Online Appendix

Exporting and Plant-Level Efficiency Gains: It's in the Measure

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A Estimation of the Production Function

In this appendix we explain the procedure we follow to estimate the production function (1).[1] For space reasons, we rewrite the translog production function (1) more succinctly as

$$q_{it} = f_s(l_{it}, k_{it}, m_{it}; \boldsymbol{\beta}^s) + \omega_{it} + \alpha d^x_{it} + \varepsilon_{it} \tag{A.1}$$

where all lowercase variables are in logs; q_{it} are revenues of plant i in year t; ω_{it} represents plant-level productivity, d^x_{it} is an export dummy, and ε_{it} represents measurement error as well as unanticipated shocks to output.[2] The vector $\boldsymbol{\beta}^s = (\beta^s_l, \beta^s_k, \beta^s_m, \beta^s_{ll}, \beta^s_{kk}, \beta^s_{mm}, \beta^s_{lk}, \beta^s_{mk}, \beta^s_{lm}, \beta^s_{lmk})$ collects the 10 coefficients of the translog production function to be estimated.

To estimate (A.1) we follow the methodology by Ackerberg, Caves, and Frazer (2006, henceforth ACF), which controls for the simultaneity bias that arises because input demand and unobserved productivity are positively correlated. This approach uses material inputs to control for the correlation between input levels and unobserved productivity. We modify the canonical ACF procedure, specifying an endogenous productivity process, where past export-status is allowed to impact current productivity.[3] Accordingly, the law of motion for productivity is:

$$\omega_{it} = g(\omega_{it-1}, d^x_{it-1}) + \xi_{it}$$

An important innovation of the ACF procedure is the timing for choosing capital, labor and materials. In particular, in the ACF framework plants choose labor after capital is known in $t-1$, but before materials are chosen and the productivity innovation ξ is revealed in t. In contrast, materi-

[1] The discussion of this section follows closely De Loecker, Goldberg, Khandelwal, and Pavcnik (2012).

[2] We include an export dummy as an additional input in the production function to allow exporters to produce under a different technology (following De Loecker and Warzynski, 2012).

[3] This reflects the correction suggested by De Loecker (2013); if productivity gains from exporting also lead to more investment (and thus a higher capital stock), the standard method would overestimate the capital coefficient in the production function, and thus underestimate productivity (i.e., the residual).

als are chosen when plants learns about their productivity in t. Hence, material's choice is made conditional on the values of capital, labor and productivity. Demand for material demand can be expressed then as

$$m_{it} \quad = \quad m_t(l_{it}, k_{it}, \omega_{it}, \boldsymbol{x}_{it})$$

where $\boldsymbol{x}_{it}$ contains all other variables affecting materials demand (time and product dummies, reflecting aggregate shocks and specific demand components). Note that in contrast to Olley and Pakes (1996) and Levinsohn and Petrin (2003), the labor coefficient is not identified in the ACF framework. However, provided that m_{it} is invertible in ω_{it}, productivity can be proxied using the materials' demand function: $\omega_{it} = h_t(m_{it}, l_{it}, k_{it}, \boldsymbol{x}_{it})$. The ACF methodology uses this fact to implement a consistent two-step procedure to estimate the production function.

In the first stage of the ACF routine a consistent estimate of expected output $\hat{\phi}_t(\cdot)$ is obtained from the regression

$$q_{it} \quad = \quad \phi_t(l_{it}, k_{it}, m_{it}; \boldsymbol{x}_{it}) + \varepsilon_{it}$$

where $\phi_t(\cdot) = f_s(l_{it}, k_{it}, m_{it}; \boldsymbol{x}_{it}) = f_s(l_{it}, k_{it}, m_{it}; \boldsymbol{\beta}^s) + h_t(m_{it}, l_{it}, k_{it}, \boldsymbol{x}_{it}) + \alpha d^x_{it}$.[4] Using the estimate of expected output, productivity can be computed for any candidate coefficient vector $\tilde{\boldsymbol{\beta}}^s$ as $\omega_{it}(\tilde{\boldsymbol{\beta}}^s) = \hat{\phi}_t - \hat{f}_s(l_{it}, k_{it}, m_{it}; \tilde{\boldsymbol{\beta}}^s)$. Estimating non-parametrically $\omega_{it}(\tilde{\boldsymbol{\beta}}^s)$ on its own lag $\omega_{it-1}(\tilde{\boldsymbol{\beta}}^s)$ and on prior exporting status (d^x_{it-1}), the productivity innovation can be recovered for each candidate $\tilde{\boldsymbol{\beta}}^s$.[5]

In the second stage, all coefficients of the production function are identified through GMM using the moment conditions

$$\mathbb{E}\left(\xi_{it}(\boldsymbol{\beta}^s)\mathbf{Z}_{it}\right) = 0 \tag{A.2}$$

where $\mathbf{Z}_{it}$ is a vector of variables that comprises lags of all the variables in the translog production function, and the current values of labor and capital in the corresponding interactions appear in the translog production function. These variables are valid instruments since labor and materials are chosen before the productivity innovation is observed.

Following De Loecker et al. (2012), we estimate (A.2) for each 2-digit manufacturing sector using the sample of single product plants that are observed in at least three consecutive peri-

[4] We approximate the function $\hat{\phi}_t(\cdot)$ with a full fourth-degree polynomial in capital, labor and materials, and product fixed effects.

[5] Following Levinsohn and Petrin (2003), we approximate the function $g(\cdot)$ with polynomial function.

ods. The reason for using single-product firms is that we do not observe how inputs are allocated across outputs within a plant, which makes the estimation of (1) at the product level unfeasible for multiple-product plants. However, for the set of single product plants no assumption on the allocation of inputs to outputs is needed, and the estimation of (1) can be performed with standard plant level information. Since our goal is to estimate revenue productivity, we use revenues as a proxy of physical production.

A summary of the estimated elasticities of labor, capital and materials, and the returns to scale by sector are shown in Table A.7. We cannot reject the null hypothesis of constant returns to scale; the mean (median) returns to scale is 1.02 (1.01).

B Estimation of Marginal Cost

In this appendix we provide details on the estimation of marginal costs. As explained in the main text, we follow a two-step approach. First, we derive the product-level markup for each plant, following the methodology outlined by De Loecker and Warzynski (2012). Second, we divide product-plant level output prices (observed in the data) by the calculated markup to obtain marginal cost.

For estimating the product-level markup we use equation (3), according to which the markup equals the elasticity of output (with respect to the flexible input), divided by the share of the flexible input in the sales of the product. This equation provides a simple formula to obtain product-level markups. However, this calculation cannot be performed directly in our data since part of the data necessary for computing (3) is not observed at the product level. In what follows, we explain our strategy to recover product-level markups in an approach that is similar to De Loecker et al. (2012).

The first element we need to estimate markups is the output elasticity of the flexible input. In our estimates of (1) we use materials as the flexible input to compute the output elasticity.[6] Note that because we use a translog production function, material elasticities depends on the use of *all* inputs in production. In particular, the materials-input elasticity for plant i producing product j in period t can be obtained as:

$$\theta^M_{ijt} \quad = \quad \beta^j_m + 2\beta^j_{mm} m_{ijt} + \beta^j_{mk} k_{ijt} + \beta^j_{lm} l_{ijt} + \beta^j_{lmk} l_{ijt} k_{ijt} \tag{A.3}$$

The vector of coefficients $\boldsymbol{\beta}^j = (\beta^j_m, \beta^j_{mm}, \beta^j_{mk}, \beta^j_{lm}, \beta^j_{lmk})$ is obtained from the estimation of the production function described in Section 2.2. We estimate $\boldsymbol{\beta}^j$ using the sample of single-product

[6] In principle, labor could be used as an alternative. However, in the case of Chile, labor being a flexible input would be a strong assumption due to its regulated labor market. A discussion of the evolution of job security and firing cost in Chile can be found in Montenegro and Pagés (2004).

plants, following De Loecker et al. (2012).[7] The reason for using the set of single-product plants is that we need product-level estimates of the output elasticity of materials to compute product-level markups. For multiple-product plants we do not observe how inputs are allocated across outputs within a plant, which makes the estimation of (1) at the product level unfeasible for these plants. However, for the set of single product plants no assumption on the allocation of inputs to outputs is needed, and the estimation of (1) can be performed with standard plant level information.

Next, we compute the output elasticity of materials using (A.3) for each plant-product. In this calculation, we use the coefficients in $\boldsymbol{\beta}^j$ together with information on inputs – capital, labor and materials. In multi-product plants, we do not observe how inputs are allocated across outputs. To resolve this issue, we follow Foster, Haltiwanger, and Syverson (2008) in assuming that plants allocate their inputs proportionally to the share of each product in total revenues. After applying this adjustment, the markup for each plant-product is computed using (3). To avoid that extreme values drive our results, we only use observations within the percentiles 1 and 99 of the markup distribution. Altogether, we are left with markup observations varying between (approximately) 0.5 and 4. In Table A.9 we show the average and median markup by sector.

C Data Appendix

In this appendix we provide additional detail on our data.

C.1 Details on Sample Selection and Data Consistency

In order to ensure consistent product-plant categories in our panel, we follow four steps. First, we drop plant-year observations whenever there are signs of unreliable reporting. In particular, we exclude plants that have missing or zero values for total employment, investment, demand for raw materials, sales, and product quantities. Second, given that we use unit values to proxy for prices, we restrict our sample to the set of plant-product-year observations with strictly positive sales and quantities. In addition, to avoid noisy observations we drop observations where price or quantities jump by a factor of 10 or more relative to the preceding or succeeding periods.

Third, whenever our analysis involves quantities of production, we have to carefully account for possible changes in the unit of measurement. For example, wine production changes from "bottles" to "liters." Total revenue is generally unaffected by these changes, but the derived unit values (prices) have to be corrected. We correct the derived unit values as follows: Suppose that the unit of measurement changed in year t. We assume that total quantity (measured in the 'old'

[7] The underlying assumption is that the technology for producing a given product is the same in single and multiple product plants.

unit) grew at the same rate as total revenue between $t-1$ and t. This allows us to derive quantity measured in the 'old' unit for period t, Q_t^{old}. Consequently, we can derive the price in terms of the old and the new unit: $P_t^{old} = R_t/Q_t^{old}$; $P_t^{new} = R_t/Q_t^{new}$, where R denotes revenue. This implies the conversion rate $X = P_t^{old}/P_t^{new}$ that we use for all periods from t onwards – which allows us to measure the good in the old unit throughout the sample period. This procedure is needed for 501 cases, less than 1% of all plant-product observations.

Fourth, a similar correction is needed because the product identifier in our sample changes in the year 2001. The Chilean Statistical Institute provides a correspondence for the new product categories in terms of the former product category. However, this crosswalk does not allow to establish a one-to-one match for all observations. This generates two problems. First, for a subset of the sample (5% of the original sample) no correspondence is provided, and only the new product category is available. We drop all plant-product pairs for which no correspondence is available. Second, for other subset of the sample (8% of the original sample) multiple observations are assigned to a single product-category within a plant. In these cases, we aggregate the information of these observations. We also use an additional procedure to link old and new product identifiers in 2001: We chain products within plants when there is reasonable evidence that they represent the same product. In particular, we assign a common product category for (i) single-product plants producing products in the same 4-digit category (1,296 changes), (ii) multiple-product plants with no adding or dropping of products and with exactly one product changing classification per year (538 changes), (iii) multiple-product plants with at most one product being exported, and with the exported product in two consecutive years changing of product category (167 changes). For (i)-(iii), we require potential candidates to stay within the same 4-digit category (in CUP) before and after the change.[8] In addition, whenever the chained products are recorded in different units we apply the procedure outlined in the previous paragraph to homogenize the unit of measurement. This methodology expands the sample by 2,001 plant-product observations – approximately 2% of the overall sample size.

After these adjustments, our sample consists of 109,210 plant-product-year observations.

D Propensity Score Matching Estimation

In this appendix we provide technical details on the implementation of the matching estimator outlined in section 4.2. The specification of the propensity score is

$$Pr(\text{ENTRY}_{ij,t} = 1) = \Phi\{f(\Delta mc_{ij,t-1}, mc_{ij,t-1}, TFPR_{i,t-1}, k_{i,t-1}, Z_{ij,t-1})\} \tag{A.4}$$

[8] The categories we use – which we define in terms of the CUP – are comparable to 4-digit ISIC categories.

where $\text{ENTRY}_{ij,0}$ is a categorical variable equal to one if product j produced by plant i enters the export market at period t and $\Phi(\cdot)$ is the normal cumulative distribution function.[9] As dependent variables, we include a polynomial in the elements of $f(\cdot)$ on the left-hand side variables of equation (A.4).[10] As Wooldridge (2002) suggests, this could improve the resulting matching as less structure is imposed. Importantly, in our specification we include the lagged and differential marginal cost ($\Delta mc_{ij,t-1}, mc_{ij,t-1}$) to control for pre-trends.[11] The inclusion of the pre-trend for marginal costs comes at a cost: it reduces the number of available observation in the matching procedure because one period is lost (see Table A.11). We also include lagged productivity – which is one of the underlying variables causing entry into export markets in the stylized model presented in Appendix E – and lagged capital stock. Both summarize the state of the plant at the pre-entry period. Finally, we include other product and plant variables in the vector $Z_{ij,t-1}$ to control for differences unaccounted for by the states and the pre-trend of the marginal cost. Within the set of variables in $Z_{ij,t-1}$, we consider the number of employees and product sales to control for the size and scale of production, the share of white collar workers to control for differences in human capital, and the import-status of the plant to control for potential differences in efficiency arising from the use of more advanced technology embodied in the use of foreign goods.

All our results are derived using the nearest neighbor matching technique. Accordingly, the group of controls are the plants/products with a propensity score that is closest to that of the new exported product. In our benchmark analysis we use the five nearest-neighbors. As we show in Table A.4, our main results stay relatively unchanged if 1, 3 or the 10 nearest neighbors are used instead. We perform this matching procedure within products. Thus, each new exported product is compared to products in the same product category. To minimize the presence of bad quality matches, we trim the resulting distribution – we drop the 1st and 99th percentiles – before computing the average effect of entry.

E Stylized Theoretical Framework: Derivation

In this section we provide details on the derivation of the stylized framework presented in Section 2 in the paper.

[9] The definition of entry is provided in section 3.2.

[10] We include the level and square of all variables, and all variables are interacted with size and product-level sales.

[11] In Table A.10 we show that our results are very similar when we do not include a pre-trend for marginal costs in the estimation of the propensity score.

E.1 Preferences

We assume a quasi-linear utility function with a quadratic subutility as in Foster et al. (2008):[12]

$$U = y + \int_{i\in I}(\alpha + \delta_i)q_i di - \frac{1}{2}\eta\left(\int_{i\in I} q_i di\right)^2 - \frac{1}{2}\gamma\int_{i\in I} q_i^2 di$$

where y and q_i represent the consumption levels of an undifferentiated good and each variety i respectively, $\gamma \geq 0$ is an index of substitutability across varieties – it can be interpreted as the cost of variance in the consumption of different varieties. If γ is large, consumers have a strong taste for variety, so that individual q_i's are less substitutable. Finally, α and $\eta \geq 0$ govern the substitutability with the numeraire, and δ_i is a variety-specific, mean-zero taste shifter.

E.2 Partial Equilibrium for the Differentiated Good in the Domestic Market

Given the above preferences, if income is large enough so that quantity demanded of the numeraire is positive, the (inverse) demand for any differentiated good i is given by

$$p_i = \alpha + \delta_i - \gamma q_i - \eta Q \tag{A.5}$$

We can solve for aggregate demand Q by integrating individual demand over the range of goods for which the quantity demanded is positive:

$$Q = \frac{N(\alpha - \bar{\delta} - \bar{p})}{\gamma + \eta N}\ , \tag{A.6}$$

where N is the measure of consumed varieties and $\bar{\delta}$ and $\bar{p}$ are average taste shifter and price, respectively. Replacing this expression in the inverse demand function leads to:

$$p_i = M + \delta_i - \gamma q_i \tag{A.7}$$

where $M = \frac{1}{\eta N+\gamma}\left(\alpha\gamma + \eta N(\bar{p} - \bar{\delta})\right)$ is a variety-invariant term that we interpret as the relevant domestic market size for producer i. Thus, producer i's market is the smaller the more other varieties (N) are sold, and the stronger demand is shifted towards these other products ($\bar{\delta}$). In addition, demand for variety i is increasing in the price charged by other producers ($\bar{p}$).

There is no entry or exit of plants, so that the mass N of plants is stable. Plants differ in their technology, which is fixed. For now, we assume that each plant produces a single variety, using

[12] In the derivation of the demand and profit function we follow their notation. This approach goes back to the earlier work by Ottaviano, Tabuchi, and Thisse (2002).

a constant returns technology. Later on we discuss the case of increasing returns. In contrast to Foster et al. (2008), we impose no particular degree of returns to scale; we only assume Hicks-neutrality.[13] There are no fixed costs and the marginal cost of production of variety i is given by MC_i, which is related inversely to the efficiency of the firm because of Hicks neutrality.[14] Importantly, MC_i is driven by input costs and firm efficiency. To the extent that all producers within a sector face the same or similar input costs, lower marginal cost will directly reflect higher technological efficiency (TFPQ). Profit maximizing price and quantity are given by

$$p_i = \frac{1}{2}\left(M + \delta_i + MC_i\right), \qquad q_i = \frac{1}{2\gamma}\left(M + \delta_i - MC_i\right) \tag{A.8}$$

which implies that profits in the domestic market are given by

$$\pi_i = \frac{1}{4\gamma}\left(M + \delta_i - MC_i\right)^2 \tag{A.9}$$

Assuming Hicks-neutrality, physical productivity (TFPQ) can be computed as

$$TFPQ_i = \frac{q_i}{\phi(\mathbf{X})} = A_i \tag{A.10}$$

where $\mathbf{X}$ is a vector of inputs, and the functional form $\phi(\cdot)$ depends on the particular production function chosen.[15] Revenue productivity (TFPR) is obtained by multiplying TFPQ with the corresponding price:

$$TFPR_i = p_i \cdot A_i = \left[\frac{1}{2}(M + \delta_i + MC_i(\underset{(-)}{A_i}, \underset{(+)}{\mathbf{w}}))\right] \cdot A_i \,, \tag{A.11}$$

where $\mathbf{w}$ is a vector of input prices. As highlighted by Foster et al. (2008), TFPR reflects not only efficiency differences, but also input prices and demand factors, as given by market size M and idiosyncratic demand shocks δ_i. TFPR also depends on marginal costs, which in turn fall with A_i.[16] Therefore, a positive relation between TFPR and TFPQ cannot be ensured.

[13] This assumption is standard in the literature that studies production function estimation (c.f. Ackerberg, Benkard, Berry, and Pakes, 2007).

[14] The marginal cost is expressed in units of the numeraire good.

[15] For example, in a standard Cobb-Douglas production function with capital and labor, $\phi(\cdot) = K^{\alpha}L^{1-\alpha}$.

[16] For example, in a Cobb-Douglas production function, we would have the standard result $\frac{1}{A_i}\left(\frac{r}{\alpha}\right)^{\alpha}\left(\frac{w}{1-\alpha}\right)^{1-\alpha}$ for marginal cost.

E.3 Partial Equilibrium for the Differentiated Good in the External Market

We assume that preferences in the external market have the same functional form as in the domestic market. We add asterisks to all variables and parameters in the external market to differentiate them from domestic values. Demand for variety i is given by $p_i^* = M^* + \delta_i^* - \gamma q_i^*$, where $M^* = \frac{1}{\eta N^* + \gamma^*}\left(\alpha^*\gamma^* + \eta^* N^*(\bar{p}^* - \bar{\delta}^*)\right)$.

We use the standard assumption that to sell their output in the external market, plants need to pay a fixed entry cost F_E. Exports are also subject to an iceberg trade cost τ. Profit maximizing price and quantity in the external market are:

$$p_i^* = \frac{1}{2}\left(M^* + \delta_i^* + \tau MC_i\right), \qquad q_i^* = \frac{1}{2\gamma}\left(M^* + \delta_i^* - \tau MC_i\right) \tag{A.12}$$

We define the categorical variable E_i that equals 1 if product i is exported. Total profits from domestic and foreign sales are then given by

$$\pi_i^* = \underbrace{\frac{1}{4\gamma}\left(M + \delta_i - MC_i\right)^2}_{\text{profits in domestic market}} + E_i \underbrace{\left[\frac{1}{4\gamma\tau}\left(M^* + \delta_i^* - \tau MC_i\right)^2 - F_E\right]}_{\text{profits in external market}} \tag{A.13}$$

In this context, plants export if the profits under exporting (i.e., $E = 1$) are higher than under domestic sales only ($E = 0$). We use this condition to define an exporting threshold in terms of marginal cost:

$$\begin{aligned} \pi_i^0(E_i = 1) &\geq \pi_i^0(E_i = 0) \\ \Leftrightarrow MC_i &\leq \underbrace{\frac{1}{\tau}\left(M^* + \delta_i^* - 2\sqrt{F_E\gamma\tau}\right)}_{\text{exporting threshold}} \end{aligned} \tag{A.14}$$

This is equivalent to saying that, as in Melitz (2003), plants select into exporting if their additional profits under exporting exceed the (annualized) export fixed cost F^E.[17] Note that for a given marginal cost, the tendency of a plant to exports is the higher (i) the larger the external market M^*, (ii) the higher the idiosyncratic foreign demand δ_i^*, and (iii) the lower the fixed and variable export cost F_E and τ.

We now define ε_i as the export entry wedge (in terms of marginal costs). This variable indicates how far (in percentage terms) plant i's marginal cost is from the export threshold – where annual

[17] In contrast to Melitz (2003), in our setup the export threshold is firm-specific, because it also depends on the idiosyncratic parameter δ_i^*.

profits equal the annualized fixed entry cost F_E. This wedge is implicitly defined by:

$$1+\varepsilon_i = \frac{MC_i}{\frac{1}{\tau}\left(M^* + \delta_i^* - 2\sqrt{F_E\gamma\tau}\right)} \tag{A.15}$$

Thus, for plants selling only domestically, $\varepsilon_i > 0$. On the other hand, for exporters $\varepsilon_i \leq 0$, i.e., marginal costs are below the threshold.

E.4 Demand- and Supply Drivers of Export Entry

In this subsection we derive the expressions used in the main text for the scenarios that can cause a plant's export entry.

Demand Shock

Plants will enter the export market if overall foreign demand M^* increases or if foreign demand shifts towards their product (δ_i^* rises). In terms of equation (A.14), this implies that the marginal-cost-threshold for export entry increases, making entry profitable for relatively less productive plants. If this was the dominant mechanism, marginal costs should not change after export entry, which is not in line with our data.[18]

Domestic Productivity Shock

A second channel that could induce entry into export markets is a plant-specific productivity shock. In terms of equation (A.14), more efficient plants produce at a lower marginal cost, making it more likely that they fall below the threshold for export entry.

We analyze the case of a plant that initially does not export ($\varepsilon_i > 0$) and that after the domestic productivity shock decides to enter the export market. Denote the marginal cost after the domestic productivity shock by $MC_i^{post} = \frac{MC_i^0}{1+\varphi_i^{PS}}$, with $\varphi_i^{PS} > 0$. Suppose that the shock is large enough to trigger export entry. Then MC_i^{PS} must be below the threshold defined by equation (A.14). Thus, the following condition must hold for a firm that is induced to export by a positive productivity shock:

$$\frac{MC_i^0}{1+\varphi_i^{PS}} \leq \frac{1}{\tau}\left(M^* + \delta_i^* - 2\sqrt{F_E\gamma\tau}\right) \tag{A.16}$$

[18] Note that the effect on product price is not determined. Because the product has not previously been exported, its price in the foreign market was unobserved. The price charged after export entry may be below, equal, or above the domestic price, depending on the parameters in (A.8) and (A.12). Correspondingly, the effect on TFPR is also ambiguous.

Using (A.15), this implies that a productivity shock induces entry if

$$\varphi_i^{PS} \geq \varepsilon_i \tag{A.17}$$

Note that this mechanism implies a reverse causality between exporting and efficiency gains, since the increase in efficiency occurs before entry. Nevertheless, TFPR may not reflect this shock if the increased efficiency is passed on to customers in the form of lower prices – see (A.8) and (A.12). Analyzing marginal cost, on the other hand, allows us to identify the associated efficiency gains.

Learning by Exporting

Suppose now that plants learn after export entry so that they become more efficient. In particular, after paying the fixed cost $F^E > 0$ for entry, the marginal cost becomes $MC_i^{LBE} = \frac{MC_i^0}{1+\varphi_i^{LBE}}$, $\varphi_i^{LBE} > 0$. We assume for simplicity that plants correctly anticipate these efficiency gains. As in the case with no learning, plants start exporting if the profits obtained exporting are higher than the profits obtained selling in the domestic market only:

$$\pi_i^{LBE}(E=1) \geq \pi_i^0(E=0)$$

This entry condition can also be expressed as:

$$\Leftrightarrow \underbrace{\frac{\left[M^* + \delta_j^* - \tau \frac{MC_i^0}{1+\varphi_i^{LBE}}\right]^2}{\tau} - 4\gamma F_E}_{\geq \mathbf{0} \text{ if } \varphi_i^{LBE} \geq \varepsilon_i} \geq \underbrace{\left[M + \delta_i - MC_i^0\right]^2 - \left[M + \delta_i - \frac{MC_i^0}{1+\varphi_i^{LBE}}\right]^2}_{\leq \mathbf{0}} \tag{A.18}$$

This condition is less restrictive than the one derived for the case where plants experience a domestic productivity shock. The LHS of (A.18) is greater than zero as long as $\varphi_i^{LBE} > \varepsilon_i$, while the RHS is always negative because the domestic profits are higher when plants experience LBE than when selling domestically only.

Equation (A.18) can be solved implicitly for φ_i^{LBE} in terms of ε_i and F^E. Since the LHS is strictly increasing in φ_i^{LBE} while the RHS of (A.18) is decreasing in φ_i^{LBE}, there exists a unique φ_i^{LBE} that solves (A.18). In particular, it can be shown that the LHS is strictly decreasing in (ε_i, F^E) while the RHS is strictly increasing in ε_i. Therefore, the export entry condition can be written as:

$$\varphi_i^{LBE} \geq f(\underset{(+)}{\varepsilon_i}, \underset{(+)}{F^E}) \tag{A.19}$$

so that plants that are farther away from the export entry threshold need larger efficiency gains induced by entry in order to start exporting. The same is true for larger fixed costs of export entry. Note that if plants experience LBE, entrants should display increasing efficiency trajectories.

Moreover, since LBE is a causal mechanism – i.e., there are efficiency gains only if there is entry – we should observe higher efficiency levels only *after* entry.

Technology-export complementarity

The last mechanism we study involves a complementarity between the exporting decision and investment in new technologies. In particular, assume that after paying a fixed cost $F^I > 0$, plants gain access to new technology with lower marginal cost $MC_i^{TEC} = \frac{MC_i^0}{1+\varphi_i^{TEC}}$, with $\varphi_i^{TEC} > 0$. As in Lileeva and Trefler (2010), we focus on the case in which export entry is only profitable in combination with investment in the new technology – which is the relevant case for a complementarity between technology investment and exporting. In this setup, plants enter the export market if $\pi_i^{TEC}(E=1) \geq \pi_i^0(E=0)$. We can manipulate this expression as in the previous case:

$$\frac{\left[M^* + \delta_i^* - \tau \frac{MC_i^0}{1+\varphi_i^{TEC}}\right]^2}{\tau} - 4\gamma F^E \geq \left[M + \delta_i - MC_i^0\right]^2 - \left[\left[M + \delta_i - \frac{MC_i^0}{1+\varphi_i^{TEC}}\right]^2 - 4\gamma F^I\right] \quad \text{(A.20)}$$

The LHS of equation (A.20) is positive as long as $\varphi_i^{TEC} \geq \varepsilon_i$. However, the RHS can be positive or negative depending on whether investing without exporting is more profitable than the status quo. As in the previous case, we can solve equation (A.20) implicitly for φ_i^{TEC} in terms of ε_i and (F^E, F^I). The LHS is strictly increasing in φ_i^{TEC}, while the RHS of (A.20) is decreasing in φ_i^{TEC}. Thus, there exists a unique solution for φ_i^{TEC}. The export entry condition can then be written as:

$$\varphi_i^{TEC} \geq f(\underset{(+)}{\varepsilon_i}, \underset{(+)}{F^E}, \underset{(+)}{F^I}) \quad \text{(A.21)}$$

Consequently, plants farther away from the export entry threshold, or with higher fixed investment or export cost, require a higher efficiency gain from the new technology in order to start exporting. Note that (implicit in this analysis) the magnitude of the complementarity between investment and exporting depends on both the efficiency gain (φ_i^{TEC}) and the size of the foreign market.

F Additional Tables

Table A.1: Within Plant-Product Trajectories, Including One-Time Exporters

Periods After Entry	-2	-1	0	1	2	3	Obs/R^2
Revenue TFP	-.0445*	-.0216	-.0135	.00388	-.00423	.00272	1,985
	(.0246)	(.0218)	(.0202)	(.0274)	(.0467)	(.0558)	.564
Price	.0391	.00688	-.0859	-.172**	-.182**	-.184*	2,653
	(.0692)	(.0487)	(.0547)	(.0672)	(.0920)	(.106)	.829
Marginal Cost	.0385	-.0154	-.0902	-.172**	-.189*	-.213*	2,653
	(.0692)	(.0509)	(.0563)	(.0699)	(.0968)	(.112)	.816
Markup	.000534	.0222	.00432	.000562	.00709	.0290	2,653
	(.0192)	(.0164)	(.0152)	(.0210)	(.0321)	(.0292)	.539
Reported Average Cost	.0452	-.0328	-.106*	-.155**	-.0869	-.215*	2,653
	(.0720)	(.0573)	(.0580)	(.0739)	(.103)	(.111)	.804
Physical Quantities	.00229	.127*	.221***	.322***	.255**	.264*	2,653
	(.0932)	(.0679)	(.0700)	(.0816)	(.107)	(.145)	.823

Notes: This table replicates Table 2 in the main text when products that are exported for only one period throughout the sample are included in the regressions. See notes to Table 2 for details on the definition of entry, and the controls used in each regression. Clustered standard errors (at the plant-product level) in parentheses. Key: ** significant at 1%; ** 5%; * 10%.

Table A.2: Matching Robustness: Accounting for Intermittent Exports

Periods After Entry	0	1	2	3
Revenue TFP	-.0118	-.0293	.0299	-.0248
	(.0229)	(.0472)	(.102)	(.116)
Price	-.145***	-.187**	-.236	-.562**
	(.0529)	(.0847)	(.241)	(.270)
Marginal Cost	-.103*	-.185*	-.261	-.719**
	(.0586)	(.104)	(.236)	(.312)
Markup	-.00920	-.0647	.0251	-.0672
	(.0284)	(.0575)	(.131)	(.134)
Average Cost	-.137*	-.278***	-.288	-.722**
	(.0795)	(.103)	(.198)	(.272)
Treated Observations (Min/Max)	129 / 130	83 / 84	46 / 48	24 / 25
Control Observations (Min/Max)	645 / 650	415 / 420	230 / 240	120 / 125

Notes: This table accounts for entrants exporting intermittently after export entry including a "domestic only" dummy for a plant-product in period t when the product had previously entered the export market but is not exported in t. Coefficients correspond to the differential growth of each variable with respect to the pre-entry year ($t = -1$) between entrants and controls. Period $t = 0$ corresponds to the entry year. See notes to Table 3 for details about the matching technique and the definition of entrants. The number of treated and control observations differ across dependent variables; the minimum (Min) and maximum (Max) number of observations are reported. Robust standard errors in parentheses. Key: ** significant at 1%; ** 5%; * 10%.

Table A.3: Within Plant-Product Average Cost Trajectory for New Exported Products

Periods After Entry	-2	-1	0	1	2	3	Obs/R^2
Reported Average Cost	.0187	-.0893	-.193**	-.201**	-.133	-.257**	1,668
	(.102)	(.0820)	(.0851)	(.0872)	(.112)	(.115)	.795

Notes: Regression output corresponds to the estimation of equation (5). See notes to Table 2 for details on the estimation of the trajectories and the entry definition. Key: ** significant at 1%; ** 5%; * 10%.

Table A.4: Matching Robustness: Different Number of Neighbors

Periods After Entry	0	1	2	3
Panel A: 1 Neighbor				
Revenue TFP	-.0152	.0639	.00879	.153
	(.0271)	(.0427)	(.0504)	(.0901)
Price	-.122**	-.159**	-.407**	-.407**
	(.0547)	(.0753)	(.180)	(.173)
Marginal Cost	-.0896	-.204**	-.264*	-.682***
	(.0612)	(.0909)	(.148)	(.186)
Markup	-.00946	.0411	-.0414	.158
	(.0323)	(.0554)	(.0521)	(.101)
Average Cost	-.156**	-.222**	-.0629	-.621***
	(.0622)	(.0881)	(.247)	(.172)
Treated Observations	128	83	46	23
Control Observations	128	83	46	23
Panel B: 3 Neighbors				
Revenue TFP	-.0108	.0472	.0251	.119
	(.0240)	(.0442)	(.0555)	(.0706)
Price	-.0583	-.193**	-.350**	-.665*
	(.0478)	(.0776)	(.133)	(.355)
Marginal Cost	-.0676	-.156*	-.259*	-.894**
	(.0519)	(.0903)	(.130)	(.353)
Markup	-.00588	.0233	-.0122	.197*
	(.0273)	(.0530)	(.0613)	(.111)
Average Cost	-.0493	-.207**	-.164	-.503***
	(.0761)	(.0858)	(.201)	(.170)
Treated Observations	130	83	46	24
Control Observations	390	249	138	72
Panel C: 10 Neighbors				
Revenue TFP	-.00979	.0493	.0423	.127*
	(.0225)	(.0432)	(.0518)	(.0693)
Price	-.0991**	-.143*	-.257**	-.637**
	(.0411)	(.0726)	(.101)	(.252)
Marginal Cost	-.103**	-.179**	-.325**	-.805***
	(.0482)	(.0842)	(.127)	(.247)
Markup	.00416	.0132	-.00613	.170
	(.0258)	(.0533)	(.0483)	(.123)
Average Cost	-.111	-.218***	-.136	-.517***
	(.0742)	(.0807)	(.188)	(.164)
Treated Observations	128	83	46	23
Control Observations	1280	830	460	230

Notes: This table documents the robustness of the results in Table 3 when changing the number of neighbors in the matching procedure. The benchmark number of neighbors is 5. Coefficients correspond to the differential growth of each variable with respect to the pre-entry year ($t = -1$) between entrants and controls. Period $t = 0$ corresponds to the entry year. See notes to Table 3 for details about the matching technique and the definition on entrants. Robust standard errors in parentheses. Key: ** significant at 1%; ** 5%; * 10%.

Table A.5: Placebo using Domestic Goods Sold by Export Entrants (Matching Results)

Periods After Entry	0	1	2	3
Price	-0.0413	0.0597	-0.217	0.304
	(0.0637)	(0.119)	(0.158)	(0.175)
Marginal Cost	0.0346	0.222	-0.0358	0.121
	(0.0746)	(0.194)	(0.183)	(0.298)
Markup	-0.0621*	-0.0979*	-0.0710	-0.177
	(0.0328)	(0.0526)	(0.0729)	(0.134)
Reported Average Cost	-0.110	0.0979	-0.0450	-0.383
	(0.0781)	(0.195)	(0.141)	(0.256)
Treated Observations (Min/Max)	104 / 105	51 / 53	33 / 34	8 / 8
Control Observations (Min/Max)	520 / 525	255 / 265	165 / 170	40 / 40

Notes: The table shows the differential growth of each variable with respect to the pre-entry year ($t = -1$) between non-exported products produced by export entrants and controls. Thus, treated observations include only multi-product plants. The control group is selected using the criteria explained in Table 3. Period $t = 0$ corresponds to the export entry year. The criteria for defining a plant as entrant can be found in the notes to Table 2. Robust standard errors in parentheses. Key: ** significant at 1%; ** 5%; * 10%.

Table A.6: Change in Domestic and Exported Prices After Export Entry

Dependent Variable: Price of Product when:		
	Exported	Domestic
Export Dummy	-.230*	-.204*
	(.134)	(.118)
R-squared	.798	.809
Obs.	814	814

Notes: The regressions report the average change in exported and domestic prices of new exported products after export entry. The analysis includes only plant-products that have been exported for a maximum of 3 years. The period covered is 1997-2000, where our data contain separate information for exported and domestic product prices. The regression controls for plant-product fixed effects (at the 7-digit level), and for product-year effects at the 4-digit level. A product is defined as an entrant if it is the first product exported by a plant and is sold domestically for at least one period before entry into the export market. Standard errors (clustered at the plant-product level) in parentheses. Key: ** significant at 1%; ** 5%; * 10%.

Table A.7: Translog Output Elasticities

	Elasticities			Returns to Scale	
	Labor	Capital	Materials	Mean	Median
Food and Beverages	0.069	0.236	0.763	1.068	0.997
	(0.697)	(0.531)	(0.064)	(0.023)	
Textiles	0.197	0.049	1.017	1.263	1.38
	(0.866)	(1.007)	(0.277)	(0.493)	
Apparel	0.241	0.142	0.68	1.063	1.111
	(0.441)	(0.539)	(0.044)	(0.097)	
Wood and Furniture	0.016	0.17	0.83	1.016	1.052
	(0.827)	(0.676)	(0.148)	(0.079)	
Paper	0.333	0.051	0.789	1.174	1.012
	(0.459)	(0.74)	(0.054)	(0.079)	
Basic Chemicals	0.261	0.127	0.828	1.216	0.809
	(0.583)	(0.714)	(0.137)	(0.264)	
Plastic and Rubber	0.053	0.126	0.768	0.947	0.977
	(0.725)	(0.653)	(0.12)	(0.063)	
Non Metallic Manufactures	0.235	0.181	0.748	1.164	1.247
	(0.525)	(0.578)	(0.113)	(0.14)	
Metallic Manufactures	-0.011	0.442	0.424	0.856	1.012
	(0.472)	(0.186)	(0.185)	(0.151)	
Machinery and Equipment	0.105	0.061	0.974	1.14	0.857
	(0.911)	(0.953)	(0.272)	(0.33)	
All	0.096	0.26	0.668	1.024	1.015
	(0.617)	(0.47)	(0.233)	(0.211)	

Notes: The table reports the estimated output elasticities for the translog production function (1). Columns 1-3 display the sales-weighted mean elasticities (by aggregate sectors) with respect to each production factor for all plant-products. In columns 4 and 5 we report the sales-weighted mean and median returns to scale, which are equal to the sum of the coefficients in columns 1-3. Standard errors are in parenthesis.

Table A.8: Heterogeneous Effect on Initially Low and High Productivity Entrants

Periods After Entry	0	1	2	3
A. Revenue TFP				
Low Initial Productivity	.0386	.124**	.0446	.287***
	(.0327)	(.0553)	(.0468)	(.0947)
High Initial Productivity	-.0570*	-.0413	.00323	-.00436
	(.0314)	(.0610)	(.0900)	(.0852)
t-test (p-value)	.0367**	.048**	0.6856	.0322**
B. Price				
Low Initial Productivity	-.153**	-.0980	-.397*	-.698
	(.0630)	(.0861)	(.231)	(.587)
High Initial Productivity	-.138	-.215**	-.225	-.474*
	(.0852)	(.108)	(.180)	(.252)
t-test (p-value)	.8882	.3968	.5602	.7292
C. Marginal Cost				
Low Initial Productivity	-.210**	-.221**	-.374*	-1.053*
	(.0804)	(.0879)	(.218)	(.559)
High Initial Productivity	-.00162	-.187	-.199	-.520**
	(.0837)	(.148)	(.205)	(.234)
t-test (p-value)	.075*	.8403	.5622	.3888
D. Average Cost				
Low Initial Productivity	-.192***	-.137	-.317**	-1.164*
	(.0719)	(.0982)	(.133)	(.582)
High Initial Productivity	-.0847	-.300**	-.0186	-.494**
	(.139)	(.124)	(.321)	(.237)
t-test (p-value)	.4952	.3082	.3936	.2977
E.Markup				
Low Initial Productivity	.0748**	.119*	-.0282	.178
	(.0341)	(.0654)	(.0534)	(.139)
High Initial Productivity	-.0858**	-.0796	-.0591	.0460
	(.0428)	(.0771)	(.0885)	(.132)
t-test (p-value)	.0039***	.0532*	.7663	.4979
Treated Observations (Min/Max)	129 / 130	83 / 84	46 / 48	24 / 25
Control Observations (Min/Max)	645 / 650	415 / 420	230 / 240	120 / 125

Notes: This table examines the presence of heterogenous entry effects for export entrants with initially low vs. high productivity. We use pre-exporting TFPR to split plant-products into above- and below- median productivity. Coefficients correspond to the differential growth of each variable with respect to the pre-entry year ($t = -1$) between entrants and controls. Period $t = 0$ corresponds to the entry year. See notes to Table 3 for details about the matching technique and the definition on entrants. The null hypothesis for the F-test in each panel is that the entry effect is equal in initially low and high productivity entrants. Robust standard errors in parentheses. Key: ** significant at 1%; ** 5%; * 10%.

Table A.9: Estimated Markups

	Mean		
	Unweighted	Weighted	Median
Food and Beverages	1.364	1.507	1.265
	(0.46)	(0.54)	
Textiles	1.756	2.08	1.561
	(0.766)	(0.812)	
Apparel	1.317	1.483	1.183
	(0.548)	(0.553)	
Wood and Furniture	1.325	1.652	1.234
	(0.514)	(0.511)	
Paper	1.423	1.864	1.293
	(0.597)	(0.63)	
Basic Chemicals	1.306	1.528	1.16
	(0.591)	(0.681)	
Plastic and Rubber	1.385	1.458	1.309
	(0.453)	(0.401)	
Non Metallic Manufactures	1.755	2.114	1.582
	(0.671)	(0.862)	
Metallic Manufactures	1.29	1.112	1.11
	(0.642)	(0.623)	
Machinery and Equipment	1.133	1.696	0.995
	(0.538)	(0.582)	
All	1.39	1.547	1.243
	(0.626)	(0.79)	

Notes: This table reports the estimated markup by aggregate sector for the period 1996-2005 (see Appendix B for details on the computation). Columns 1 and 2 display the unweighted and sales-weighted average markup, respectively. Standard errors are in parenthesis.

Table A.10: Matching Robustness: Main Results without pre-Trend

Periods After Entry	0	1	2	3
Panel A: Benchmark				
Revenue TFP	-.00605	.0165	.0121	.0737
	(.0230)	(.0398)	(.0432)	(.0695)
Price	-.116**	-.230***	-.282**	-.517**
	(.0480)	(.0760)	(.118)	(.191)
Marginal Cost	-.0935*	-.206**	-.301**	-.665***
	(.0527)	(.0843)	(.124)	(.196)
Markup	.00259	-.0142	-.0378	.127
	(.0271)	(.0479)	(.0447)	(.123)
Reported Average Cost	-.153***	-.251***	-.466***	-.643***
	(.0566)	(.0791)	(.135)	(.169)
Treated Observations (Min/Max)	128 / 129	84 / 85	47 / 48	23 / 25
Control Observations (Min/Max)	640 / 645	420 / 425	235 / 240	115 / 125
Panel B: Accounting for Intermittent Exporters				
Revenue TFP	-.00605	-.0438	-.0224	-.0731
	(.0230)	(.0476)	(.0993)	(.116)
Price	-.116**	-.279***	-.297	-.933***
	(.0480)	(.0904)	(.235)	(.318)
Marginal Cost	-.0935*	-.181*	-.257	-1.075***
	(.0527)	(.102)	(.230)	(.331)
Markup	.00259	-.0817	.0194	.142
	(.0271)	(.0567)	(.119)	(.280)
Reported Average Cost	-.153***	-.291***	-.308	-1.019***
	(.0566)	(.0989)	(.196)	(.263)
Treated Observations (Min/Max)	128 / 129	84 / 85	47 / 48	23 / 25
Control Observations (Min/Max)	640 / 645	420 / 425	235 / 240	115 / 125

Notes: This table examines the robustness of the results in Table 3 when we exclude the pre-trend marginal cost term ($\Delta mc_{ij,t-1}$) from the specification of the propensity score. For comparability of results, we only consider plant-products with information for at least two periods before export entry (since this is needed to calculate $\Delta mc_{ij,t-1}$ in the baseline case). Panel A replicates the baseline results from Table 3 without pre-trends. In Panel B we also control for a "domestic only" dummy that accounts for periods where new exported products are sold domestically only (see notes to Table A.2). Coefficients correspond to the differential growth of each variable with respect to the pre-entry year ($t = -1$) between entrants and controls. Period $t = 0$ corresponds to the entry year. See notes to table 3 for details about the matching technique and the definition on entrants. Robust standard errors in parentheses. Key: ** significant at 1%; ** 5%; * 10%.

Table A.11: Observations for Export Entrants in our Sample

Periods After Entry	0	1	2	3
All	671	499	390	244
With MC in t={-1,0}[(a)]	458	338	270	170
With MC in t={-2,-1,0}[(b)]	183	129	101	53
With MC in t={-2,-1,0} and PSM Controls[(c)]	159	109	82	44

Notes: The table shows the number of available observations up to 4 periods after entry into export markets. A product is defined as an export entrant if it is the first product exported by the plant and is sold domestically for at least one period before exporting. Period 0 corresponds to the entry period. (a): With available information of marginal cost in the period of entry and one period before entry; (b): (a) + with marginal cost information two periods after entry; (c): (b) and with information for all controls used in the propensity score specification.

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