a] Millions of constant Uruguayan pesos

[b] Professionals and technicians out of total employment

we take the whole sample (permanent exporters, switchers and non-exporting firms).

As the treatment variable, we try investments as a binary variable defined in various ways as we outline above: firms that increase investments (ginv),[8] firms that undertake investments (dinv = 1) and those that do not (dinv = 0). We define the average level of investment for the various sectors at the three-digit level and calculate the ratio between the level of investment of the firm in relation to the average of the sector. If this ratio was higher than one, we computed the value of one for the firm (di = 1), and if the value was below the average of the sector, we compute a zero (di = 0).

[8] For permanent exporters ginv is 0.44 (44 %), for switchers into exporting it is 0.39 (39 %) and for non-exporting firms the figure is lower at 0.28 (28 %).

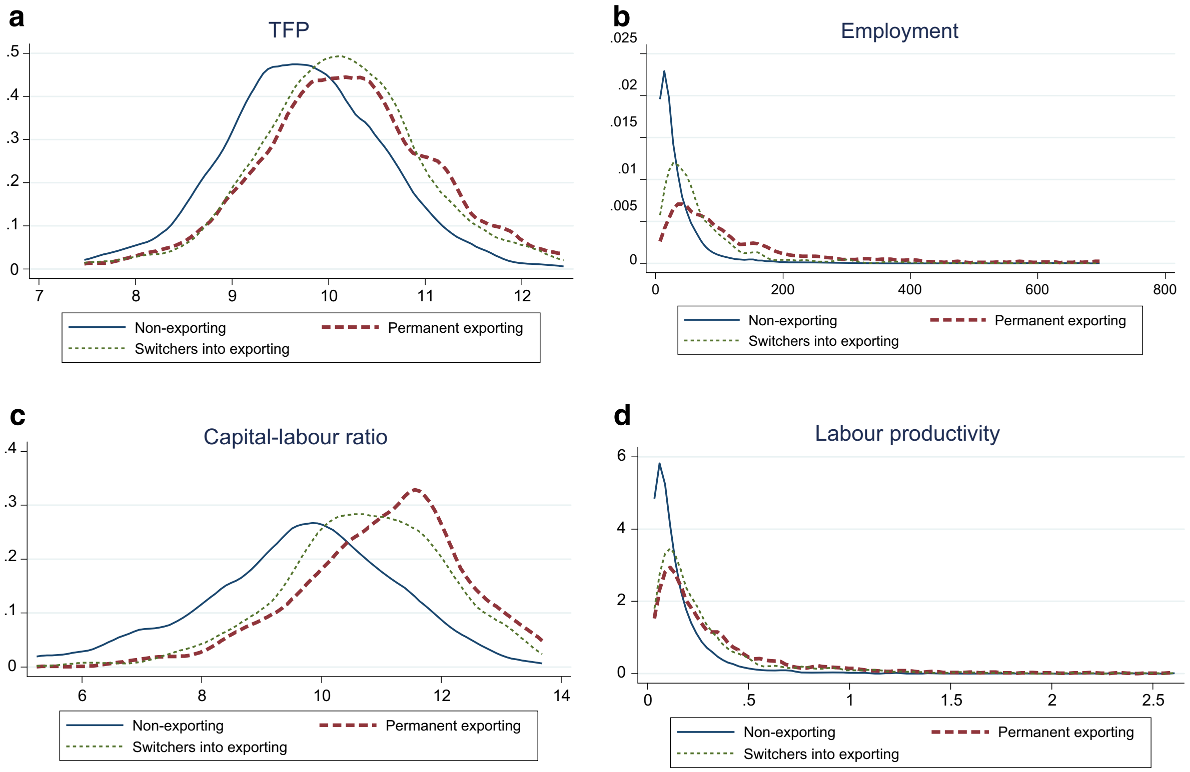


Fig. 1 Kernel densities by firm export status. **a** Total factor productivity by firm export status. **b** Employment by firm export status. **c** Capital/labour ratio by firm export status. **d** Labour productivity by firm export status

It can be seen from the logit model that lagged productivity, lagged employment, undertaking R&D activities and worker training have a positive effect on the probability of investing (dinv), of increasing investments (ginv) and of investing more than the average of the industry (di). Capital intensity has a positive impact on investing (dinv) and on investing more than the industry average (di) but not on an increase in investments (ginv). On the other hand, lagged markups are negatively significant for growth in investments (ginv) only, and lagged average wages is negatively significant only for investing more than the industry average (di). The results are given in Table 3.

Firstly, we perform matching and double-difference estimation, i.e. we estimate the propensity score and run a regression in double differences on the common support. We report the results in Table 4 for the *ginv*, *dinv,* and *di* treatments, and our outcome variable is switching into the export market. We find that for all the treatment variables investments do cause switching into exports markets with a higher effect for *di*, i.e. for those firms that invest more than the average of the sector in which the firm has its main activity. The effect of firms' investments on entry into foreign markets could indicate active and deliberate efforts to enter into export markets (Fernandes and Isgut 2009). These results are also in line with the idea of "built-in capacity" to enter into foreign markets (Rho and Rodrigue 2012).

We also try alternative definitions for the ratio of a firm's investments to average investment in the industry[9] using various cut-off points: (a) firms with an investment ratio in relation to the industry equal to or greater than 0.05 (di1); (b) firms with an investment ratio equal to or greater than 0.10 (di2); (c) firms with an investment ratio equal to or greater than 0.15 (di3); and (d) firms with an investment ratio equal to or greater than 0.20 (di4). We present the results in Table 5. We find positive and significant effects of the

[9] Firms that invest more than the average of the industry to which they belong are in the upper 90th percentile of the investment distribution.

Table 2 Descriptive statistics for SMEs, averages over 1997–2008

Type	Non-exporters	Permanent exporters	Switchers into exports	All
Total factor				
Productivity (in logarithm)	9.631	10.329	9.988	9.812
	(8.664)	(149.724)	(19.784)	(55.983)
Output[a]	6.682	43.116	16.732	13.822
	(4.078)	(82.228)	(10.445)	(30.416)
Value added[a]	2.835	19.216	7.383	6.053
	(0.964)	(2.264)	(1.401)	(1.319)
Investment in machinery and equipment[a]	0.831	12.170	2.466	2.680
	(12.581)	(13.398)	(13.090)	(13.566)
No. of workers	19.221	29.551	27.755	22.663
	(0.919)	(1.281)	(0.956)	(1.012)
Share of P&T	0.010	0.049	0.026	0.019
	(0.040)	(0.093)	(0.058)	(0.056)
Capital intensity	9.466	10.616	10.502	9.881
	(1.792)	(1.588)	(1.568)	(1.789)
Export propensity	0.000	0.530	0.089	0.090
	(0.000)	(0.349)	(0.215)	(0.239)
Share of imported inputs	0.087	0.411	0.301	0.181
	(0.229)	(0.383)	(0.367)	(0.317)
Price–cost margin	−0.131	−1.292	0.008	−0.242
	(6.438)	(36.460)	(3.003)	13.989)
Age	21.102	22.484	26.793	22.702
	(4.415)	(22.073)	(8.648)	(10.212)
Expenditures on R&D[a]	0.003	0.026	0.020	0.010
	(0.029)	(0.133)	(0.108)	(0.076)
R&D (share of firms)	0.028	0.132	0.112	0.062
	(0.0126)	(0.116)	(0.039)	(0.048)
Expenditures on worker training[a]	0.002	0.027	0.010	0.007
	(13.939)	(13.236)	(16.063)	(14.613)
Training (share of firms)	0.077	0.387	0.248	0.159
	(0.266)	(0.487)	(0.432)	(0.366)

SDs in parentheses

[a] Millions of constant Uruguayan pesos

[b] Professionals and technicians out of total employment

various cut-off points on entry into export markets, while there are no significant effects on export propensity. Nevertheless, when we analyse the value of exports as an outcome variable, we find positive and significant effects of the ratio of investments on this variable.

Another treatment we try is the rate of growth of investments taking different cut-off points: an indicator variable equal to one if investment growth is nonzero (gri1), a dummy equal to one if investment growth is greater than 0.10 (gri2), a dummy equal to one if investment growth is greater than 0.15 (gri3), and a dummy equal to one if investment growth is greater than 0.20 (gri4). In Table 6, we present the results. We find that the higher the cut-off point for the rate of growth in investments the greater the effect on

Table 3 Results of the logit model

	ginv	dinv	di
Lagged markups	−0.034	−0.031	0.004
	(0.020)*	(0.020)	(0.082)
Lagged TFP	0.167	0.136	0.354
	(0.064)***	(0.066)**	(0.121)***
Lagged employment	0.139	0.469	0.900
	(0.046)***	(0.049)***	(0.075)***
Lagged capital intensity	−0.030	0.226	0.577
	(0.024)	(0.025)***	(0.050)***
Lagged average wages	0.068	−0.083	−0.336
	(0.078)	(0.079)	(0.141)**
Dummy R&D	0.280	0.345	0.412
	(0.117)**	(0.141)**	(0.159)**
Dummy training	0.417	0.733	0.399
	0.088	(0.096)***	(0.130)***
Industry dummies	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes

ginv: dummy equal to one for firms that increase their investments; dinv: dummy equal to one for firms that undertake investments; di: dummy equal to one for firms with a level of investment higher than the average at the 3-digit level

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

Table 4 Average treatment effects for the binary treatment (ginv, dinv and di) on entry into export markets and export propensity

Treatment	Outcome	
	Entry into exports	Export propensity
ginv	0.023	0.029
	(0.015)*	(0.008)***
dinv	0.026	0.071
	(0.016)*	(0.007)***
di	0.055	0.148
	(0.027)***	(0.010)***

ginv: dummy equal to one for firms that increase their investments; dinv: dummy equal to one for firms that undertake investments; di: dummy equal to one for firms with a level of investment higher than the average at the 3-digit level

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

starting to export, but there are no significant effects for export share.

We present the balancing tests in Tables 7, 8 and 9. Balancing tests verify the correct performance of the propensity score matching procedure (after matching, the distribution of observable characteristics is not statistically different between the treated and control groups). For reasons of brevity, we do not report the results for the sector and time dummies.

When we consider export propensity (i.e. the share of exports in total sales) as the outcome variable (Table 4, column 2), we also find positive and significant effects of the treatment variables considered, namely nonzero growth in investments, undertaking investments and investing more than the average of the sector. Thus, the big picture that emerges is that, when we consider the full sample, investments do cause entry into export markets and a rise in exports.

On the other hand, when we analyse only the subset of SMEs (Table 10) we find that only the nonzero investments (dinv) treatment has a positive and significant effect on entry into export markets, while growth in investments (ginv) and investing more than the average of the industry to which the firm belongs have no significant effect. Furthermore, for all the treatments analysed there is no significant effect on export share as outcome variable. Nevertheless, we find that the three treatments considered (ginv, dinv and di) have positive and significant effects on the value of exports and output growth. There is a slighter greater effect for output growth, which may indicate that firms expand first in domestic markets and afterwards in foreign ones.

When we consider growth in investments as a treatment, we find that all four treatments (gri1–gri4) have a positive and significant effect on entry into export markets. Nevertheless, only nonzero growth in investments (gri1) also has a positive impact on the value of exports and on the firm’s total output. This

Table 5 Average treatment effects for the binary treatment (rate of investments/average investment in the industry)

Treatment	Outcome		
	Entry into exports	Export propensity	Exports (a)
di1	0.046	0.019	36.24
	(0.017)***	(0.011)	(4.66)***
di2	0.057	0.017	40.61
	(0.018)***	(0.011)	(5.22)***
di3	0.060	0.02	45.69
	(0.019)***	(0.011)	(5.74)***
di4	0.051	0.015	48.42
	(0.020)***	(0.012)	(6.18)***

(a) In millions of constant pesos; di1: firms with an investment ratio in relation to the industry equal to or greater than 0.05; di2: ratio equal to or greater than 0.10; di3: ratio equal to or greater than 0.15; di4: ratio equal or greater than 0.20

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

Table 6 Average treatment effects for the binary treatment (rate of growth of investments) on entry into export markets and export propensity

Treatment	Outcome	
	Entry into exports	Export propensity
gri1	0.02	0.005
	(0.015)**	(0.009)
gri2	0.025	0.004
	(0.015)**	(0.009)
gri3	0.025	0.0078
	(0.015)**	(0.009)
gri4	0.031	0.008
	(0.015)**	(0.009)

gri: dummy equal to one if the rate of growth in investments is greater than zero; gri2: dummy equal to one if the rate of growth in investments is greater than 0.10; gri3: dummy equal to one if the rate of growth in investments is greater than 0.15; gri4: dummy equal to one if the rate of growth in investments is greater than 0.20

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

result may be due to the fact that a small number of SMEs undertake investments and to the lower growth rate of investments in small firms. Our results are presented in Table 11.[10]

[10] For SMEs gri1 is of 690 observations, gri2 is of 640 observations, gri3 is of 620 and gri4 is 602 firm-year observations. For the full sample, these figures are 1832 for gri1, 1719 for gri2, 1664 for gri3, and 1624 observations for gri4.

Table 7 Balancing tests for firms that increase investments (ginv)

Variable	Mean			*t* test	
	Treated	Control	% bias	*t*	$p > t$
leeva	0.11411	0.14525	−1	−0.37	0.713
ltfp	10.026	10.016	1.1	0.32	0.751
lpo	3.8015	3.8057	−0.4	−0.12	0.907
lkint	10.271	10.302	−1.8	−0.48	0.629
law	11.172	11.163	1.2	0.35	0.73
rd	0.14674	0.14021	1.8	0.49	0.622
training	0.40014	0.39135	1.8	0.47	0.635

leeva: lagged markups; ltfp: lagged total factor productivity; lkint: lagged capital intensity; lpo: lagged size of the firm measure as the number of workers; law: average wages, rd: dummy equal to one for firms that undertake R&D activities; training: dummy equal to one for firms that undertake training activities for their workers. Time and industry dummies not reported. Number treated: 1397; number control: 2723 (on support)

Since the number of SMEs with investments higher than the average of the industry is very low (only 303 observations), we do not carry out the analysis for these treatments (di1–di4).[11]

[11] For the subset of small firms, for ginv we have 3117 observations with 869 with ginv = 1, and the median is zero; for dinv we have 4599 observations and 2296 with dinv = 1 and a median of zero, finally for di we have 4599 observations with only 303 firms with di = 1. In contrast, in the full sample the number of firms with dinv = 1 is 4856, ginv = 1 is 2083, and di = 1 is 1392.

Table 8 Balancing tests for firms that undertake investments (dinv)

Variable	Mean			t test	
	Treated	Control	% bias	t	$p > t$
leeva	0.13949	0.16082	−0.8	−0.38	0.703
ltfp	10.001	9.9988	0.2	0.07	0.944
lpo	3.8701	3.8685	0.1	0.06	0.955
lkint	10.522	10.562	−2.4	−0.89	0.376
law	11.192	11.176	2.1	0.8	0.426
rd	0.14427	0.12697	5.6	1.72	0.085
training	0.41219	0.41508	−0.7	−0.2	0.842

leeva: lagged markups; ltfp: lagged total factor productivity; lpo: lagged size of the firm measure as the number of workers; lkint: lagged capital intensity; law: average wages; rd: dummy equal to one for firms that undertake R&D activities; training: dummy equal to one for firms that undertake training activities for their workers. Time and industry dummies not reported. Number treated: 2329; number control: 1787 (on support)

Table 9 Balancing tests for firms that invest more than the average of the industry (di)

Variable	Mean			t test	
	Treated	Control	% bias	t	$p > t$
leeva	0.31964	0.31283	0.2	0.13	0.898
ltfp	10.24	10.244	−0.4	−0.08	0.935
lpo	4.3916	4.3269	6.2	1.06	0.287
lkint	11.165	11.106	3.9	0.68	0.5
law	11.436	11.406	4	0.68	0.494
rd	0.20432	0.19299	3.1	0.45	0.651
training	0.58743	0.56482	4.9	0.73	0.466

leeva: lagged markups; ltfp: lagged total factor productivity; lpo: lagged size of the firm measure as the number of workers; lkint: lagged capital intensity; law: average wages; rd: dummy equal to one for firms that undertake R&D activities; training: dummy equal to one for firms that undertake training activities for their workers. Time and industry dummies not reported. Number treated: 509; number control: 3608 (on support)

Thus, it seems that, for SMEs, investment favours entry into export markets, the value of exports and output, but does not have a significant effect on export intensity.

3.2 Continuous treatment effects

For the continuous treatment effects, we focus on the analysis of continuous outcome variables (export propensity and the value of exports). First, we use the Stata program developed by Bia and Mattei (2008). Since our previous treatment variables are non-normal, we use the level of investment over capital as treatment and we apply a zero skewness Box–Cox transformation (bcskew0) and a quadratic

Table 10 Average treatment effects for the binary treatment (ginv, dinv and di) on entry into export markets, export propensity, exported values and output

Treatment	Outcome			
	Entry into exports	Export propensity	Exports	Output
Results for SMEs				
ginv	0.028	0.009	7.590	7.969
	(0.020)	(0.010)	(3.892)***	(4.027)***
dinv	0.053	0.004	7.238	7.511
	(0.019)***	(0.111)	(3.336)***	(3.447)***
di	0.031	0.025	45.89	44.778
	(0.0442)	(0.030)	(26.002)**	(2.476)***

ginv: dummy equal to one for firms that increase their investments; dinv: dummy equal to one for firms that undertake investments; di: dummy equal to one for firms with a level of investment higher than the average at the 3-digit level

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

Table 11 Average treatment effects for the binary treatment (rate of growth of investments) on entry into export markets and export propensity, value exported and output

Treatment	Outcome			
	Entry into exports	Export propensity	Exports	Output
Results for SMEs				
gri1	0.066	0.024	15.923	15.996
	(0.027)***	(0.016)	(8.953)**	(9.149)**
gri2	0.077	0.021	15.996	3.305
	(0.028)***	(0.016)	(9.149)	(2.456)
gri3	0.076	0.021	3.11	3.668
	(0.029)***	(0.016)	(2.311)	(2.570)
gri4	0.068	0.022	3.353	4.068
	(0.029)***	(0.017)	(2.413)	(2.777)

gri: dummy equal to one if the rate of growth in investments is greater than zero; gri2: dummy equal to one if the rate of growth in investments is greater than 0.10; gri3: dummy equal to one if the rate of growth in investments is greater than 0.15; gri4: dummy equal to one if the rate of growth in investments is greater than 0.20

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 12 Continuous treatment effect for the treatment ratio of investment to capital and export propensity as outcome variable

xshare	Coef.	SE	t	$p > \|t\|$	[95 % conf. interval]	
inv_k	0.242	0.127	1.91	0.056	−0.006	0.489
inv_k_sq	−0.220	0.101	−2.18	0.029	−0.418	−0.022
gps	0.180	0.065	2.78	0.006	0.053	0.307
inv_k_gps	−0.749	0.311	−2.41	0.016	−1.358	−0.140
_cons	0.160	0.019	8.47	0	0.123	0.198

xshare: exports/total sales, inv_k: investments/capital, inv_k_sq: squared investments/capital, gps: generalised propensity score, inv_k_gps: investments/capital interacted by the propensity score

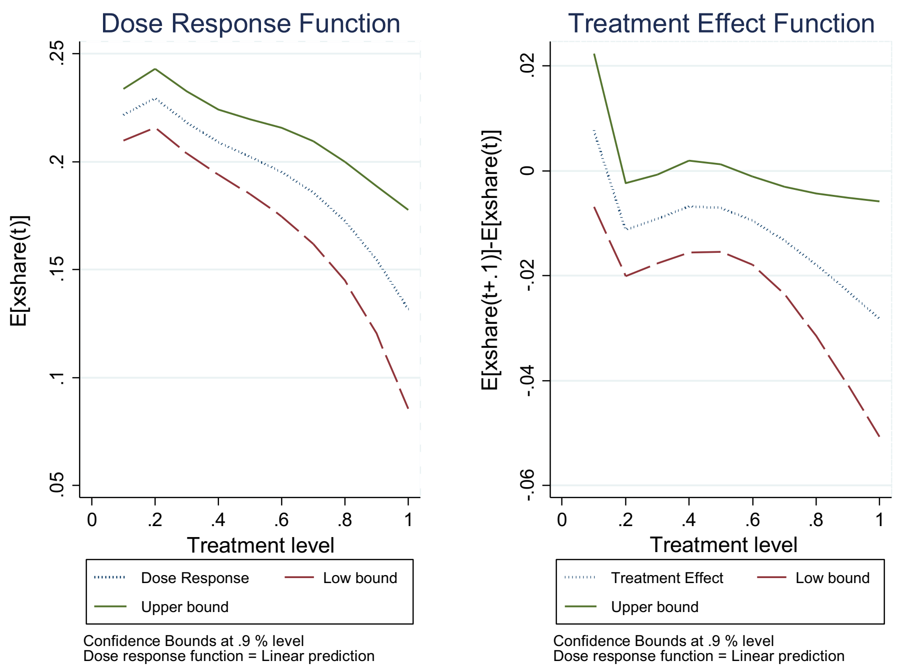


Fig. 2 Continuous treatment effect of investment/capital on export share

regression type. The results are given in Table 12 and Fig. 2 for export propensity as outcome variable. As regards the dose–response, we find increases in export propensity up to 0.2 and a fall thereafter. The treatment effect figure shows a negative nonlinear effect of investments/capital on export share beyond 0.2. In Table 13, we report the balancing test for the five intervals of the treatment we have defined. We find an adequate balancing of the covariates, i.e. after matching the covariates are not statistically different in the various subgroups/intervals of the treatment.

Then, we apply the new Stata program developed by Cerulli (2014) which has the advantage of addressing non-normal distribution of variables. We analyse the effect of investment levels on export share and the value of exports. As covariates we use lagged total factor productivity, lagged capital intensity, lagged size of the firm measure as the number of workers, lagged markups, and a dummy for R&D and for training activities. We also use industry and time dummies as controls.

We find a significant positive effect of investments on export share (Table 14). Nevertheless, the dose–response function (DRF) shows nonlinear behaviour with a maximum around 10 %, then a decline and then a rise to 60 % (see Fig. 3a, b).

Table 13 Balancing tests for investments/capital as treatment variable

	Treatment interval no. 1—[0.00150, 0.05427]			Treatment interval no. 2—[0.05445, 0.1586]		
	Mean difference	SD	*t* value	Mean difference	SD	*t* value
ltfp	0.04103	0.02959	1.3866	−0.04954	0.03872	−1.2794
lkint	−0.0505	0.0402	−1.2562	−0.1154	0.09056	−1.2743
lpo	0.00827	0.03192	0.2592	−0.0689	0.06104	−1.1288
leeva	0.00437	0.09501	0.04604	−0.09134	0.08809	−1.0369
rd	0.01964	0.01472	1.3342	0.00213	0.0121	0.1763
training	0.0247	0.01981	1.2468	−0.03428	0.02528	−1.3560
	Treatment interval no. 3—[0.1586, 0.3599]			Treatment interval no. 4—[0.3605, 1]		
	Mean difference	SD	*t* value	Mean difference	SD	*t* value
ltfp	−0.00465	0.02952	−0.1575	−0.00322	0.0329	−0.0977
lkint	−0.10573	0.08922	−1.1850	0.29045	0.1728	1.6808
lpo	−0.11783	0.07228	−1.6302	0.16997	0.1363	1.2470
leeva	0.02302	0.08456	0.27224	−0.00871	0.08654	−0.10061
rd	−0.03365	0.03221	−1.0447	0.01303	0.01333	0.9778
training	−0.00463	0.01583	−0.2926	0.03522	0.02768	1.2724
	Treatment interval no. 5—[1.0006, 1.0412]					
	Mean difference	SD	*t* value			
ltfp	0.27586	0.19937	1.3837			
lkint	0.44094	0.29233	1.5084			
lpo	0.42556	0.25126	1.6937			
leeva	−0.0628	0.30718	−0.20444			
rd	0.05793	0.04699	1.2328			
training	0.15044	0.1598	0.9414			

ltfp: lagged total factor productivity; lkint: lagged capital intensity; lpo: lagged size of the firm measure as the number of workers; leeva: lagged markups; rd: dummy equal to one for firms that undertake R&D activities; training: dummy equal to one for firms that undertake training activities for their workers. Time and industry dummies not reported. *t* values greater than 1.96 are significant at the 10 % level

As regards the effect of investments on the value of exports, we find also a positive significant effect (Table 16), with an increasing effect over the whole range of the treatment (Fig. 4a, b) with a small spike at 20 % and a big increase after approximately 50 %. We present the balancing tests in Tables 15 and 17.

Finally, when take only the subset of SMEs, we do not find significant effects of the continuous treatment model. This may be because a small number of SMEs undertake investments, there are fewer observations and there is high dispersion in the set of SMEs, as shown by the standard deviation (SD). We perform the analysis for the levels of investment as treatment on export intensity, and the value of exports finding not significant effects. The export intensity results are given in Table 18 and Fig. 5, and those of the values of exports in Table 19 and Fig. 6.[12]

4 Concluding remarks

We find that, for the full sample of firms, investments have a positive effect on entry into exports markets, export propensity and the level of exports. Thus, there is some evidence that investments precede exports,

[12] We do not report the balancing test due to space reasons, but they are available upon request form the author.

Table 14 Continuous treatment effect for investment on export propensity as outcome variable

xshare	Coef.	SE	*t*	*p* > *t*	[95 % conf. interval]	
Treatment	0.0167	0.0087	1.92	0.055	−0.0004	0.0338
leeva	−0.0020	0.0014	−1.45	0.147	−0.0046	0.0007
ltfp	0.0349	0.0072	4.87	0.000	0.0209	0.0490
lpo	0.0361	0.0064	5.79	0.000	0.0244	0.0494
lkint	0.0275	0.0024	11.32	0.000	0.0227	0.0322
Industry dummies	Yes					
Time dummies	Yes					
Tw	0.0329	0.0053	6.16	0.000	0.0225	0.0434
T2w	−0.0016	0.0003	−5.5	0.000	−0.0021	−0.0010
T3w	0.00001	0.0000	5.37	0.000	0.00001	0.00002
_cons	−0.5104	0.0752	−6.79	0.000	−0.6578	−0.3629

Investments in constant Uruguayan pesos; xshare: export propensity; leeva: lagged markups; ltfp: lagged total factor productivity; lkint: lagged capital intensity; lpo: lagged size of the firm measure as the number of workers; rd: dummy equal to one for firms that undertake R&D activities; training: dummy equal to one for firms that undertake training activities for their workers. Tw, T2w and T3w are the three polynomial factors of the dose–response function

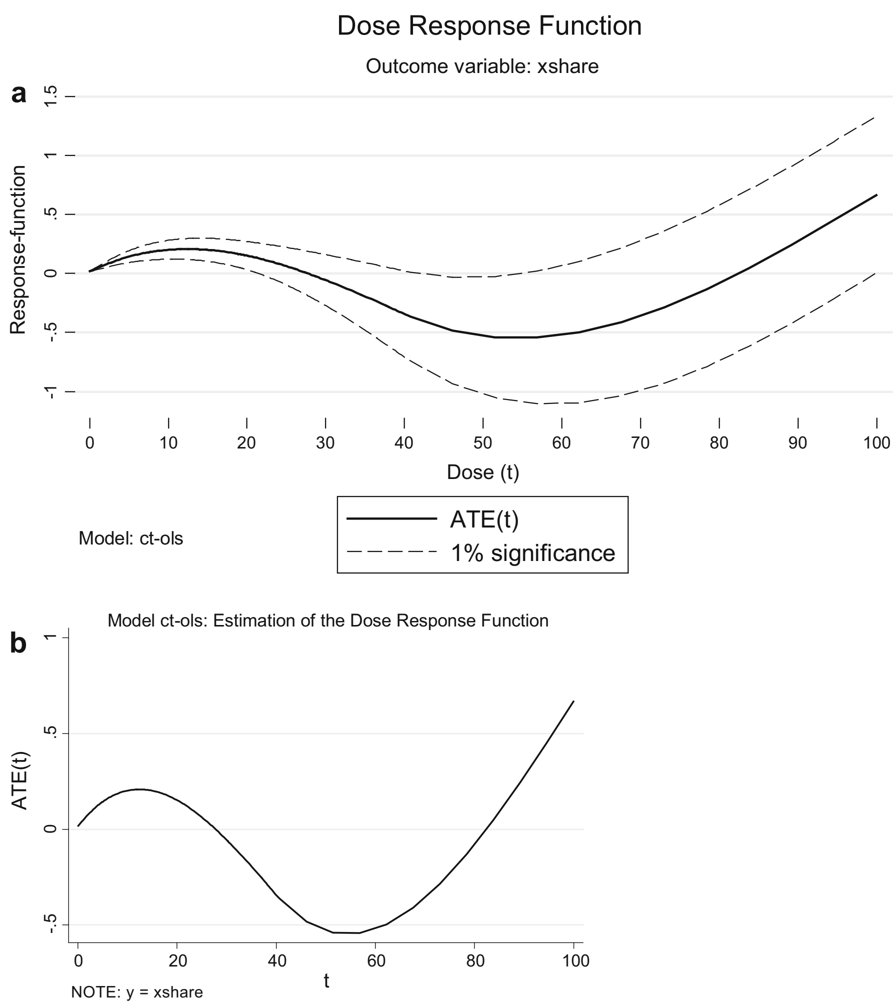


Fig. 3 **a** Dose–response function for export propensity and investment as treatment variable. **b** Dose–response function for the impact of investment on export propensity (xshare)

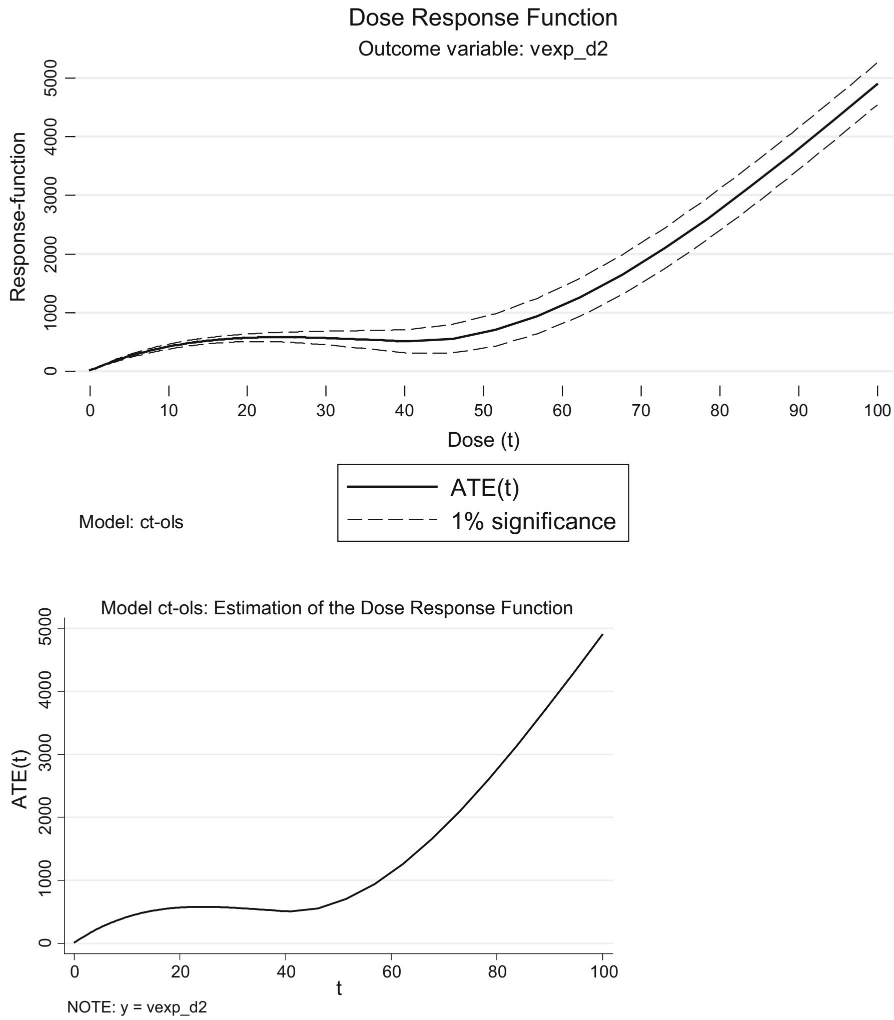


Fig. 4 **a** Dose–response function for investment as treatment and the value of exports (in millions of constant pesos) as outcome variable. **b** Estimation of the dose–response function for investment as treatment and the value of exports as outcome variable

which indicates the firm is making a deliberate active effort to break into foreign markets and to built-in capacity.

For the continuous treatment effect, we find that investments have a positive effect on export propensity and also on the value of exports. While the export propensity results show a nonlinear effect, the value of exports tends to increase as investments rise.

When we consider only the subset of SMEs, we find that investments have a significant effect on entry into exports markets, and some evidence of growth in exported values and production for the binary treatments. For continuous treatment, we find no evidence of increases in export intensity or exported values. The latter results may be due to the high dispersion in this subset of firms.

Nevertheless, similarly to the full sample which includes big and small firms, we confirm that investments seem to play an important role in easing access to foreign markets for SMEs.

To sum up, we have found evidence that investments "cause" exports, which provides a rationale for carefully designing investment promotion policies rather than focusing on other export promotion policies such as subsidies. These results are of interest to development and trade economists in general, and to policymakers and stakeholders in Uruguay and other countries experimenting with stimuli for investment, innovations and exports.

Table 15 Balancing tests for the level of investment as treatment and export propensity as outcome variable

	Treatment interval no. 1—[419, 64,485]			Treatment interval no. 2—[64,640, 302,777]		
	Mean difference	SD	*t* value	Mean difference	SD	*t* value
ltfp	0.10243	0.07905	1.2958	0.08666	0.07365	1.1766
lkint	0.36542	0.28674	1.2744	0.21752	0.1791	1.2145
lpo	0.24301	0.19431	1.2506	0.22451	0.13365	1.6798
leeva	−0.008	0.11247	−0.0712	0.06856	0.10421	0.6579
rd	0.03315	0.02647	1.2524	0.03844	0.02965	1.2965
training	0.14276	0.12855	1.1105	0.01674	0.01643	1.0189
	Treatment interval no. 3—[303,808, 1,360,946]			Treatment interval no. 4—[1,369,533, 5,467,842]		
	Mean difference	SD	*t* value	Mean difference	SD	*t* value
ltfp	0.00235	0.03127	0.0752	−0.05427	0.04152	1.3071
lkint	−0.00947	0.04874	−0.1943	−0.19372	0.15963	1.2135
lpo	0.07285	0.06911	1.0541	−0.12112	0.13868	−0.8734
leeva	−0.07991	0.10115	−0.7900	−0.01822	0.1079	0.1689
rd	0.00364	0.0126	0.2889	−0.0456	0.03639	1.2531
training	0.00069	0.016	0.0431	−0.06546	0.04143	1.5800
	Treatment interval no. 5—[5,479,815, 525,614,515]					
	Mean difference	SD	*t* value			
ltfp	−0.09227	0.07911	−1.1664			
lkint	−0.25495	0.19723	−1.2927			
lpo	−0.25181	0.19255	−1.3078			
leeva	−0.14815	0.1352	−1.0958			
rd	−0.04387	0.03466	−1.2657			
training	−0.10286	0.09165	−1.1223			

Investments in constant Uruguayan pesos; ltfp: lagged total factor productivity; lkint: lagged capital intensity; lpo: lagged size of the firm measure as the number of workers; leeva: lagged markups; rd: dummy equal to one for firms that undertake R&D. activities; training: dummy equal to one for firms that undertake training activities for their workers. Time and industry dummies not reported; *t* values greater than 1.96 are significant at the 10 % level

Table 16 Continuous treatment effect for investment on the value of exports (millions of constant pesos) as outcome variable (ctreatreg, Cerulli 2014)

Vexp_d2	Coef.	SE	*t*	$p > t$	[95 % conf. interval]	
Treatment	18.092	4.691	3.86	0	8.897	27.288
leeva	−3.165	0.731	−4.33	0	−4.597	−1.733
ltfp	19.163	3.859	4.97	0	11.597	26.728
lpo	7.864	3.432	2.29	0.022	1.136	14.591
lkint	5.822	1.307	4.46	0	3.261	8.383
Industry dummies	Yes					
Year dummies	Yes					
Tw	56.952	2.875	19.81	0	51.316	62.588
T2w	−1.800	0.154	−11.71	0	−2.101	−1.499

Table 16 continued

Vexp_d2	Coef.	SE	*t*	*p* > *t*	[95 % conf. interval]	
T3w	0.017	0.001	13.13	0	0.015	0.020
_cons	−188.227	40.474	−4.65	0	−267.571	−108.883

Vexp_d2: value of exports in millions of constant pesos; leeva: lagged markups; ltfp: lagged total factor productivity; lkint: lagged capital intensity; lpo: lagged size of the firm measure as the number of workers; rd: dummy equal to one for firms that undertake R&D activities; training: dummy equal to one for firms that undertake training activities for their workers; Tw, T2w and T3w are the three polynomial factors of the dose–response function. *t* values greater than 1.96 are significant at the 10 % level

Table 17 Balancing tests for level of investment as treatment and value of exports as outcome

	Treatment interval no. 1—[419, 64,485]			Treatment interval no. 2—[64,640, 302,777]		
	Mean difference	SD	*t* value	Mean difference	SD	*t* value
ltfp	0.10563	0.07905	1.3362	0.08566	0.06765	1.2662
lkint	0.13742	0.09674	1.4205	0.12452	0.0991	1.2565
lpo	0.15301	0.09841	1.5548	0.11451	0.09465	1.2098
leeva	−0.008	0.11247	−0.0712	0.06856	0.10421	0.6579
rd	0.04315	0.03647	1.1832	0.04044	0.03365	1.2018
training	0.11276	0.09855	1.1442	0.01674	0.01643	1.0187
	Treatment interval no. 3—[303,808, 1,360,946]			Treatment interval no. 4—[1,369,533, 5,467,842]		
	Mean difference	SD	*t* value	Mean difference	SD	*t* value
ltfp	0.00235	0.03127	0.07503	−0.07427	0.06152	−1.2072
lkint	−0.00947	0.04874	−0.1943	−0.14372	0.09963	−1.4425
lpo	0.07285	0.05511	1.3219	−0.15112	0.09868	−1.5314
leeva	−0.07991	0.10115	−0.7900	−0.01822	0.1079	−0.1689
rd	0.00364	0.0126	0.2888	−0.0656	0.05639	−1.1633
training	0.00069	0.016	0.0432	−0.07546	0.06143	−1.2284
	Treatment interval no. 5—[5,479,815, 525,614,515]					
	Mean difference	SD	*t* value			
ltfp	−0.10227	0.07911	−1.2928			
lkint	−0.16425	0.09723	−1.6893			
lpo	−0.19781	0.15255	−1.2967			
leeva	−0.14815	0.1352	−0.1689			
rd	−0.05268	0.05466	−0.9638			
training	−0.10586	0.08165	−1.2965			

Investments in constant Uruguayan pesos; ltfp: lagged total factor productivity; lkint: lagged capital intensity; lpo: lagged size of the firm measure as the number of workers; leeva: lagged markups; rd: dummy equal to one for firms that undertake R&D activities; training: dummy equal to one for firms that undertake training activities for their workers. Time and industry dummies not reported, *t* values greater than 1.96 are significant at the 10 % level

Table 18 Continuous treatment effect for investment on the value of exports as outcome variable for SMEs

Value of exports	Coef.	SE	*t*	*p* > *t*	[95 % conf. interval]	
Treatment	1.482	2.541	0.58	0.560	−3.500	6.464
leeva	−2.882	0.448	−6.44	0.000	−3.760	−2.005
ltfp	13.587	2.162	6.28	0.000	9.348	17.825
lpo	4.113	2.549	1.61	0.107	−0.886	9.111
law	−0.524	2.725	−0.19	0.848	−5.866	4.819
lkint	3.188	0.763	4.18	0.000	1.691	4.684
Industry dummies	Yes					
Time dummies	Yes					
Tw	0.836	0.156	5.36	0.000	0.530	1.141
T2w	−0.005	0.001	−4.32	0.000	−0.007	−0.003
T3w	0.000	0.000	3.71	0.000	0.000	0.000
_cons	−151.938	27.924	−5.44	0.000	−206.692	−97.184

Value of exports in millions of constant pesos; leeva: lagged markups; ltfp: lagged total factor productivity; lkint: lagged capital intensity; lpo: lagged size of the firm measure as the number of workers; rd: dummy equal to one for firms that undertake R&D activities; training: dummy equal to one for firms that undertake training activities for their workers. Tw, T2w and T3w are the three polynomial factors of the dose–response function

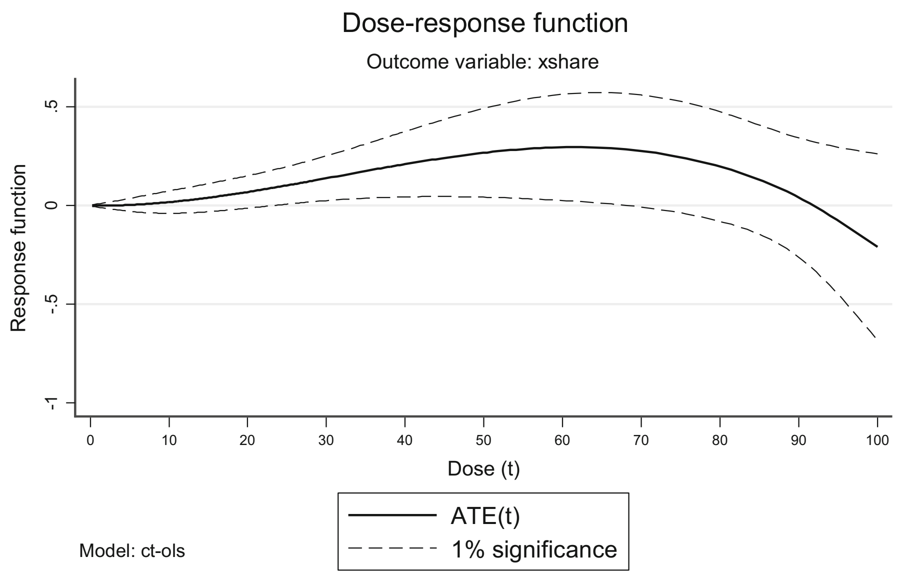


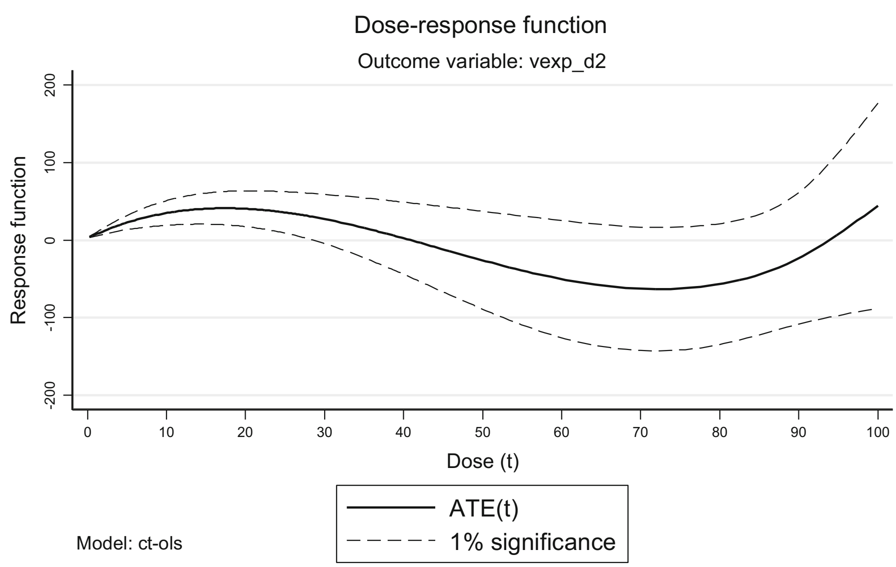
Fig. 5 Continuous treatment effect for investment on export propensity as outcome variable for SMEs

Table 19 Continuous treatment effect for investment on export propensity as outcome variable, SMEs

xshare	Coef.	SE	t	$p > t$	[95 % conf. interval]	
Treatment	−0.003	0.009	−0.35	0.724	−0.021	0.015
leeva	−0.006	0.002	−3.96	0.000	−0.009	−0.003
ltfp	0.040	0.008	5.15	0.000	0.025	0.056
lpo	0.026	0.009	2.8	0.005	0.008	0.044
law	−0.028	0.010	−2.85	0.004	−0.047	−0.009
lkint	0.022	0.003	8.05	0.000	0.017	0.027
Industry dummies	Yes					
Time dummies	Yes					
Tw	0.000	0.001	0.46	0.648	−0.001	0.001
T2w	0.000	0.000	1.33	0.183	0.000	0.000
T3w	0.000	0.000	−1.77	0.076	0.000	0.000
_cons	−0.286	0.101	−2.81	0.005	−0.484	−0.087

xshare: export propensity; leeva: lagged markups; ltfp: lagged total factor productivity; lkint: lagged capital intensity; lpo: lagged size of the firm measure as the number of workers; rd: dummy equal to one for firms that undertake R&D activities; training: dummy equal to one for firms that undertake training activities for their workers. Tw, T2w and T3w are the three polynomial factors of the dose–response function

Fig. 6 Dose–response function for investment as treatment and the value of exports (in millions of constant pesos) as outcome variable, SMEs



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Appendix: Total factor productivity estimation

The estimation of firms' TFP is carried out using structural techniques: the Olley and Pakes (1996), Levinsohn and Petrin (2003) and Ackerberg et al. (2006) methodologies. All these techniques use observed input decisions to control for unobserved productivity shocks, thus addressing one of the main endogeneity problems that usually arises in empirical estimations of production functions at the micro-level, the so-called simultaneity bias (i.e. the fact that firms' input choices may respond to productivity shocks). Estimating TFP using Olley and Pakes (OP) and Levinsohn and Petrin (LP) involves different proxy variables: while OP use investments, LP use either materials or energy. Nevertheless, LP have been questioned due to serious collinearity problems, which are addressed by means of the ACF technique.

The OP and ACF methodologies differ in the choice of the state variable: it can be materials used or energy—electrical energy or fuels—as a proxy for unobserved productivity shocks. In OP, the state variable is capital, chosen in period $t - 1$, and labour adjusts freely in period t. While in ACF, labour is not considered to freely adjust in t, but somewhere else before, since there may be rigidities in the labour market like labour regulations that prevent free adjustment.

We estimate the following Cobb–Douglas production function:

$$y_{it} = \beta_{sl}sl_{it} + \beta_{ul}ul_{it} + \beta_k k_{it} + \beta_m m_{it} + \varpi_{it} + \eta_{it} \quad (1)$$

where y_{it} is gross output (we also tested value added), sl_{it} skilled labour, ul_{it} is unskilled labour, m_{it} is materials and inputs, and k_{it} capital stock of firm i at time t (all variables in logarithms); and ω_{it} and ω_{it} are firm- and time-specific unobserved shocks (ω_{it} is a productivity shock that affects the firm's input choices, while η_{it} is an i.i.d. shock that has no impact on the firm's decisions).

The residual of Eq. (1) is the firm's TFP, retrieved from the estimated coefficients as:

$$TPF_{it} = y_{it} - \hat{\beta}_{sl}sl_{it} - \hat{\beta}_{ul}ul_{it} - \hat{\beta}_m m_{it} - \hat{\beta}_k k_{it} \quad (2)$$

We estimate the production function for the full set of observations since the number of firm-year observations is small and the estimation of TFP may be sensitive to the number of firm-year observations. In the upper panel of Table 20, we present the coefficients of the production function for the three techniques when the dependent variable is value added; in the lower pane, we present the results for gross output as dependent variable. As proxy variables, we use investments for OP and electrical energy for ACF and LP.

The estimated coefficients of the production function are not directly comparable to previous works such as LP (2003) or ACF (2006) since in those works the estimations of the production functions are

Table 20 Production function estimation

	Olley and Pakes (1996)	Ackerberg et al. (2006)	Levinsohn and Petrin (2003)
Ln value added			
Ln (capital)	0.180***	0.175***	0.129***
	(0.0391)	(0.0223)	(0.0202)
Ln (unskilled workers)	0.311***	0.329***	0.331***
	(0.0390)	(0.0235)	(0.0397)
Ln (skilled workers)	0.470***	0.482***	0.457***
	(0.0285)	(0.0192)	(0.0285)
Ln (materials)	–	–	–
Observations	4857	5453	5745
Ln gross output			
Ln (capital)	0.165***	0.265***	0.171***
	(0.0346)	(0.0114)	(0.0239)
Ln (unskilled workers)	0.245***	0.265***	0.231***
	(0.0287)	(0.0145)	(0.0268)
Ln (skilled workers)	0.299***	0.317***	0.325***
	(0.0223)	(0.0132)	(0.0219)
Ln (materials)	0.168***	0.155***	0.197***
	(0.0212)	(0.0164)	(0.0273)
Observations	5596	6183	5745

SEs in parenthesis

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 21 Correlation matrix of TFP estimated using different methodologies

	OP1	LP1	ACF1	OP2	LP2	ACF2
OP1	1					
LP1	0.9922	1				
ACF1	0.9996	0.9904	1			
OP2	0.9805	0.9803	0.9794	1		
LP2	0.9581	0.9844	0.9524	0.9556	1	
ACF2	0.9996	0.9904	1	0.9794	0.9524	1

OP: Olley and Pakes estimation; ACF: Ackerberg et al. estimation; LP: Levinsohn and Petrin estimation; 1 represents estimation using value added as dependent variable; 2 indicates estimation using gross output as dependent variable

performed at the 3-digit ISIC industry level. Nevertheless, we find reasonable estimates for capital and labour, though smaller than those found by ACF for three industries and alike the Wood industry in ACF (2006). Furthermore, the standard errors (SEs) and returns to scale are also smaller. Moreover, we find some differences in the estimated coefficients depending on the methodology used. Nevertheless, the estimated TFP are highly correlated, as can be seen in Table 21.

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