Learning from Exporting Revisited in a Less Developed Setting *

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Abstract

This study asks if firms become more productive by learning through exporting. We do so by estimating production functions using a panel dataset of Indonesian manufacturing establishments from 1990 to 1996. In contrast to previous studies of more developed countries, we find strong evidence that firms experience a jump in productivity of about three to five percent following the initiation of exporting. The timing of the performance improvement suggests learning from exporting rather than just self-selection of better firms into export markets.

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1. Introduction

Based on the observation that exporting firms are more productive than non-exporting firms, many analysts have concluded that participation in export markets confers a benefit. The World Bank, for example, writes that, "Improving the policy and business environments to create conditions favorable to trade, *especially exports*, is one of the most important ways for countries to obtain knowledge from abroad (emphasis added)(World Bank 1998, p. 18)." The hypothesis is that exporting increases firm productivity through learning, defined broadly to include knowledge, technology, and operational efficiencies gained from participation in international markets.

Despite the encouraging policy prescriptions, empirical evidence carefully documenting technology acquisition through exporting is scarce. Recent research seeking to extract causation from the correlation between exporting and firm performance rejects the learning hypothesis in favor of the explanation that more productive firms select into export markets. (e.g. Clerides, Lach, and Tybout 1998, Bernard and Jensen 1999, Aw, Chung, and Roberts 2000, and Delgado, Fariñas, and Ruano 2002) These studies argue that firms incur a large fixed cost to enter export markets, and therefore only the more productive firms are profitably able to export. They find that productivity actually increases in advance of exporting and therefore conclude that exporting is a result of a productivity increase rather than a cause.

In contrast, we find evidence of learning in Indonesia. We estimate production functions using a rich panel dataset of Indonesian manufacturers from 1990 to 1996. Our results suggest an increase in productivity of about three to six percent from exporting. We also find that the productivity gains follow the initiation of exports rather than proceed it and do not disappear if the manufacturer stops exporting. These results suggest evidence of learning from exporting, attributable to knowledge and efficiencies gained from participation in international markets.

These results are consistent with Van Biesebroeck's (2003) evidence from six sub-Saharan countries in finding a causal link between exporting and productivity supportive of the learning hypothesis. Heterogeneity in the level of development may be a possible explanation as to why our results differ from the literature supporting the selection hypothesis. Whereas our work and that of Van Biesebroek examines very poor countries, Indonesia and sub-Saharan Africa respectively, the majority of earlier work considers more developed economies. While firms in developed and middle income counties are likely to be as efficient as those in their trading partners' countries, firms in the poorest countries may have much more to gain from exposure to international export markets.

The paper proceeds as follows. The next section discusses the theory and extant literature about learning from exporting. Section 3 describes Indonesia's trade liberalization, which led to a sudden increase in exporting. Sections 4 and 5 discuss the data and econometric methods, respectively, and Section 6 presents the results, which we summarize in Section 7.

2. Exports and Firm Productivity

The literature cites two reasons why exporting may lead to an increase in firm productivity. First, exporting firms may receive technical assistance from overseas buyers. Second, exporting firms must innovate rapidly to remain viable in competitive international markets. We consider each explanation in turn.

Firms may benefit from the technical expertise of foreign buyers. In less developed economies, in particular, overseas buyers may share knowledge of the latest design specifications and production techniques that might otherwise be unobtainable. In the purchase of an input requiring some degree of customization or extended coordination with the seller, as opposed to a commodity purchase on the spot market, the buyer has strong incentives to transmit knowledge to the supplier. Pack and Saggi (2001) build a model establishing the incentive of buyers to provide technology to sellers, even if that technology may eventually diffuse to other sellers and thereby benefit other buyers.

Technology transfer from international buyers is borne out in anecdotal evidence from case studies. For example, Rhee, Pursell, and Ross-Larson (1984) describe the role of foreign buyers in the early development of Korean manufacturing.[1]

> The relations between Korean firms and the foreign buyers went far beyond the negotiation and fulfillment of contracts. Almost half of the firms said they had directly benefited from the technical information foreign buyers provided: through visits to their plants by engineers or other technical staff of the foreign buyers, through the provision of blueprints and specifications, through information on production techniques and on the technical specifications of competing products,

[1]As quoted in Pack and Saggi (2001).

and through feedback on the design, quality and technical performance of their products (p. 61).

We interviewed several Indonesian exporting factory managers in the summer of 2000 and found similar, albeit anecdotal, evidence. Although the interviews cannot be generalized, they did highlight some mechanisms by which learning from exporting might occur. For example, one Indonesian textile exporter praised its relationship with a large Japanese buyer because the customer sent engineers from Japan annually to review its production methods and suggest improvements for cost reduction. The firm manager added that the Japanese firm's desire for extremely consistent cloth color renditions had prompted him to invest in new machinery imported from Switzerland. Another garment firm reported that it exported 100 percent of its output to Germany. Its main customer, a large German retailer, sent efficiency experts to advise on how best to expand production capacity. In fact, during the day of our interview, four product designers from the German customer were at the plant advising how to adapt the product appearance to suit new consumer trends.

Exporting firms may also benefit from exposure to the intense competition of export markets. Whereas non-exporting firms may be insulated from such competition by trade policy or geographical barriers, firms producing for world markets likely cannot survive without adopting best-practice technology. The obvious question, of course, is why a profit maximizing firm would not adopt the most efficient means of production available, *even in the absence of any competition.* Some have reasoned that the returns of participation in large export markets might motivate greater managerial effort otherwise unwarranted in only the local market.

The majority of recent studies find little evidence of the productivity gains described above. Instead, they argue that the correlation of productivity growth and exporting is explained by better firms selecting into export markets. Bernard and Jensen (1999) examine productivity growth before and after entry into export markets using a panel dataset of U.S. manufacturing firms. They find that productivity increases occurred prior to exporting suggesting selection rather than technological improvement as result of exporting. This result is not entirely surprising in the context of U.S. firms, for which exposure to overseas buyers may be less likely to provide otherwise unavailable technology. Clerides, Lach, and Tybout (1998) find similar evidence of self-selection in Columbia and Morocco, and Aw, Chung, and Roberts (2000) come to the same conclusions for Taiwan and Korea in the late 1980's and early 1990's, a time by which both Taiwan and Korea had already developed successful export-oriented technology industries. Finally, Delgado, Fariñas, and Ruano (2002) consider the case of Spanish firms and find evidence of self-selection into export markets but only weak evidence of learning from exporting.

In contrast to these studies, Van Biesebroeck (2003) examines six sub-Saharan African countries and is one of the few studies to find evidence of learning from exporting. A possible explanation for the differing results is the level of economic development. Both Indonesia and sub-Saharan Africa are much less developed than the economies in other studies. One may reasonably argue that exposure to international markets would have a greater marginal benefit to firms in markets with poor technology and low productivity.

3. Indonesian Manufacturing and Export Policy

Indonesia's manufacturing sector is an attractive setting for research on learning from exporting for several reasons. First, with the fourth largest population in the world and thousands of islands stretching over three time zones, the country has abundant labor and natural resources to support a large sample of manufacturing facilities in a wide variety of industries. Second, Indonesian government agencies employ a number of well trained statisticians who have collected exceptionally rich manufacturing data for a developing country. Last, the Indonesian government legislated a major reform of the trade regime in the late 1980's, which led to a dramatic surge in exporting activity in the study period.

Indonesia shifted from a policy of import substitution to one of export promotion in the mid-1980's. In 1986, Indonesia substantially reduced import tariffs, reformed customs administration, and introduced a more generous duty drawback scheme. The duty drawback program allowed exporters to reclaim duties paid on inputs used to fabricate exported goods.[2] To reduce complaints of corruption and delays at the customs department in the payment of the duty drawbacks, the government contracted the program administration to a private Swiss firm, which reportedly reduced the average processing time of drawback requests by weeks.

The impact of this reform was profound, particularly on export-oriented indus-

[2]The duty drawback scheme introduces a concern that input price disparities between exporters and non-exporters may bias our results. That is, exporters may appear more productive simply because they can obtain inputs at lower cost. We have adjusted our input price deflators to reflect the cost savings under a range of tariff rate estimates. These price adjustments have little effect on our results.

tries such as textiles and garments. Pangestu (1996), in her review of Indonesian economic liberalization, writes that, "The increase in non-oil exports has been partly attributed to the deregulation drive, and the most oft-cited positive deregulation that is seen to help exporters (based on interviews) was the improvement in the duty drawback facility."

The trade reform was implemented throughout the late 1980's and was followed by a dramatic increase in exports beginning in 1989. The dataset used here records export activity from 1990 to 1996, so there is strong anecdotal evidence that much of the increased exporting activity was prompted by the trade regime reforms. Table 1 shows the number of wholly Indonesian-owned factories exporting from 1990 to 1996. The number of exporters more than doubles whereas the number of factories increases by only 18 percent.

4. Data

The analysis is based on data from the Republic of Indonesia's *Budan Pusat Statistik* (BPS), the Central Bureau of Statistics.[3] The primary data are taken from an annual survey of manufacturing establishments with more than 20 employees conducted by *Biro Statistik Industri*, the Industrial Statistics Division of BPS. Additional data include several input and output price deflators. The remainder of this section describes each dataset and the measurement of firm learning from exports.

The principal dataset is the *Survei Tahunan Perusahaan Industri Pengolahan* (SI), the Annual Manufacturing Survey conducted by the Industrial Statistics Division of BPS. The SI dataset is designed to be a complete annual enumeration of all manufacturing establishments with 20 or more employees from 1975 onward. Depending on the year, the SI includes up to 160 variables covering industrial classification (5-digit ISIC), ownership (public, private, foreign), exports, status of incorporation, assets, asset changes, electricity, fuels, income, output, expenses, investment, labor (head count, education, wages), raw material use, machinery, and other specialized questions.

BPS submits a questionnaire annually to all registered manufacturing establishments, and field agents attempt to visit each non-respondent to either encourage compliance or confirm that the establishment has ceased operation.[4] Because

[3]We identify names in Bahasa Indonesia, the language of most government publications, with italics. Subsequently, we use the English equivalent or the acronym.

[4]Some firms may have more than one factory; we refer to each observation as an establish-

field office budgets are partly determined by the number of reporting establishments, agents have some incentive to identify and register new plants. In recent years, over 20,000 factories have been surveyed annually. Government laws guarantee that the collected information will only be used for statistical purposes. However, several BPS officials commented that some establishments intentionally misreport financial information out of concern that the tax authorities or competitors may gain access to the data. Because the fixed-effect analysis used here admits only within-factory variation on a logarithmic scale, errors of under- or over-reporting will not bias the results provided that each factory consistently misreports over time. Further, even if the degree of misreporting for a factory varies over time, the results are unbiased provided the misreporting is not correlated with other factory attributes in the right-hand-side of the regression.

Not surprisingly, particularly in a developing country environment, there is a high level of non-reporting and obvious erroneous responses to many of the survey questions. Questions that require some accounting expertise, such as the replacement and book value of fixed assets, were especially problematic. We have cleaned key variables to minimize noise due to non-reporting, misreporting, and obvious mistakes in data keypunching as described in Appendix B.

The analysis here starts from 1990, the first year data on exporting activity are available. To avoid measurement error in price and other uncertainties introduced by the 1997-1998 Asian financial crisis, the last year of analysis is 1996.

We deflated output, materials, and capital to express values in real terms. The deflators are based on *Indeks Harga Perdangangan Besar* (IHPB), wholesale price indexes (WPI), published by BPS. Appendix B describes the deflator calculation in detail.

We used two criteria to select the sample for the estimation of Equation 1. First, because foreign-owned firms are more likely to export than wholly Indonesian-owned firms, it would be easy to confound changes in exporting behavior with changes in foreign ownership. To avoid such confounding, which is a particular concern since the liberalization of Indonesia's trade regime was accompanied by reforms of foreign investment regulations as well, the sample is limited to wholly Indonesian-owned firms. Second, because data on establishment exports are only available beginning in 1990, we cannot determine whether firms

ment, plant, or factory. BPS also submits a different questionnaire to the head office of every firm with more than one factory. Although these data were not available for this study, early analysis by BPS suggests that less than 5 percent of factories belong to multi-factory firms. We therefore generalize the results to firms in our discussion.

that exported in 1990 had any previous exporting experience. Because the fixed-effect estimation is identified by changes in exporting activity, we have removed all establishments that exported in 1990 unless 1990 was the year of the factory's founding.

Table 2 shows descriptive statistics for all wholly Indonesian-owned factories in the cleaned dataset. As one would expect, exporting firms tend to produce more output, employ more workers, and have more capital than non-exporting firms.

5. Identification and Estimation

Our objective is to identify and estimate the effect of exporting on productivity. We do so by estimating an establishment-level transcendental logarithmic (translog) production function. The translog production function is second-order logarithmic approximation of the production that places no functional form restrictions on the nature of input substitution or returns to scale. The translog production function controls for input levels and scale effects. In effect, we ask whether the residual in the production function is correlated with exporting controlling flexibly for the levels of inputs used in production.

We specify the translog production function as

$$\begin{aligned} \ln Y_{it} = &\beta_0 Exported_{it} + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \beta_3 \ln M_{it} + \\ &\beta_4 \ln^2 K_{it} + \beta_5 \ln^2 L_{it} + \beta_6 \ln^2 M_{it} + \\ &\beta_7 \ln K_{it} \ln L_{it} + \beta_8 \ln K_{it} \ln M_{it} + \beta_9 \ln L_{it} \ln M_{it} + \\ &\alpha_i + \gamma_t + \nu_{rt} + \omega_{it} + \varepsilon_{it} \end{aligned} \tag{1}$$

where $Exported_{it}$ is a dummy indicator of whether establishment i exported in year t, Y_{it}, K_{it}, L_{it}, and M_{it} are the amounts of production output, capital, labor, and raw materials for establishment i at time t, α_i is a fixed effect for factory i, γ_t is a dummy variable for year t, ν_{rt} is a dummy variable for the interaction of a region r and year t, ω_{it} is an idiosyncratic productivity shock, and ε_{it} is a true i.i.d. error term. The distinction between ω_{it} and ε_{it} is that factory managers can observe the former and adjust inputs in response, whereas they cannot respond to the latter. A positive coefficient on $Exported_{it}$ indicates that exporting is associated with higher productivity.[5]

[5]Output, capital, and materials are nominal rupiah values deflated to 1983 rupiah. Labor is

The translog production function cannot be consistently estimated by least squares because input levels and exporting are choices and most likely correlated with unobserved heterogeneity in productivity captured in the error term. This is especially important for identifying a causal relationship between exporting and productivity. In particular, more productive firms are more likely to export. If one does not account for the unobserved heterogeneity between exporters and non-exporters, a correlation between exporting and productivity could simply be attributed to selection.

We adopt three approaches to this problem: adding fixed effects, controlling for idiosyncratic time-varying shocks with proxy estimators, and testing the ordinal sequence of productivity increases and exports. Our first approach includes both establishment and year-region fixed effects in the production function. The firm fixed effects control for static (time invariant) productivity differences, industry-specific factors, and other stationary attributes. The year-region fixed effects control for time varying changes that are common to firms within regions (e.g. fluctuations in exchange rates, and regional effects, such as labor strife or natural disasters).

Our second approach considers the possibility of idiosyncratic productivity shocks, ω_{it}, that are contemporaneous with the decision to export. For example, the firm may discover a better production process or hire a talented manager. Such an event would simultaneously improve productivity and increase the likelihood that the firm chooses to export. To control for this problem, we employ two non-parametric estimators that generate proxies for ω_{it}, one the uses investment as a proxy (Olley and Pakes 1996) and another that uses intermediate inputs, such as electricity (Levinsohn and Petrin 2003).

Both the Olley-Pakes and Levinsohn-Petrin estimators make two key identifying assumptions. First, the shock proxy must be monotonically increasing with respect to the true shock. Second, so-called freely variable inputs, like labor and materials, must respond immediately to a shock while state variables, like capital, must respond only after an adjustment lag. The insight is that because state variables do not respond to contemporaneous noise, the contribution of the idiosyncratic shock can be represented as a function of the proxy variable and state variables. In practice, the interpretation is that an increase in investment or intermediate input use, conditional on a given level of capitalization, indicates a positive idiosyncratic shock.

Appendix C summarizes the Olley-Pakes estimation, which is conducted in

the total number of production and non-production workers.

two stages and very similar to Levinsohn-Petrin. The first stage determines the contribution of freely variable inputs, conditional on the proxies of idiosyncratic shocks. The second stage then estimates the return to the state variables conditional on the prior period shock. The key difference between the Olley-Pakes and Levinsohn-Petrin estimators is the choice of the proxy variable. Olley-Pakes uses investment whereas Levinsohn-Petrin uses intermediate inputs. We use electricity as the intermediate input in the Levinsohn-Petrin estimation because it is widely reported in the data and because it cannot be stored from period to period.

We modify the standard Olley-Pakes and Levinsohn-Petrin approaches in three ways. First, we include factory fixed effects to allow establishment-specific intercepts. The inclusion of fixed effects thus removes time-invariant unobservables, leaving only idiosyncratic shocks to be captured by the shock proxies.

Second, we do not estimate the second stage of either estimation routine. Recall that the first stage of each estimation routine determines the returns to freely variable inputs, materials, labor, and exporting behavior, which may respond contemporaneously to shocks. The second stage estimates the returns to quasi-fixed inputs (state variables), such as capital, which respond to shocks in a lagged fashion. Because the variable of interest here, exporting behavior, is fully estimated in the first stage, the second stage may be eliminated to simplify the analysis.

Third, a limitation of both the Olley-Pakes and Levinsohn-Petrin estimations is that idiosyncratic shocks are only identified when the proxy variables, investment or intermediate inputs, are positive. In practice, less than half of the establishment observations show positive investment and about three fourths report electricity consumption. Rather than removing observations with non-positive investment or electricity, we have added an indicator dummy variable to these observations and interacted the indicator with the state(quasi-fixed) inputs. In the Olley-Pakes estimation, positive investment is likely to occur only in the presence of positive shocks, whereas zero or negative investment (from selling fixed assets) likely indicates a negative shock. Rather than censor negative shocks, the indicator variable captures all shocks below the threshold level needed to induce new investment.

Finally, our third identification approach examines the relative timing of productivity gains and exporting to test the self-selection hypothesis. Clerides, Lach, and Tybout (1998), Bernard and Jensen (1999), and others argued that firms will incur the fixed cost of entering overseas markets only after productivity rises sufficiently for exporting profits to justify the expense. They find that productivity gains precede exporting and conclude that exporting is the result of rather than the cause of efficiency. We test this self-selection hypothesis by reviewing productivity in the year prior to the the initiation of exporting.

Further, if the benefit of exporting is a learned increase in productivity, then we would expect it to be permanent and not disappear if the firm stops exporting. Therefore, we also examine whether productivity drops after firms stop exporting.

6. Results

The main results of the paper are seen in Table 3, which reports the estimated production functions using several estimators. The first two columns show the results of pooled OLS and factory fixed-effect estimation. Columns (3)-(6) show Olley-Pakes (OP) estimation and columns (7)-(10) show Levinsohn-Petrin (LP) estimation. For both the OP and LP estimators, four specifications are displayed as described above: with and without observations reporting non-positive proxy variables removed, and with and without fixed effects.

The first row reports the coefficient on whether or not the firm exported in the current year. The estimated coefficients on $Exporting_{it}$ are positive and significant in all ten specifications. These results suggest that exporting increases productivity by about two to five percent.

6.1. Selection Bias

We next consider the relative timing of exporting activity and productivity gains to test the self-selection hypothesis directly. Recall that our estimation above already accounts for selection based on static firm attributes and idiosyncratic shocks contemporaneous with exporting. However, the self-selection argument suggests that firms might begin exporting only after productivity grew sufficiently to justify the expense. We therefore examine whether productivity was higher in the year before firms initiate exporting. In addition, the selection hypothesis argues that firms would export only in relatively good years. We would thus expect the cessation of exporting to coincide with productivity declines. In contrast, if firms actually learned from exporting, we would expect those productivity gains to be more permanent and persist even after exporting stopped.

Table 4 considers these hypotheses. Column (1) repeats the baseline fixed effect analysis from above for reference. Column (2) adds a dummy variable to indicate the year before a factory initiated exporting. The coefficient on the indicator is nearly zero, suggesting that productivity does not rise prior to exporting, but rather is contemporaneous with exporting at the earliest. Column (3) displays the results for a model in which we added a dummy variable to indicate the years after a firm stopped exporting. The variable takes the value of one during years when a previously exporting firm did not export. The selection hypothesis suggests that the coefficient of this variable would be negative indicating a reduction in productivity coincident with export stoppage. Instead, the estimated coefficient is near zero and not significant, consistent with the learning hypothesis. These two results suggest that the productivity gain from exporting is probably not the result of selection. Finally, column (4) replaces the "exported current year" indicator with a "exported current year or in the past" indicator. In other words, the indicator is coded one if the firm has exporting experience. The results are very similar to those with the contemporaneous indicator, suggesting that the benefits of exporting appear to be permanent.

6.2. Survival Bias

Finally, we consider survival bias. Our concern here is that exporting may be correlated with the likelihood that a firm exits the panel, either due to bankruptcy or a change in ownership. If exporters and non-exporters exit the sample at differing rates, we could confound changes in the productivity of the remaining sample with changes in firms' inherent productivity. To address this concern, we estimated hazard models to determine the effect of exporting behavior on firm death. After conditioning on firm size, as measured by labor force or capitalization, exporting firms were no more likely to survive than non-exporting firms. We thus conclude that survival bias is not a concern.

6.3. Intensity of Exporting Behavior

We next explore how different exporting behaviors affect performance. We test whether the intensity of exporting matters, and whether cumulative exporting experience counts. We reject these hypotheses in favor of the simple finding that exporting leads to a one-time increase in productivity. To reduce the number of estimations to a manageable number, we select the within-factory fixed-effect estimator for further analysis.

Column (5) of Table 4 asks whether the proportion of factory output exported affects performance by including both a discrete exported (or not) indicator and a continuous exported output share variable. The positive coefficient on the discrete indicator suggests a non-linearity in the contribution of exporting in going from no exports to some exports. However, exporting greater proportions of output has no effect. This result could be due to two reasons. First, any exposure to export markets, largely regardless of the exported share of output, could be sufficient to accrue benefits. Second, the data may have insufficient within-factory variation over time to identify the benefits of exporting intensity. Indeed, among factories that export, the proportion of output exported tends to be stable.

Column (6) explores the benefits of cumulative exporting experience. Both an indicator variable for exporting experience, in the current or past years, along with a variable indicating the cumulative number of exporting years, are estimated. The contribution of cumulative exporting years is zero, suggesting that that the benefit of exporting is a *one-time* performance gain. That is, factories that have exported or are exporting perform better after they begin exporting. But, the growth rate of this increased performance is flat over time.

6.4. Industry Analysis

One concern is that we may be biasing the results by pooling across industries with widely varying technologies. To explore this issue, we next estimate the contribution of exporting by industry. Further, to verify that the analysis is comparing treatment factories (those that begin exporting) with otherwise equivalent control factories (those that do not export), we use a F-test to ask if the treatment and control groups differ *prior to the initiation of exporting*.

Estimation by industry has two advantages. First, unlike the pooled-industry sample above, by-industry samples do not impose uniform technology across heterogenous production processes. That is, one does not need to make the possibly implausible assumption that, say, the return to capital is the same in electronics as it is in meat packing. Second, with a more targeted sample, one can concentrate on export-intensive sectors in which there is more longitudinal variation and for which treatment and control groups are more closely matched.

Table 5 lists the ten industries with the greatest number of exporting factories in our sample by 3-digit ISIC industries. Table 6 display the results of estimating the contribution of exporting for each of these industries. The effect of exporting is positive in all ten industries and significant in seven industries.

We used a F-test to verify that the treatment and control groups in each industry are not statistically different prior to the treatment factories beginning to export. The objective was to confirm that that the treatment and control groups did not significantly differ is some way not captured by the factory fixed effects.

We implemented the F-test with a sample of all observations of never-exporting factories and observations of exporting factories in only the years prior the initiation of exporting. Within this sample, we assigned a dummy variable to the factories that would eventually export, e.g., a dummy to indicate the treatment factories. We then estimated a translog production function adding the interaction of the treatment dummy and year dummies. An F-test on the joint significance of the treatment dummy and year interactions could not reject the null hypothesis that they were equal to zero in ten of the eleven industries. In other words, we cannot reject the hypothesis that the treatment factories prior to exporting were equal in performance to the control factories. Only in one industry, processed foods (ISIC 311), did the treatment factories have higher productivity growth as group than the control factories. Inspection revealed that the processed foods industry had a large number of small factories with only 20 to 30 employees. When we restricted the industry definition to only factories with more than 100 employees, the treatment and control groups were better matches and passed the F-test. This restriction is included in the sample in Table 5.

7. Summary and Implications

We find strong evidence that Indonesian firms experience a jump in productivity of two to five percent upon entering export markets, which we interpret as a learning effect. Our results differ with the majority of earlier studies that found evidence of selection of better firms into export markets, but no evidence of learning. One explanation for the difference could be Indonesia's relatively low level of development in comparison to the more technologically advanced economies examined in earlier work. Indeed, our findings are consistent with recent work by (Van Biesebroeck 2003) that finds similar results in sub-Saharan Africa, a region with a low level of development similar to that of Indonesia. Firms in these poor countries may have much more to learn from their trading partners than firms in middle income and developed countries. To the extent that our results can be generalized to other countries, this paper suggests that firms in poorly developed environments may improve their productivity from learning through exporting.

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A. Data Appendix

A.1. Product Class, Location, and Age

The main product class of each establishment is identified by 5-digit International Standard of Industrial Classification (ISIC) codes published by the United Nations Industrial Development Organization (UNIDO). The ISIC standard divides manufacturing activity into 329 codes at the 5-digit level.[6] The data include plant age and location at the province and *kabupaten* (district) level. The province and district codes divide the country into 27 and 304 areas respectively. The analysis in this paper uses province to identify region.[7]

A.2. Ownership

Two survey questions relate to establishment ownership. First, establishments report whether they operate under a domestic or a foreign investment license. All new enterprises in Indonesia must obtain an operating license from *Badan Koordinasi Penanaman Modal* (BKPM), the Investment Coordinating Board. Establishments funded with any foreign investment operate under *Penanaman Modal Asing* (PMA), foreign capital investment licenses. Establishments with only domestic investment obtain *Penanaman Modal Dalam Negeri* (PMDN), wholly domestic capital investment licenses. Second, each establishment reports the percentage of foreign equity.[8] Establishments with more than 20 percent foreign equity were defined as foreign.

A.3. Capital

The survey asks for the book value and current replacement value of fixed assets. Respondents report assets in five categories: land, buildings, machinery and equipment, vehicles, and other assets. The value of investment is also reported yearly.

[6] ISIC codes are revision 1 codes prior to 1990 and revision 2 codes thereafter. The method of concordance between the two revisions is discussed in Appendix B.

[7] Following the independence of East Timor, there are now 26 provinces and 291 districts.

[8] The source country of foreign capital is reported only in the 1988 survey. Although the survey instruments asked for this information in most years, BPS keypunched the responses in just 1988. Sadly, BPS has destroyed the original paper survey responses, so this information cannot be retrieved.

A.4. Labor and Wages

The numbers of production and non-production workers are reported in all years. Workers are categorized as either paid or unpaid (e.g., family members). In many years, the labor force is broken down by gender. In 1995-1997, the highest level of education obtained by all workers is available. In 1996, the highest degree and field of specialization for research and development workers are recorded.

Cash and in-kind wages are available for production and non-production workers in all years. In most years, wage payments are detailed in four categories: normal wages, overtime, gifts and bonuses, and other payments.

A.5. Materials and Energy

The value of all consumed materials is reported every year. The data also indicate the quantity and price of consumed petroleum products, e.g., gasoline and lubricants, and purchased and self-generated electricity.

A.6. Output

The nominal rupiah value of production output is available every year.

A.7. Exports

The percentage of production exported is reported every year.

B. Data Processing

This section provides more detail on the construction and cleaning of the dataset.

B.1. Construction of Price Deflators

Output, materials, and capital are deflated to express values in real terms. The deflators are based on *Indeks Harga Perdangangan Besar* (IHPB), wholesale price indexes (WPI), published monthly in BPS's *Buletin Statistik Bulanan Indikator Ekonomi*, the Monthly Statistical Bulletin of Economic Indicators. To calculate WPI, BPS field officers interview representative firms in all provinces to collect prices for five categories of commodities: agriculture, manufacturing, mining and quarrying, imports, and exports. In total, prices are available for 327 commodities, 192 of which are manufactured commodities.

B.1.1. Output, Materials, and Energy Deflators

Nominal rupiah output and materials values are deflated using the WPI for the nearest corresponding manufactured commodity. BPS officials provided an unpublished concordance table mapping the 192 WPI commodity codes to the 329 5-digit ISIC product codes. Energy is deflated using Indonesian petroleum prices.

B.1.2. Capital Deflators

Fixed assets are deflated using the WPI for manufactured construction materials and imported machinery. Specifically, the capital deflator combines the WPI for construction materials, imported electrical and non-electrical machinery, and imported transportation equipment. We weighted these price indexes by the average reported value shares of building and land, machinery, and vehicle fixed assets in the SI survey to obtain an annual capital deflator.

B.2. Correction for Outliers and Missing Values in Industrial Survey

We have cleaned key variables to minimize noise due to non-reporting, misreporting, and obvious mistakes in data keypunching. A three-stage cleaning process was used for capital, labor, materials. First, the earliest and latest years in which a plant reported were identified, and interpolation was used to fill-in gaps of up to two missing years within the reporting window. If more than two continous years of data were missing, the factory was dropped from the sample. The first stage of cleaning removed about 15 percent of the total sample. Second, sudden spikes in key data values likely attributable to keypunch error (often due to an erroneously added or omitted zero) were corrected with interpolation. Third, plants with remaining unreasonably large jumps or drops in key variables not accompanied by corresponding movements in other variables (for example, large increases in labor not accompanied by any increase in output) were dropped. This third stage removed about 10 percent of the sample.

The replacement value of fixed assets is used as the measure of capital stock for most factories. For the few factories that reported only the book value of fixed assets, those figures were used instead.

The percentage of foreign equity in the establishment was cleaned to remove erroneously added or omitted zeros resulting from keypunch error. For example, a factory with foreign equity reported over time as 100, 100, 10, and 100 percent was cleaned to show 100 percent in all years. We applied the same correction to the percentage of output exported.

B.3. Concordance of Rev. 1 and Rev. 2 ISIC Codes

The industrial survey reports revision 1 ISIC codes prior to 1990 and revision 2 codes thereafter. Attempts to create a concordance table at the 5-digit level from rev. 1 to rev. 2 codes yielded disappointing results. Comparing code changes for the same establishment before and after 1990 showed that the concordance table predictions were incorrect as often as half the time. Rather than accept the noise introduced by these mistakes, the analysis attempts to assign each establishment's actual rev. 2 code to its observations in 1988-1989. Specifically, for each establishment that appears in either 1988 or 1989, the analysis looks for the earliest appearance of the same establishment in 1990 and later years. In most cases, the rev. 2 code from the 1990 observation could be used. If the establishment did not appear in 1990, the rev. 2 code from 1991 or 1992 was used. If the establishment did not appear between 1990 and 1992, it was dropped. This process greatly improved the precision of ISIC code assignments at the cost of dropping about 5 percent of the 1988-1989 sample. Since the dropped establishments appear in only one or two years anyway, the 5 percent loss has little effect on the results.

B.4. Concordance of Input-Output Table Code and ISIC Codes

The IO table was published in 1990 and 1995 with four variants: domestic transactions at producer prices, domestic transactions at purchaser prices, domestic and export transactions at producer prices, and domestic and export transactions at purchaser prices. The analysis here considers domestic transactions at producer prices.

Both the 1990 and 1995 IO tables classified industrial production into 89 categories. To merge the IO table with the SI, first the 1995 IO table codes were concorded with the 1990 IO table codes. Next, the 1990 IO table codes were concorded with the 329 5-digit ISIC codes reported in the SI. The 1990 IO codes were used to define industries in the analysis.

C. Olley-Pakes Estimation

Although a full description of Olley-Pakes estimation is beyond the scope of this paper (interested readers are referred to Olley and Pakes 1996), the steps implemented here are briefly outlined below.

Because the variable of interest in this study is the return to exporting, which is estimated in the first of the three estimation stages, we do not implement the second and third stages. However, the latter two stages are briefly described below for reference.

The Levinsohn-Petrin algorithm largely follows the Olley-Pakes approach in the first stage. We implemented the Levinsohn-Petrin estimation by simply substituting electricity use for investment in the first stage.

Although we estimated a translog production function, a Cobb-Douglas function is shown below for ease of presentation.

The Estimation

The Olley-Pakes estimation consists of three stages. First, investment is used as a proxy for idiosyncratic shocks to determine the contribution of variable inputs (labor and materials) conditional on the shock and state variables (capital and vertical FDI). Second, the effect of state variables on factory exit is estimated with a probit model to control for self-selection bias in plant closings. The concern here is that factories with certain state attributes, such as low levels of capitalization, may be more likely to close if they experience a negative shock. Third, the contribution of state variables is calculated conditional on the prior period's shock and the likelihood of closure. The assumption driving the identification in this stage is that state variables respond to shocks in a lagged manner. That is, the unexpected portion of the current period shock does not immediately affect capital or vertical FDI. Rather, only investment in the current period, which yields capital or vertical FDI in the subsequent period, is affected.

STAGE 1

The estimation starts with a Cobb-Douglas production function

$$\begin{aligned} y_{it} = \beta_{exp} EXPORTED_{jrt} + \beta_l l_{it} + \beta_m m_{it} + \beta_k k_{it} \\ + \omega_{it} + \eta_{it} \end{aligned} \tag{2}$$

where ω_{it} is the factory's idiosyncratic productivity shock (that could affect the factory's choice of freely variable inputs) and η_{it} is measurement error (or error that does not affect the factory's choice of inputs), and lower case variable names represent logs. Olley and Pakes show that investment is monotonically increasing in ω_{it} and can hence be used as a proxy for the shock conditional on state variables. That is, investment, i, can be expressed as a function of the state variables and the shock.

$$i_{it} = i_{it}(\omega_{it}, k_{it}) \tag{3}$$

Provided that $i_{it} > 0$, investment can be inverted to reveal ω_{it}.

$$\omega_{it} = h_{it}(i_{it}, k_{it}) \tag{4}$$

Conditioning output on ω_{it} and the state variables yields the following semi-parametric estimation.

$$y_{it} = \beta_{exp}EXPORTED_{jrt} + \beta_l l_{it} + \beta_m m_{it} + \phi_{it}(i_{it}, k_{it}) + \eta_{it} \tag{5}$$

where

$$\phi_{it}(i_{it}, k_{it}) = \beta_0 + \beta_k k_{it} + h_{it}(i_{it}, k_{it})$$

Since the error term η_{it} is uncorrelated with the inputs, estimation of equation 5 provides unbiased estimates of β_{exp}, β_l and β_m. We use a third-order polynomial expansion in i_{it} and k_{it} to estimate ϕ_{it}.

D. Tables

All monetary values are displayed in 000's of 1983 rupiah. Year and region-year dummies are included in all regressions but not reported.

	No. establishments	
Year	Exporting	Not exporting
1990	13,967	1,646
1991	13,504	2,069
1992	13,869	2,595
1993	14,202	2,692
1994	14,835	2,798
1995	17,020	2,999
1996	17,843	3,502

Table 1: Number of establishments exporting and not exporting, by year.

	Exporting establishments			Non-exporting establishments		
	No. obs.	Mean	Std. dev.	No. obs.	Mean	Std. dev.
log(output)	3877	13.33	1.91	16141	11.71	1.51
No. employees	3877	251.95	545.35	16141	65.03	159.81
log(capital)	3877	12.46	2.08	16141	10.89	1.76
log(materials)	3877	12.59	2.11	16141	10.89	1.80
Share output exported	3877	.44	.43	16141	0	0

Table 2: Descriptive statistics for establishments that exported (one year or more) and never-exporting establishments. Statistics are for the first year the establishment entered the panel during 1990-1996.

Dependent var.: log(output)	OLS	F.E.	Olley-Pakes				Levinsohn-Petrin			
Exported current year (0=N, 1=Y)	0.028	0.049	0.016	0.025	0.045	0.049	0.019	0.018	0.051	0.050
	(5.23)	(7.98)	(1.89)	(4.69)	(4.14)	(7.90)	(3.85)	(3.54)	(8.51)	(8.31)
log(labor)	0.822	0.701	0.743	0.774	0.649	0.685	0.865	0.863	0.694	0.690
	(51.74)	(25.91)	(26.32)	(46.23)	(12.60)	(24.85)	(53.32)	(53.34)	(25.80)	(25.66)
log(capital)	0.310	0.147	-0.694	0.005	-0.847	-0.021	-0.029	0.098	0.163	0.193
	(42.38)	(12.27)	(3.12)	(0.04)	(2.92)	(0.16)	(0.31)	(1.05)	(1.34)	(1.60)
log(materials)	0.040	0.306	0.017	0.041	0.355	0.307	-0.051	-0.050	0.257	0.264
	(5.28)	(26.08)	(1.39)	(5.34)	(15.44)	(26.06)	(6.64)	(6.54)	(21.23)	(21.85)
log(K)*log(K)	0.014	0.007								
	(28.94)	(11.22)								
log(L)*log(L)	0.013	0.038	0.006	0.012	0.037	0.037	0.013	0.013	0.036	0.038
	(5.54)	(10.86)	(1.50)	(4.98)	(5.36)	(10.63)	(5.59)	(5.74)	(10.69)	(11.14)
log(M)*log(M)	0.073	0.048	0.079	0.072	0.053	0.048	0.069	0.069	0.048	0.048
	(142.64)	(71.15)	(89.25)	(142.17)	(37.01)	(71.00)	(141.72)	(141.66)	(72.02)	(71.78)
log(K)*log(M)	-0.059	-0.033								
	(70.13)	(29.80)								
log(K)*log(L)	0.043	0.034								
	(24.62)	(14.07)								
log(L)*log(M)	-0.096	-0.094	-0.102	-0.096	-0.110	-0.094	-0.097	-0.098	-0.093	-0.094
	(53.82)	(40.51)	(33.74)	(53.55)	(22.18)	(40.38)	(56.14)	(56.83)	(41.18)	(41.69)
Constant	3.463	3.321	6.736	5.161	6.384	3.889	4.948	4.195	3.235	2.671
	(45.66)	(34.81)	(9.76)	(13.65)	(6.99)	(9.19)	(17.19)	(13.82)	(8.69)	(7.00)
Observations	73635	73635	23440	73635	23440	73635	73396	73635	73396	73635
R-squared	0.95	0.78	0.96	0.95	0.79	0.78	0.95	0.95	0.79	0.79
No. of factories	20446	20446	10863	20446	10863	20446	20414	20446	20414	20446

Absolute value of t statistics in parentheses

Table 3: Estimation of a translog production function on a sample of wholly Indonesian-owned factories from 1990 to 1996. (1) OLS estimation, (2) factory fixed-effect estimation, (3) Olley-Pakes estimation on observations reporting positive investment, (4) Olley-Pakes estimation on all observations with indicator variable for non-positive investment observations, (5) Olley-Pakes estimation with fixed effects on observations reporting positive investment, (6) Olley-Pakes estimation with fixed effects on all observations and an indicator variable for non-positive investment observation observations, (7)-(10) estimation of (3)-(6) using Levinsohn-Petrin estimator and substituting electricity for investment. “No. of factories” indicates the number of unique establishments in the fixed-effect estimations.Year and year-region indicator variables are included but not reported.

dependent var.: log(output)	(1)	(2)	(3)	(4)	(5)	(6)
Exported current year (0=N, 1=Y)	0.054	0.057	0.054		0.049	0.054
	(9.62)	(9.06)	(8.01)		(5.69)	(8.77)
Year prior to exporting		0.007				
		(0.87)				
Exported in prior years but not this year (0=N, 1=Y)			-0.002			
			(0.23)			
Exported this year or in the past (0=N, 1=Y)				0.041		
				(6.29)		
Share of output exported					0.009	
					(0.78)	
Number of years exported						0.001
						(0.43)
log(labor)	0.636	0.636	0.635	0.636	0.635	0.636
	(27.61)	(27.60)	(27.59)	(27.61)	(27.60)	(27.59)
log(capital)	0.155	0.155	0.155	0.155	0.155	0.155
	(14.26)	(14.26)	(14.25)	(14.22)	(14.26)	(14.26)
log(materials)	0.257	0.257	0.257	0.256	0.257	0.257
	(24.00)	(23.99)	(23.99)	(23.90)	(23.99)	(24.00)
log(K)*log(K)	0.005	0.005	0.005	0.005	0.005	0.005
	(8.75)	(8.74)	(8.75)	(8.72)	(8.75)	(8.75)
log(L)*log(L)	0.013	0.013	0.013	0.013	0.013	0.013
	(4.66)	(4.65)	(4.65)	(4.64)	(4.65)	(4.65)
log(M)*log(M)	0.048	0.048	0.048	0.048	0.048	0.048
	(75.93)	(75.93)	(75.93)	(75.99)	(75.94)	(75.93)
log(K)*log(M)	-0.031	-0.031	-0.031	-0.031	-0.031	-0.031
	(31.92)	(31.91)	(31.92)	(31.87)	(31.92)	(31.92)
log(K)*log(L)	0.039	0.039	0.039	0.039	0.039	0.039
	(19.33)	(19.33)	(19.33)	(19.35)	(19.33)	(19.31)
log(L)*log(M)	-0.078	-0.078	-0.078	-0.078	-0.078	-0.078
	(38.01)	(38.00)	(37.99)	(38.01)	(38.01)	(38.01)
Constant	3.690	3.690	3.690	3.693	3.690	3.687
	(43.10)	(43.10)	(43.08)	(43.10)	(43.11)	(42.95)
Observations	87587	87587	87587	87587	87587	87587
No. of factories	23201	23201	23201	23201	23201	23201
R-squared	0.79	0.79	0.79	0.79	0.79	0.79
Absolute value of t statistics in parentheses						

Table 4: Fixed-effect estimation using differing definitions of exporting behavior. Year and year-region indicator variables are included but not reported.

ISIC code	Description	No. non-exporters	No. Exporters
331	Plywood and processed wood	1,657	900
322	Garments	2,688	826
332	Wood and rattan furniture	944	764
311	Processed foods (1)	2,952	591
321	Textiles	2,553	509
383	Electronics	411	214
312	Processed foods (2)	2,322	239
324	Footwear	393	212
356	Plastics	1,094	193
381	Metal tools and structures	1,098	190

Table 5: Number of exporting (at any time) and never-exporting factories by 3-digit ISIC code.

Dependent var.: log(output)	Industry ISIC code										
	all	331	322	332	311	321	383	312	324	356	381
Exported current year (0=N, 1=Y)	0.049	0.062	0.049	0.040	0.068	0.015	-0.040	0.049	0.211	0.006	0.056
	(7.98)	(3.18)	(2.33)	(2.54)	(2.29)	(0.75)	(0.85)	(2.29)	(4.42)	(0.21)	(1.91)
log(labor)	0.701	0.998	1.225	0.691	0.848	1.188	0.755	0.927	1.207	1.527	0.340
	(25.91)	(9.29)	(11.04)	(6.00)	(5.27)	(13.78)	(3.26)	(11.11)	(4.28)	(13.24)	(2.43)
log(capital)	0.147	0.063	0.153	-0.014	0.197	0.211	0.157	0.168	-0.025	0.066	0.214
	(12.27)	(1.25)	(2.89)	(0.24)	(2.23)	(5.87)	(1.73)	(3.80)	(0.15)	(1.03)	(2.96)
log(materials)	0.306	0.150	-0.141	0.310	0.791	-0.017	0.125	0.482	-0.190	-0.063	0.230
	(26.08)	(2.63)	(3.16)	(4.81)	(10.87)	(0.43)	(1.00)	(13.89)	(1.30)	(1.22)	(3.61)
log(K)*log(K)	0.007	-0.001	0.002	0.012	0.022	0.005	0.007	0.012	-0.002	0.017	0.005
	(11.22)	(0.37)	(0.57)	(3.54)	(4.86)	(2.40)	(1.21)	(5.25)	(0.25)	(4.66)	(1.68)
log(L)*log(L)	0.038	0.038	0.027	0.066	-0.042	0.047	-0.025	0.022	0.205	0.038	-0.008
	(10.86)	(2.58)	(1.91)	(4.90)	(2.56)	(4.19)	(1.18)	(2.51)	(7.15)	(2.71)	(0.41)
log(M)*log(M)	0.048	0.043	0.051	0.037	0.048	0.062	0.042	0.054	0.068	0.069	0.053
	(71.15)	(14.12)	(20.56)	(10.06)	(14.46)	(28.31)	(6.80)	(28.61)	(10.12)	(21.40)	(14.18)
log(K)*log(M)	-0.033	-0.005	-0.009	-0.017	-0.075	-0.026	-0.029	-0.051	0.013	-0.032	-0.046
	(29.80)	(1.04)	(2.01)	(3.19)	(12.02)	(6.91)	(2.72)	(16.71)	(0.88)	(6.46)	(7.89)
log(K)*log(L)	0.034	0.026	-0.005	-0.002	0.071	0.018	0.018	0.047	-0.014	-0.008	0.060
	(14.07)	(2.48)	(0.48)	(0.20)	(5.33)	(2.34)	(1.02)	(5.38)	(0.56)	(0.70)	(5.25)
log(L)*log(M)	-0.094	-0.107	-0.083	-0.081	-0.082	-0.120	-0.036	-0.117	-0.218	-0.128	-0.062
	(40.51)	(10.06)	(9.93)	(7.45)	(6.70)	(17.54)	(2.23)	(15.86)	(10.48)	(12.08)	(4.97)
Constant	3.321	4.108	4.908	4.402	-0.769	3.519	4.637	1.827	6.618	4.425	4.395
	(34.81)	(10.21)	(12.19)	(10.03)	(1.01)	(11.53)	(5.07)	(5.70)	(5.28)	(9.16)	(7.84)
Observations	73635	5609	6622	3651	2676	7544	1136	7195	1142	3370	3028
No. of factories	20446	1815	2071	1203	651	1973	310	1866	350	872	820
R-squared	0.78	0.79	0.75	0.86	0.78	0.77	0.86	0.81	0.79	0.88	0.85
Absolute value of t statistics in parentheses											

Table 6: Fixed-effect estimation by 3-digit ISIC code. Industries are ordered from left to right by decreasing numbers of exporting factories. Year and year-region indicators variables are included but not reported.