Working Papers in Trade and Development

Does export performance improve firm performance? Evidence from Indonesia

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May 2019

Working Paper No. 2019/05

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Abstract

'Learning-by-exporting' hypothesis suggests that once a firm enters a foreign market, its productivity will increase thanks to the exposure to new knowledge and experience abroad. We test this hypothesis using Indonesia's firm level data from 2000 to 2012. The methodology involves scrutinizing the learning process of exporters by incorporating 'export age' – the number of years engaged in exporting activities – as an explanatory variable in the model. We find that exporter's total factor productivity increases with export age, but not linearly. Furthermore, larger exporting firms and those in particular industries undergo a clearer learning process. However, even though export experience can boost productivity, it is only applicable for firms that have high productivity from the beginning, supporting the 'self-selection' hypothesis.

Keywords: Indonesia, learning-by-exporting, Indonesia, export performance, productivity

JEL codes: F12, F14, L23, L25

Forthcoming in *Journal of Development Studies*

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1. Introduction

Does export experience improve firms' productivity? Studies have shown that export experience matters in determining future export success (Albornoz et al. 2012; Álvarez, Faruq & Lopez 2013; Timoshenko 2015). Firms acquire new knowledge by exporting and then learn to improve their performance. However, experience might not always bring significant productivity improvement if it only involves repetitions in doing the same activities (Fernandes & Isgut 2015). Arrow (1962) suggests that repetitions might have a diminishing effect whereas 'stimulus situation' might encourage a learning effect. Thus, the effect of export experience on productivity remains unclear.

Recent empirical studies on 'learning-by-exporting' (LBE) hypothesis has attempted to shed light on this inconclusive issue. The LBE hypothesis postulates that when a firm breaks into an export market, it would obtain external knowledge from abroad that allows it to improve its efficiency level, whereas a firm that only serves domestic markets are excluded (Blalock & Gertler 2004). The evidence, however, is mixed. Bernard and Jensen (1999), Delgado, Farinas and Ruano (2002); Aw and Hwang (1995); Clerides, Lach and Tybout (1998); and Haidar (2012) find no learning effect from exporting. In contrast, Van Biesebroeck (2005); Blalock and Gertler (2004); Baldwin and Gu (2003); De Loecker (2007) show some evidence of learning-by-exporting. Martins and Yang (2009) show that the LBE the stimulus situations tend to occur in firms from developing countries than those in developed economies. . This is because firms in developing countries are more likely to enter market that is more challenging than their domestic market, and that forces them to improve their capabilities, such as product qualities, production processes or management techniques - to be able to compete in the foreign markets. On the other hand, firms from advanced countries are more likely to have smaller level of stimulus situations in entering foreign markets since these markets are probably not too different from their domestic market (Fernandes & Isgut 2015).

There are at least two channels through which LBE can take place: buyers channel and competitors channel (Blalock & Gertler 2004). Buyers, especially of intermediate goods, may have the incentives to share knowledge, such as the latest design specifications and production techniques, as they want to obtain good quality products with precise specifications. On the other hand, more intense competition in foreign markets encourages firms to improve their efficiency and so they learn from competitors on how to survive in the markets. The longer a firm takes part in fulfilling foreign market's demands, the longer it interacts with buyers and competitors. These interactions might provide benefits for the firm to improve its productivity.

Some studies show that the impact of exporting on productivity in developing countries is significant. For example, Blalock and Gertler (2004), using Indonesian data of 1990-1996, find an evidence of LBE in Indonesia and show that a firm's productivity increases by about 2-5 percent after it starts exporting. However, their study only compares productivity change before- and after exporting. There is only a few studies that investigate how exporting affects firms' productivity and the results are mixed. De Loecker (2007) shows that Slovenian manufacturing firms are 8.8 percent more productive once they start exporting and 13 percent more

productive after 4 years of exporting, suggesting a positive long-term effect of export experience. In contrast, Alvarez and Lopez (2005), using Chilean firm level data, find that productivity gains from exporting take place only for new exporters and not for 'permanent exporters' – those who always export during the time of observation –, suggesting a short-run effect of learning-by-exporting. Therefore, the study on how export experience affects productivity leaves room for investigation.

Some studies explain the mechanism of how export experience determines firms' performance. Exporters often start by selling small quantities to a single neighboring country. If it succeeds, they tend to keep exporting and start expanding to a new market and/or with new products (Albornoz et al. 2012; Álvarez, Faruq & Lopez 2013). Firms obtain more knowledge by exporting, and this generates persistence in exporting because profitability in the market rises with the length of export experience (Timoshenko 2015). Moreover, per period fixed costs, such as the costs involved in maintaining overseas distribution networks, are expected to fall as firms are getting more experience, which can help them forecast foreign demand more accurately and find more reliable overseas partners (Inui, Ito & Miyakawa 2016). By accruing this knowledge and experience, exporting firms then also potentially gain positive impact on their productivity.

We aim to provide an empirical analysis of how export experience can affect firms' productivity in a developing country. Using firm-level data for Indonesian manufacturing over the period 2000–12, we examine learning process of exporters by incorporating the export age - the number of years a firm is engaged in exporting activities—as an explanatory variable in the model. Our outcome variable is total factor productivity (TFP) that we estimate using Levinsohn and Petrin (2003) technique. In the main model, we use fixed-effect strategy by incorporating a propensity score matching (PSM) in the first stage to control for self-selection bias. For comparison, we also run an alternative approach by matching exporting firms that have specific exporting ages with their corresponding non-exporters then combine it with a difference-in-difference (DID) technique to see if different export experiences, in terms of export age, matter in determining the firms' productivity. Both strategies show that productivity increases with export age, but the effect is not linear: it decreases once the firm becomes more experienced. Furthermore, we also find that the effect is larger for relatively larger firms and by those in certain industries in the unskilled labor intensive sector.

We also run additional analyses to give more understanding of exporting firms' behavior and to help us interpret the main results better. Firstly, we check if exporting firms are systematically different from non-exporting. Second, we check for an evidence of self-selection mechanism to show that a high productivity level might be a pre-condition for firms to be able to export; that is, only higher productive firms that are able to make profits in export markets. Third, we check that the export sales are indeed increasing throughout the years of exporting, to facilitate the investigation of the learning channel. As far as we know, this is the first study that evaluates the learning mechanism of Indonesian exporters using the most recent firm level data.

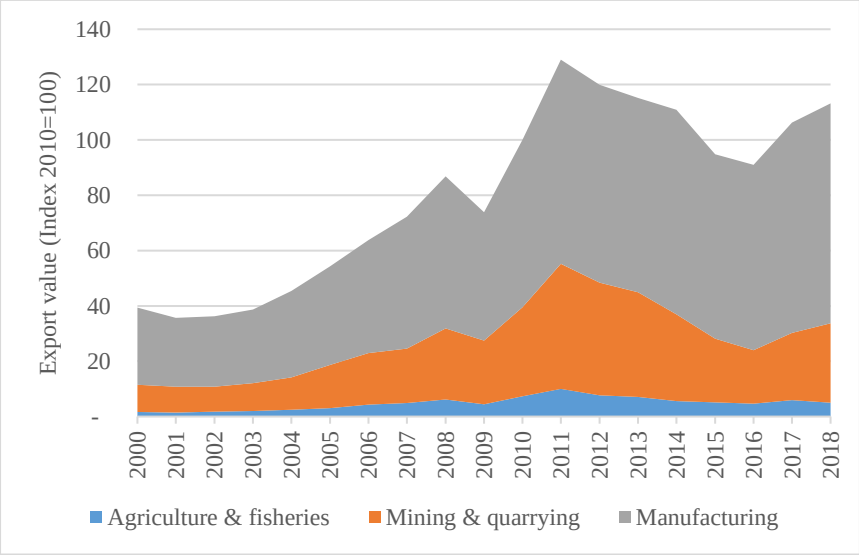
The rest of the paper is organized as follows. Section 2 provides a summary of Indonesian export in manufacturing sector. Section 3 discusses the main relevant literature. Section 4 describes the method and highlights some potential sources of bias. Section 5 explains the data and variables used. Section 6 discusses the results, followed by an array of robustness checks and finally, Section 7 concludes the study.

2. The Indonesian context

Like in most other developing countries, export of manufactures has been an important source of growth in Indonesia, although their share in total exports was lower during the last decade (Figure 1) due to the increase in commodity prices that reduced the relative attractiveness of manufacturing sector. The main traditional market destinations of manufacturing product exports of Indonesia are ASEAN, Europe, USA and Japan; and in recent years, exports to China and India have increased significantly (Table 1). Because of its abundant low-skilled and relatively cheap labor, Indonesia's comparative advantage still lies in low-tech products. The leading sectors for export have been food and beverage products, wood products, textiles and wearing apparels. Only recently, the share of chemical products and basic metal products are larger.

The export performance of manufacturing sector dropped significantly in the aftermath of the 1997-1998 Asian Financial Crisis and failed to recover even until the recent years (Basri & Patunru 2012). The average export growth of manufacture products during 1986-1996 was remarkably high at 20.3 percent, but it dropped below 7 percent during the last two decades. The export earnings after the crisis were more likely to be driven by the price effects rather than volume expansions (Athukorala 2006). The increase in commodity prices has led to commodity boom and then lowered the contribution of export of industrial goods on average in the early 2000s, an indication of possible Dutch disease (Corden 1984). Resource-based manufacturing goods, such as crude palm oil (CPO), have taken the highest proportions in the industrial export (see Table 2). The global financial crisis that started in 2007 also affected Indonesia's export. The manufacturing export dropped during 2007–08, though it recovered after 2009.

Figure 1. Indonesia's export



Source: Compiled from UNCOMTRADE database

Table 1. Geographical profile of manufacturing exports (percentage)

	2000	2010	2018
ASEAN	20.9	25.2	23.7
China	4.0	7.5	12.6

Eu27	17.7	14.0	11.9
India	2.1	6.4	5.8
Japan	15.4	10.7	8.1
Korea, rep.	3.4	3.5	3.5
United states	16.6	11.5	13.0
Other countries	19.8	21.2	21.4
Total exports	100	100	100

Source: Compiled from UNCOMTRADE database

Table 2. Composition of manufacturing exports of some industries (percentage)

	Industry (ISIC 3 - 2 digit)	**2000**	**2005**	**2010**	**2015**	**2018**
15	Food products and beverages	8.3	13.5	21.7	24.8	23.5
17	Textiles	8.6	6.5	5.2	5.0	4.2
18	Wearing apparel	8.9	7.5	5.4	5.8	5.6
19	Tanning and dressing of leather	4.4	2.9	2.9	4.6	4.6
20	Wood and products	8.3	5.6	3.1	3.7	3.3
21	Paper and products	6.5	5.5	5.8	5.0	5.7
24	Chemicals and products	8.4	9.3	9.9	9.9	12.3
27	Basic metals	4.9	8.3	10.4	7.2	10.9
29	Machinery and equipment	1.8	2.5	4.0	3.2	2.9
30	Office and accounting products	6.9	5.2	1.3	1.8	1.5
31	Electrical machinery	4.1	4.6	4.1	3.7	3.5
32	Radio and televisions	10.2	8.3	6.3	3.9	3.1
34	Motor vehicles	0.8	2.4	2.8	4.7	5.2
36	Furniture & others	5.6	4.9	3.7	6.5	4.5
	Total manufacturing exports	100	100	100	100	100

Source: Compiled from UNCOMTRADE database

The export participation of Indonesian manufacturing firms was relatively low at about 18 percent on average during 2000–12, implying that export activity was rare Bernard et al. (2012). Furniture, wood products and radio and television are some sectors that are relatively export-oriented; their participation rates are 45 percent, 39 percent and 38 percent, respectively (see Table A1, Appendix A). The export participation is relatively low among firms in food and beverages (10 percent), fabricated metal (12 percent), textiles (14 percent) and wearing apparel (16 percent). However, the export intensity (the share of output that is exported among exporting firms) is relatively high, at about 74 percent on average. This indicates that once a firm decides to export, it will focus on its export market rather than on the domestic market. Furniture, wearing apparel and wood products have the highest export intensity above 80 percent. However, during the observed period, the export intensity seems to decrease for all sectors, from 79 percent in 2000 to 71 percent in 2012. The decrease might be the result of the slowing down of foreign demand following the world economic crisis, which has forced exporters to turn to the domestic market.

The behaviour of Indonesian exporting firms has been studied in various ways. As found in other countries, exporting firms from Indonesia are more productive than firms that serve only domestic markets (Rho & Rodrigue 2015; Rodriguez-Pose et al. 2013). Foreign direct investment (FDI) ownerships and import status are the key distinguishing factors between exporters and non-exporters (Sjöholm 2003), as well as the age of firms,

capital ownership and the location of firms (Rodriguez-Pose et al. 2013). Also, sunk costs matter in a firm's decision to 'always export' or 'never export', whereas export experience affects the current status of firms (Narjoko & Atje 2007). It can also be noted that Blalock and Gertler (2004) found an increase in productivity of about 2–5 percent from exporting activity among Indonesian firms in the period from 1990 to 1996, prompting them to conclude that productivity gains followed the initiation of exports rather than preceded it. The productivity gains did not disappear if the manufacturer stopped exporting. These results suggest evidence of LBE, attributable to knowledge and efficiencies gained from participating in international markets.

3. Literature review

There are many empirical studies that show higher performance of exporting firms relative to those that only serve domestic markets. Exporting firms are found to be larger, more productive, more skill- and capital-intensive, using more different input mix and paying higher wages than non-exporting firms (Bernard, Redding & Schott 2007). Two hypotheses have been used to explain these differences: self-selection mechanism and learning-by-exporting mechanism (Greenaway, Gullstrand & Kneller 2005; Greenaway & Yu 2004).

The first hypothesis postulates that the distinctions between exporters and non-exporters are already present even before the exporting begins. That is, exporting firms are more productive, not as a result of exporting, but because only the most productive firms are able to overcome the costs of entering the export markets (Bernard & Jensen 1999; Bernard & Jensen 2004). These sunk costs, such as those associated with finding buyers, researching the foreign regulatory environment and ensuring that the products can conform to foreign standards (e.g. testing, packaging, and labeling) can be substantial. In some instance, this may also include the costs to set up new distribution channels in the foreign country and to adapt to the shipping regulation in that country (Roberts & Tybout 1997). Prior to exporting, firms make a prediction and estimate their export profits in the future based on their expectation of future market conditions, including the potential sunk costs that they have to pay (Das, Roberts & Tybout 2007). An array of evidence from many countries using various methods has confirmed the self-selection hypothesis (Bernard et al. 2012). Using US data, Bernard and Jensen (1999) show that performing firms are those who export and who already showed good performance several years before exporting. A study by Clerides, Lach and Tybout (1998) for several developing countries (Columbia, Mexico, and Morocco) finds that more efficient firms tend to become exporters. Comparing Taiwan and Korea, Aw, Chung and Roberts (2000) find that productivity matters in inducing self-selection into export in the case of Taiwan, but not in Korea. As for Indonesia, Rodriguez-Pose et al. (2013) show that productivity is a significant determinant of export decision.

Such findings with respect to the self-selection hypothesis prompted Melitz (2003) to develop the theory of heterogeneous firms. In this theory, attitude towards sunk costs is heterogeneous across firms, in that, only the most efficient firms can break into a foreign market and make a stable stream of export revenues and profits from exporting, whereas the less productive ones would serve domestic market only and the least productive ones would exit. In other words, the presence of sunk costs ensures that only those firms with productivity above a certain 'export productivity cut-off' find it profitable to export.

The heterogeneity of firms occurs in various dimensions, observable and non-observable. Most empirical studies utilize firm characteristics available from statistics or surveys, such as foreign ownership status,

information about import, location, firm age, capital, and labor to analyze the self-selection hypothesis of export. Sjöholm (2003) suggests that international network, such as foreign ownership and import might be the most important factors in determining export propensities because they can decrease export costs and open more opportunity to learn about overseas markets. If other information is accessible, the studies can be further extended, such as to examine the product quality or innovation and research and development. Most available data about firms, however, do not have detailed information about prices, costs, and profits. Some studies have tried to establish proxies to investigate them. Other dimensions of heterogeneity, such as how production technology, management practice, firm organization, and product attributes lead to variations in revenues across firms also contribute to the firm's decision to export (Melitz & Redding 2014). However, since data about these are not available either – especially in developing countries, they remain to be the 'unobservable heterogeneity' among firms.

The second hypothesis, learning-by-exporting, suggests that when a firm breaks into the export market, it will obtain external knowledge from abroad, and such exposure allows it to improve its efficiency level, whereas other firms that only serve domestic markets are devoid of such opportunity. There are two channels through which this effect takes place: buyers and competitors (Blalock & Gertler 2004; De Loecker 2007). Exporting firms may benefit from technical assistance given by their foreign buyers. Since buyers want to obtain good quality products with precise specifications, they often have the incentive to share knowledge to their suppliers when ordering products, such as the latest design specification and production techniques. Blalock and Gertler (2004) provide some examples of Indonesian exporters that obtain technology transfer from their buyers. A garment exporter, which exported 100 percent of its output to Germany, obtained technical assistances from its main buyer who sent efficiency experts and product designers to advise the firm about capacity expansion or new consumer trends. In another example, a textile-exporting firm got some advice from its Japanese buyer about production methods and efficiency. Exporting firms may also learn from fierce competition in foreign markets. To survive and make profits in that market, exporting firms have to increase their efficiency and adopt the best-practice technology (Athukorala & Rajapatirana 2000). De Loecker (2013) mentions that investing in marketing, upgrading product quality, innovating, and dealing with foreign buyers are some competition mechanism that might induce productivity gains during the learning process.

There have been many studies testing this hypothesis. Most of them compare the change in productivity before and after the starting date of export (Wagner 2007). The evidence is mixed, implying that exporting does not always improve firm's productivity. Many studies do not find learning effects from exporting (Bernard and Jensen (1999) for US, Delgado, Farinas and Ruano (2002) for Spain; Aw and Hwang (1995) for Taiwan; Clerides, Lach and Tybout (1998) for Colombia and Mexico; Greenaway, Gullstrand and Kneller (2005) for Sweden; and Haidar (2012) for India) . However, other studies do detect the presence of learning-by-exporting (Van Biesebroeck (2005) for six sub-Saharan African countries; Blalock and Gertler (2004) for Indonesia; Baldwin and Gu (2003) for Canada, Girma, Greenaway and Kneller (2004) for UK; Alvarez and Lopez (2005) for Chile; Greenaway and Kneller (2007) for UK; De Loecker (2007) for Slovenia; and Julan et al. (2012) for China). Martins and Yang (2009) summarize the findings and suggest that the effect of export on firm performance varies across countries, but it tends to be higher in developing countries than in developed economies. The learning effects also vary across firms in different industries (Greenaway & Kneller 2007) or different export destinations

(De Loecker 2007). That is, exporting to developed countries is most likely to produce higher learning effects. One explanation is that firms from developing countries that export to more advanced countries would face larger and more competitive markets that challenge them to improve their productivity through product and production process upgrading or via management technique improvement. Meanwhile, firms from more developed countries may face foreign markets that are as (or less) competitive than their own domestic market (Fernandes & Isgut 2015). Meanwhile, more recent studies of learning mechanism incorporate the effect of export experiences on export performance and future export decision (Álvarez, Faruq & Lopez 2013; Inui, Ito & Miyakawa 2016; Timoshenko 2015). Eaton et al. (2008) show that export starters learn by selling small quantities to a single neighbor country, and if it is successful, they tend to expand their export. Albornoz et al. (2012) introduce the concept of 'sequential exporting' to explain firms' use of their initial export experience to infer information about their future success. Moreover, it is shown that there is a positive relationship between previous export experience and the probability of exporting a new product and/or into a new market in the following year (Álvarez, Faruq & Lopez 2013) since the experience may help to reduce the entry costs for firms in the international markets. Inui, Ito and Miyakawa (2016) explain the types of cost that are expected to fall as firms become more experienced in the overseas markets. These are the 'per-period fixed costs', or the costs involved in maintaining an overseas distribution network. As exporting firms become more experienced, they are more likely to have a better understanding of the foreign market, and this can help them to forecast future demands accurately and to develop a more reliable foreign partnership. Through the learning mechanism, the uncertainty that exporters face in the overseas market, which is related to future sales, transaction partners, or contract forms, decreases. As a result, the per-period fixed costs decline. In addition, learning-by-experience also generates persistence in exporting since the profitability in the foreign market rises with the length of export experiences (Timoshenko 2015). Békés and Muraközy (2012) suggest that even though an exporting firm is hit by a productivity or demand shocks, it is probably still persistent in the export market because its past experience helps it to cope up with the shock.

To measure the export experience, several studies use years of exporting as the proxy. A study by Timoshenko (2015) models learning as an age-dependence concept, where an older and the more experienced exporting firm is more profitable in foreign markets compared to younger or less experienced exporting firms. Inui, Ito and Miyakawa (2016) use firm export duration as a proxy for experiences and find that the exit probability from export markets decreases over the export duration.

4. Methodology

The main objective of this study is to test the learning-by-exporting hypothesis, using the data on Indonesian manufacturing sector. To facilitate this, we first undertake three necessary steps. First, we need to ascertain that exporting firms are not similar to firms that only serve the domestic market. We conduct an analysis of how different exporting firms compared to non-exporting firms in various firm-level outcome performance, such as productivity, employment, wages and capital per worker. Second, we examine the hypothesis of self-selection into export. As noted, the high performance of exporting firms can be due to the fact that it is only the higher performance firms that are able to make profit in the more competitive international markets. This test is important in order to check for possible reverse causality between exporting and productivity, and to ensure that the test for

learning-by-exporting effect is not distorted by self-selection effect. Third, we investigate the export experience, the variable of interest that we use in the main model. In this analysis, we check how export experience and export sales are related in order to facilitate the investigation of learning channel. All these preliminary analyses are given in Appendix B.

4.1 Productivity estimation

We use TFP as the outcome variable. To estimate the TFP, we first assume a Cobb-Douglas production function::

$$y_t = \beta_0 + \beta_l l_t + \beta_k k_t + \varepsilon_t, \quad (1)$$

where y_t is firm's value added at time *t*; l_t is labour input at time *t*; and k_t is capital at time *t* – all these variables are logged. There is a possibility that the error term ε_t impacts the choices of inputs that we cannot observe, but observable by the firm; then, ε_t may be correlated with other variables in the right-hand-side, leading to simultaneity bias under ordinary least squares (OLS). Thus we follow Olley and Pakes (1996) and Levinsohn and Petrin (2003) – hereafter OP and LP, respectively – to decompose the error ε_t into two components: ω_t , the transmitted productivity component that is correlated with input choices and η_t, the error term that is uncorrelated with input choices. Then, we have $\varepsilon_t = \omega_t + \eta_t$, where ω_t is a state variable of productivity that affects the firm's decision rules.

Both these methods also reduce the selection bias from the possibility that some unproductive firms might leave the industry and be replaced by more productive enterprises. However, LP could be preferable to OP due to data reliability. The OP approach uses investment as a proxy for unobservable shocks. This investment variable is most likely derived from capital stock data and may not smoothly respond to productivity shock. In addition, the investment proxy is only valid for firms that report non-zero investment. On the other hand, LP uses intermediate inputs, such as materials and electricity, instead of investment, hence is less exposed to zero observation. Therefore, to avoid truncating all the zero investment firms, this study uses the LP method. For comparison, however, we also report the results with OP method.

In LP, it is assumed that the demand for the intermediate input m_t depends on the firm's state variables, capital and productivity shocks; then we have $m_t = m_t(k_t, \omega_t)$. The demand function is monotonically increasing in ω_t, which allows inversion of the intermediate demand function. We obtain $\omega_t = \omega_t(k_t, m_t)$, in which the unobservable productivity term is now expressed solely as a function of two observed inputs. With this in mind, we adjust the production function into:

$$y_t = \beta_l l_t + \phi(k_t, \omega_t) + \eta_t, \quad (2)$$

where $\phi(k_t, \omega_t) = \beta_0 + \beta_k k_t + \omega_t(k_t, m_t)$. We estimate this equation using the procedures discussed in Petrin, Poi and Levinsohn (2004). We treat consumption of material inputs and electricity as the intermediate input.

4.2 The impact of export experience on firm's productivity

The main model examines the impact of export experience on the firm's performance. The variable of interest is export age, and the aim is to evaluate to what extent this factor affects the performance of the Indonesian manufacturing firms. The model takes the following form:

$$ln\,TFP_{ikrt} = \alpha + \beta AGEX_{ikrt-1} + \boldsymbol{\gamma Z_{ikrt-1}} + \vartheta Ind_{kt-1} + \zeta Prov_{rt-1} + \delta_i + \tau_t + \kappa_k + \varepsilon_{ikrt} \qquad (3)$$

where TFP_{ikrt} represents the total factor productivity for an exporting firm i in industry k and province r at time t. $AGEX_{ikrt-1}$ is the export age in period $t-1$, Z_{ikrt-1} is the lagged values of a set of firm characteristics (foreign ownership share, import share, firm's age, and firm's age squared), Ind_{kt-1} is the number of exporting firms in the industry k at time $t-1$ and $Prov_{rt-1}$ is the number of exporting firms in the province r at time $t-1$. This lag structure is adopted because the initial level of productivity before exporting might influence the performance after exporting. We also included the firm's fixed effects, year dummies and industry dummies to control for unobservable factors at the firm's level, in a certain year and in a certain industry.

The variable of interest is $AGEX$. We construct this variable based on the duration of export or the period in which a firm is engaged in export activities over consecutive years. We assume that if a firm exits from export activity (i.e., stops exporting) at least for two years before it starts exporting again, its 'export age' starts from zero again.[1] We drop those whose exporting age cannot be defined at all. To examine how export experience and productivity relate, the square form of the export age is included. In addition, for each separate regression, we also examine the cubed export age, log of export age and dummy variables of export age.

We are aware of some potential biases – some of which have implicitly been addressed by the way we constructed the estimating equations above. First, there might be an endogeneity problem associated with measurement error especially when we contruct the TFP variable (see Data section). The second problem is reverse causality. There is a two-way relationship between productivity and export, where export activities can increase the firm productivity, and the efficient firm is more likely to continue to export. To address this issue, we apply a probit propensity score matching (PSM) procedure by matching exporters and non-exporters with similar characteristics and only incorporate the matched samples in the Equation 3 (that is, we only consider non-exporting firms that have balanced characteristics with their exporting counterparts). We expect that this technique wash away the relationship between productivity and export that is due to self-selection. Also, as noted, we include the one-year lags of firm characteristics and of spillover effects to minimize other possible endogeneities in the model.

We need to take into account the potential effect of unobserved heterogeneity. For example, managers of some firms may be more willing or more capable, to explore the new export markets, while some firms may enter new export markets because they have established relationships with distributors in other markets. Since the dataset does not allow us to directly distinguish these effects from the role of experience, we use fixed effect strategy to mitigate these concerns. The model therefore includes firm fixed effects to control for the remaining unobserved time-invariant heterogeneity at the firm level.

Finally, the model incorporates industry fixed effects and year fixed effects to control for the industry and/or year characteristics that influence the error term. The fact that the time span includes the global financial

[1] We also examine differently-constructed export age variables.

crisis may result in a biased estimation since it affects the variables in the dataset in a certain year. Thus, we control for the year fixed effect to mitigate the problem. A certain industry may also obtain certain treatment from government policies, so the industry fixed effects should lessen the impact. Moreover, the commodity boom may affect some particular sectors in a certain year, such as export of crude palm oil and other resource-based products that significantly increased during the boom. This kind of noise can also be reduced using the combination of industry and year fixed effects.

5. Data

This study employs the establishment level data from Indonesia's Industrial Statistic Survey (*Statistik Industri*, SI) as the main source. The SI contains comprehensive information about medium and large manufacturing firms in Indonesia, which are derived from an annual survey of firms in the formal sectors with 20 or more employees.[2] It is collected by the Central Bureau of Statistics (*Badan Pusat Statistik*, BPS) and captures various detailed information of firms, such as location, inputs and components of production costs, outputs and value added, ownership, export status and export intensity, import status and volume, employment, capital and new investment.

We focus on 2000–12, the period after the Asian financial crisis and the time when Indonesia underwent its key structural reform (Aswicahyono, H, Bird & Hill 2009). With this period selection, we expect limited noise from the Asian financial crisis in the data, as it broke up in 1997. There are still other factors, however, that might distort the data, such as commodity boom and the global financial crisis, but these will be dealt with using some fixed effects strategies. The number of observations every year varies with overall observations of 286,262.

The capital stock data – crucial for the construction of the TFP variable – are problematic given there are many missing observations in various years. For 2006, there is no record of the capital stock at all. To deal with these issues, we dropped all firms with no capital data and for 2006, interpolated the capital stock data for 2006 from the values in 2005 and 2007. [3] These cleanings removed about 24 percent of the total sample. Next, firms with missing capital data in three or more continuing years were also removed. For those with missing data up to two consecutive years, we again applied interpolation. And finally, firms with negative capital data were removed. This further reduced observations by about 20 percent. The final number of observations is 153,890.

Aswicahyono, Hill and Narjoko (2010) classified industries into five groups to examine trends and patterns of manufacturing performance: unskilled labor-intensive sector (ULI), resource-based labor-intensive sector (RLI), resource-based capital-intensive sector (RCI), electronics (ELE), and footloose capital-intensive sector (FCI). This paper adopts their classification to understand better how different groups of firms behave. Table A2 in Appendix A listed all the industries in each category.

Table 3 shows the annual average number of firms in 2000 to 2012. As expected, the number of firms that export are few. In 2000, 2162 of the surveyed firms were exporting, by 2012 this number increased by 54 percent to 3321 exporting firms. The total number of firms in this period also increased, but only by 15 percent,

[2] SI does not give detailed explanation about the status of an establishment, whether it is a single firm or a plant that belongs to another firm. For simplicity, we refer to any individual establishment as 'firm'.
[3] For some of the steps in cleaning the capital data, we follow Blalock and Gertler (2004).

resulting in a net increase of the share of exporting firms in Indonesian manufacturing. The third row refers to 'new exporters' or firms that only start to export during the period. On average 26 percent of the exporting firms are new entrants in the export market and in total, 7210 firms enter the market at different point of time between 2001 and 2012. Table 3 also presents the average number of firms in each group of industries during the observed period. We removed exporting firms that already exported since 2000 since we could not define the first year of exporting for those firms. The summary statistics of all variables used in the study are shown in Appendix A (Table A3).

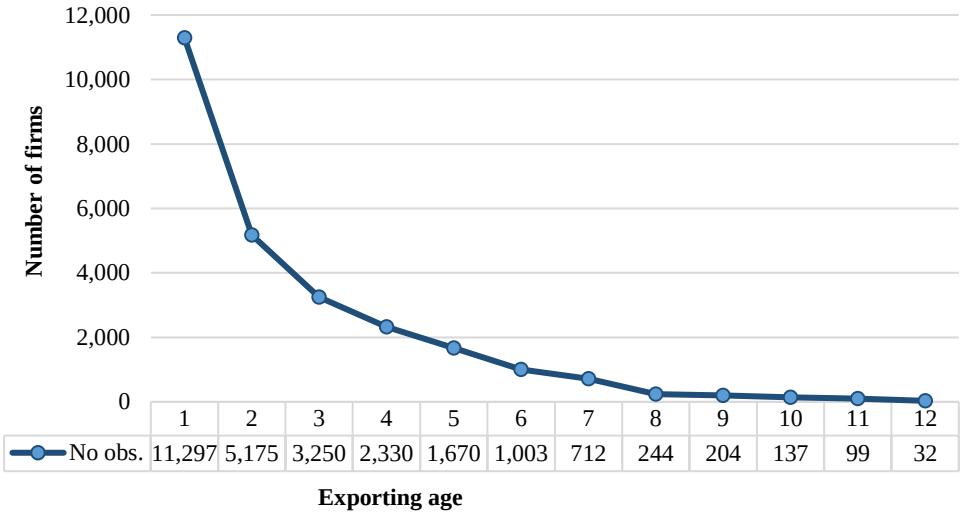
Table 3. Number of active firms, exporting firms and new exporting firms (on average)

	Annual average (2000-2012)					
	All observation	**ULI**	**RLI**	**RCI**	**ELE**	**FCI**
Active firms	12,603	2,860	601	227	117	566
Exporting firms	2,300	788	289	59	41	68
New exporting firms [a]	601	177	64	15	11	20

Note: [a] the average from 2001-2012
Source: *Statistik Industri*, calculated

Export age. Figure 2 shows the export age for all firms that start exporting within the period from 2001 to 2012. The number of observations decreases throughout the export age, implying that the number of firms that has been exporting for a long period of time is small relative to the number of firms that just start exporting. Note that more than half of firms in the observations only export once (export age equal to one). This might imply that many firms in Indonesia tried to export but they could not make profits and could not survive in the foreign markets in the first year of exporting; and so stopped exporting. Only 5.2 percent of firms that started exporting in 2001 could stay in the export market for 12 years, and 6.4 percent of firms starting export in 2001 and 2002 could stay exporting for 11 years (see Table A4 in Appendix A).

Figure 2. Distribution of firms by exporting age



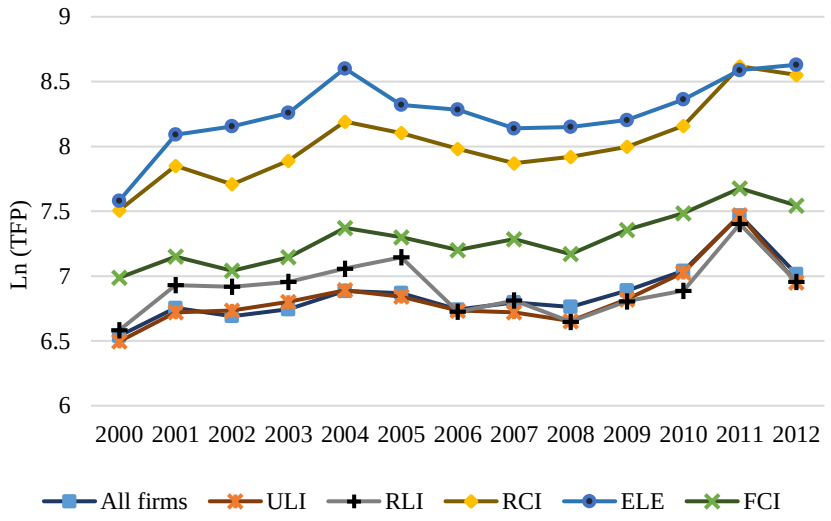
Source: Compiled from *Statistik Industri* by pooling all observations

Productivity. In LP estimation, there are two options for dependent variable: value added and output/gross revenue. In the main model, TFP is constructed using the value-added estimation from LP with material and electricity as proxies for intermediate input. For completeness and comparison, Table A5 in Appendix A displays the parameter estimates from OLS, OP model, LP-revenue and LP-value-added to construct the TFP.

Figure 3 shows the average values of the constructed TFP for all observations and 5 different industry groups, based on the LP-value-added approach. On average the productivity of firms in the electronics industry (ELE) is the highest among other sectors and that those in the unskilled labor-intensive industry (ULI) have the lowest productivity. Note that Indonesian economy is biased towards ULI sectors, so the number of observation of firms for this group is the largest among others, and this contributes to the overall low average TFP (for all firms).

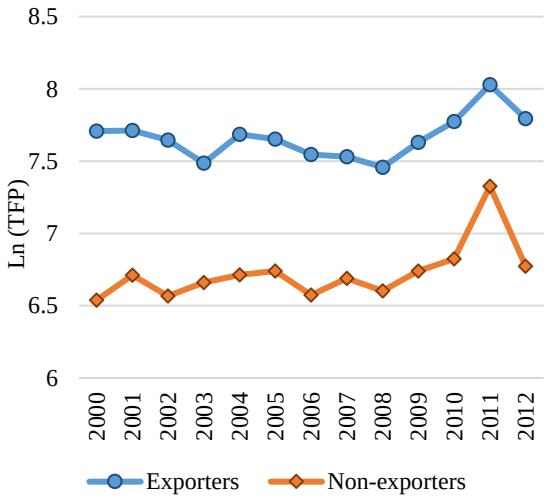
Figure 4 compares the productivity level between exporting firms and non-exporting firms in Indonesia. As expected, it shows that, on average, exporters' productivity level is much larger than those of the firms that only serve domestic market. To reflect our focus on exporting age, we classify firms based on three categories. They are 'incumbents' – firms that already export since the beginning of the observation period, 'starters' or new exporting firms – firms that start export from 2001 – 2012, and 'never export' – firms that never export during the observed period. Figure 5 presents the average productivity level of these three groups. Exporting firms that are relatively older have higher productivity level than the new ones; and firms that never export have much lower productivity level than the other groups.

Figure 3. TFP by sector groups



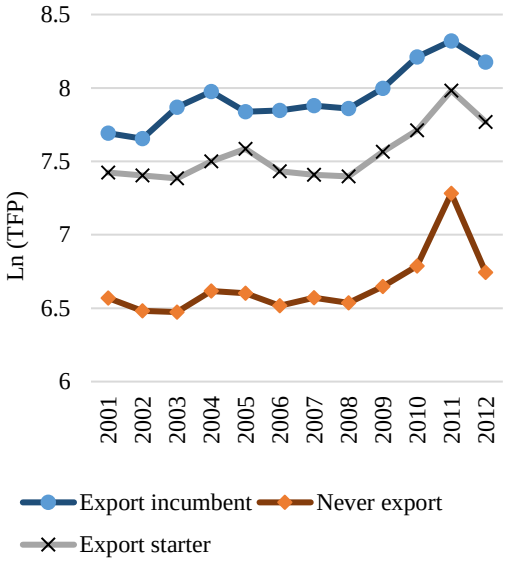
Notes: ULI is unskilled labor-intensive industry; RLI is resource-based labor-intensive sector; RCI is resource-based capital-intensive sector; ELE is electronics; and FCI is footloose capital-intensive sector.
Source: Results from TFP estimations

Figure 4. Exporters vs. non-exporters



Source: Results from TFP estimations

Figure 5. Firm's classification



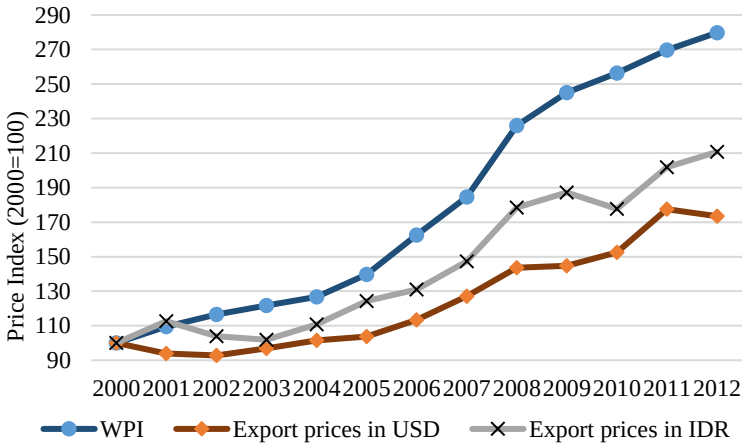
Source: Results from TFP estimations

Other variables. We use firm's characteristics, such as foreign-owned shares, import shares, and firm age as control variables in the main model. Since both firm age and export age are included, one might suspect a high correlation between them. As it turns out the correlation is only 0.13. As noted, we also control for spillover effect of other firms' export activities, constructed by aggregating the number of exporting firms in the industry level and the province level.

We also construct export value variable. As noted, this variable is used in the preliminary analysis to confirm if export experience is associated with export performance. Export value variable is derived from multiplying export intensity and total output and then it is deflated using the export prices. The export price data is not readily available, but some proxies can be used. We construct the export prices using data from UNCOMTRADE database. We take export value and export volume for each group of 4-digit ISIC industry classification. Then, the export prices are calculated by dividing the value of export with its volume. Once we get the export price, it is translated into a price index by converting the prices from dollar value to rupiah, using the year 2000 as the base. To translate dollar value into rupiah, we use the exchange rates available from Bank Indonesia website. We then match each 4-digit ISIC3 product to every firm to get the export value of each firm. As an alternative, we also check the US export price data as another proxy for the world export price.

Figure 6 shows the constructed price indexes in dollars and rupiahs, along with the wholesale price indexes (WPI). BPS collects WPI by interviewing Indonesian firms in 33 provinces, and this reflects producer prices. WPI is used to deflate most variables in values in this study, except for export sales, since the WPI is biased towards domestic prices. Over the consecutive periods, there is a slight difference between export prices in dollar and rupiah, indicating a small exchange rate effects. WPI, on the other hand, is relatively much higher than the export prices, indicating higher domestic prices in general. Since the data in SI is in rupiah (IDR), the export sales variable is also deflated by export prices in rupiah.[4]

Figure 6. Price indexes



Sources: BPS and UNCOMTRADE, calculated

6. Results

6.1 Preliminary analyses

We conduct some preliminary analyses. Explanations on how we estimate the equations are in the Appendix B. Firstly, we confirm that exporting firms are better than non-exporting firms in various indicators (see Table 4).

[4] The number of observations of exporters with non-zero export value is decreased. This is because some firms report doing export but do not report the export intensity for certain years.

The former are more productive in terms of TFP (12 percent higher), labor productivity (26 percent higher) and value added per worker (16 percent higher). They also have higher input (95 percent larger in employment and 26 percent larger in capital per worker) and they pay higher wages than firms that serve only the domestic market. These findings are similar to those of previous studies that show the superiority of exporting firms over non-exporting firms.

Table 4. Differences between exporting firms and non-exporting firms

Firm characteristics	Differences
Employment	0.952 ***
Average wage of production workers	0.018 **
Capital per worker	0.261 ***
Value added per worker	0.163 ***
Output per worker	0.260 ***
Total factor productivity (TFP)	0.118 ***

Note: ***, ** indicate significance at 1 percent and 5 percent level, respectively. All dependent variables are in the natural log form. In all regressions we control for the size effect except for the employment regression. All regressions include year, industry and province effects. All monetary variables are deflated with WPI.

Secondly, we also confirm that there is evidence of self-selection hypothesis, in which only higher performance firms that are able to export (see Table B1 in the Appendix B). The estimates, which correspond to the marginal effects, show that a 10 percent increase in productivity increases the probability of exporting by 0.09-0.12 percent. In addition, higher shares of foreign ownership, capital and import shares increase the probability to export and to start export. However, the firm age variable has negative coefficient, suggesting that younger firms are more likely to export (or start to export) compared to the older firms.

The evidence of self-selection hypothesis is crucial in investigating the impact of export experience on productivity due to the potential reverse causality problem. Therefore, we control the self-selection bias by doing the matching for the exporting firms and non-exporting firms using PSM before estimating and only including the matched samples to the main equation.

Thirdly, we also checked for the mechanism how export experience works. We test whether the firms' sales increase with export experience. If so, then we can confirm that firms continue to export because they found that exporting was profitable and their revenues increased over the year of exporting. Table B2 in Appendix B shows the results. Export experience is associated with 0.08 percent higher export sales. This shows a learning effect in exporting: as the export age increases, firms learn and accumulate knowledge and then become more enduring and make more profits in the export markets.

These findings are consistent with those from the previous studies. First, firms that export are different from non-exporters in many aspects. Second, the difference can to some extent be attributed to self-selection mechanism. Third, export experience has a positive correlation with export sales, which also implies a learning mechanism. These results provide us with a better foundation to proceed with the main analysis: whether or not firms are getting more productive as they become more experienced in export markets.

6.2 Main results

Table 5 shows the main results of the effect of export age on productivity. The first two columns are the results of pooled OLS and firm fixed effect estimations without controls. We introduce more controls in Column 3, and different combinations of year and industry fixed effects in Column 4 and 5. Overall, the variable of interest, the export age, is significant at 1 percent level and consistently has a positive sign. This suggests that as export experience increases, the productivity increases. Columns 4 and 5 suggest that the effect of export age is about 3.5 percent. In all fixed effects estimations, the export-age-squared variable is significantly negative with relatively consistent magnitudes. This implies an inverse U-shaped effect of export experience: as the export age increases, its marginal impact decreases. The increase of productivity for relatively younger exporting firms is larger than relatively older exporting firms. This is consistent with the finding by Alvarez and Lopez (2005) in that productivity gains from exporting are more likely to affect new exporters than the experienced ones. Foreign-owned shares and firm age have positive impacts on productivity but their significance vanish once industry and year fixed effects are included. Import shares and spillover effects are also insignificant.

Table 5. The effect of export experience on productivity

	(1)[a]	(2)[a]	(3)[a]	(4)[b]	(5)[b]
VARIABLES			Ln (TFP_{it})		
Export $Age_{i,t}$	0.408***	0.0637***	0.0550***	0.0349***	0.0345***
	(0.00739)	(0.00742)	(0.00785)	(0.00907)	(0.0105)
$(Export\ Age_{i,t})^2$	-0.0320***	-0.00326***	-0.00456***	-0.00384***	-0.00401***
	(0.00111)	(0.000908)	(0.000924)	(0.000866)	(0.00101)
FDI $Share_{i,t-1}$			0.000627*	0.000382	0.000493
			(0.000331)	(0.000400)	(0.000408)
Firm $Age_{i,t-1}$			0.0317***	-0.00241	-0.00206
			(0.00137)	(0.00233)	(0.00242)
$(Firm\ Age_{i,t-1})^2$			-0.000239***	-4.87e-05*	-5.19e-05*
			(2.86e-05)	(2.83e-05)	(2.59e-05)
Import $Share_{i,t-1}$			0.000369	0.000478	0.000435
			(0.000273)	(0.000437)	(0.000427)
Number of $exporters_{k,t-1}$			-2.51e-05	5.51e-05	2.65e-05
			(4.73e-05)	(7.92e-05)	(6.22e-05)
Number of $exporters_{r,t-1}$			-0.000109**	-0.000143	-0.000112
			(5.44e-05)	(9.90e-05)	(9.06e-05)
Constant	6.786***	6.882***	6.602***	6.806***	6.838***
	(0.00374)	(0.00287)	(0.0111)	(0.0490)	(0.0444)
Firm fixed effects	No	Yes	Yes	Yes	Yes
Industry fixed effects	No	No	No	No	Yes
year fixed effects	No	No	No	No	Yes
Industry - year fixed effects	No	No	No	Yes	No
Observations	123,129	123,129	123,129	123,129	123,129
R-squared	0.058	0.711	0.714	0.731	0.726

Notes: Each estimation only includes on-support firms from the matching procedure. *** p<0.01, ** p<0.05, * p<0.1; [a] Robust standard errors are in parentheses; [b] Standard errors are clustered at industrial level.

To better understand the behavior of export experience, we run separate regressions using the cubed form of export age, the log of export age and a dummy variable of export age, as reported in Table 6. As shown in the

first column, when the cube of export age is included, the impact of export age remains significant with slightly higher magnitude. The square and cube form of the export age are not significant. These results confirm that the relation of the export age and the productivity indeed follows an inverted U-shaped curve, rather than a linear or oscillating functions. The coefficient of export age is significantly positive with a similar magnitude with the main model (Column 2). Meanwhile, the results for estimation with export age dummies in Column 3 show that the relation between export age and TFP is non-linear. That is, the experience effect is significant only from 2 to 5 years of exporting.

Table 6 also provides the results from other specifications to check the robustness of the main model. Column 4 contains the results from a specification similar to the main model but with export age variable constructed differently. In the main model, the export age keeps accruing so long as the exporters continue exporting – or halt exporting but only for one year and then resume afterward. However, for the estimation in the Column 4, the temporary stop from export is not counted as part of the exporting period, so if the firm resumes its export, the export age will start from 1 again. Despite the different way in constructing the export age, however, the results are similar to the main model, confirming that the effect of export age is around 3.5 percent.

There is a possibility that a firm that started exporting in 2001 is a firm that did not export in 2000 but did in 1999. Under the assumption that a firm needs to repay sunk costs if it stops exporting for at least 2 years (Robert & Tybout 1997), as a robustness check, we drop all exporting firms that started export before 2002. By doing this, we avoid the measurement error of export age, but we have a smaller size of observations. Column 5 presents the results that accommodate this assumption. The magnitude of export age is now about 3.4 percent and the conclusion that export age affects productivity not in a linear fashion still holds.

Since we dropped many observations during the construction of the TFP, we check alternative approach where we use labour productivity as the dependent variable. As presented in the Column 6 in Table 6, we can keep all observations and replicate the model. The result shows that export age is associated with 2.6 percent increase in labour productivity and the squared form of export age is still negative and significant.

Table 6. The effect of export experience on productivity, alternative models

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
			Ln (TFP_{it})			Ln (Labour Productivity$_{it}$)
Export $Age_{i,t}$	0.0370***			0.0345***	0.0339***	0.0259***
	(0.0128)			(0.00794)	(0.00913)	(0.00595)
$(Export\ Age_{i,t})^2$	-0.00484			-0.00394***	-0.00440***	-0.00353***
	(0.00341)			(0.000936)	(0.00115)	(0.000662)
$(Export\ Age_{i,t})^3$	6.20e-05					
	(0.000245)					
Ln (Export $Age_{i,t)}$		0.0327***				
		(0.0118)				
Export $Age_{i,t}$ =1			0.00391			
			(0.0164)			
Export $Age_{i,t}$ =2			0.0784***			
			(0.0202)			
Export $Age_{i,t}$ =3			0.0903***			
			(0.0225)			
Export $Age_{i,t}$ =4			0.0728***			
			(0.0253)			
Export $Age_{i,t}$ =5			0.0942***			
			(0.0284)			
Export $Age_{i,t}$ =6			0.0224			
			(0.0346)			
Export $Age_{i,t}$ =7			0.101**			
			(0.0412)			
Export $Age_{i,t}$ =8			0.0124			
			(0.0621)			
Export $Age_{i,t}$ =9			0.00111			
			(0.0729)			
Export $Age_{i,t}$ =10			0.0326			
			(0.0983)			
Export $Age_{i,t}$ =11			-0.245**			
			(0.102)			
Export $Age_{i,t}$ =12			0.0371			
			(0.132)			
Constant	6.838***	6.842***	6.840***	6.838***	6.711***	9.435***
	(0.0635)	(0.0634)	(0.0634)	(0.0635)	(0.0748)	(0.0498)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	123,129	123,129	123,129	123,129	111,603	218,439
R-squared	0.726	0.726	0.726	0.726	0.725	0.723

Notes: Each estimation only includes on-support firms from the matching procedure. Standard errors are clustered at industrial level; *** p<0.01, ** p<0.05, * p<0.1. Column 4 and 5 use different definition of export age.

6.3 Sector and size effects

Table 7 shows the effects of specific sector or size. In these estimations, we treat export age in the natural log form as the variable of interest and interact it with specific sectoral dummies or the size dummy. The first row of columns (1)-(5) shows that a 10 percent increase in export age raises productivity by about 2.8-4.0 percent, and these numbers are true for all firms in all sectors except for those in the specific sectors (ULI, RLI, RCI, ELE or FCI). Meanwhile, the export age effect on productivity varies among those particular sectors. Adding the coefficients of the export age variable and the interaction variable yields a significant learning effect of 10.2 percent for firms in the footloose capital-intensive industry (FCI) category. This category includes the production of motor vehicle and accessories as well as the production of chemicals. We may infer that firms in these industries can have higher productivity growth, as they are more experienced in exporting. The magnitude for interaction variable for the resource labour-intensive sector (RLI) is negative and significant at 4.7 percent. This category includes firms that produce very low-tech wood and mineral products. Meanwhile, the magnitudes for the interaction variable of the export experience with RCI, ELE and ULI sector are not significant.

Column 6 in Table 7 exhibits the estimation results from the model that includes the interaction variable between export age and firm size. This model also includes a dummy for a large firm equal 1 if the number of total workers in that firm is 100 or more, and 0 otherwise. The estimation shows that learning-by-exporting is evident only in larger firms and not in smaller ones. The total magnitude is 4.2 percent, which is almost as big as the result from the main estimation, indicating that the learning effects are driven by larger firms.

Table 7. The sectoral and size effects of export experience

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Ln (TFP_{it})					
Ln (Export age_{ikrt})	0.0396***	0.0379***	0.0305**	0.0338***	0.0279**	0.00803
	(0.0137)	(0.0124)	(0.0119)	(0.0118)	(0.0120)	(0.0145)
Ln (Export age_{ikrt}) x ULI	-0.0253					
	(0.0185)					
Ln (Export age_{ikrt}) x RLI		-0.0472*				
		(0.0270)				
Ln (Export age_{ikrt}) x RCI			0.0460			
			(0.0521)			
Ln (Export age_{ikrt}) x ELE				-0.0592		
				(0.0863)		
Ln (Export age_{ikrt}) x FCI					0.102**	
					(0.0473)	
Ln (Export age_{ikrt}) x Large firm						0.0417**
						(0.0177)
Constant	6.841***	6.841***	6.841***	6.842***	6.847***	6.748***
	(0.0634)	(0.0634)	(0.0635)	(0.0634)	(0.0630)	(0.0628)
Other variables	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	123,129	123,129	123,129	123,129	123,129	123,129

R-squared	0.726	0.726	0.726	0.726	0.726	0.729

Notes: Each estimation only includes on-support firms from the matching procedure. Robust standard errors are in parentheses; *** p<0.01, ** p<0.05, * p<0.1 All control variables from the main estimation are included. The signs and magnitudes for these variables are consistent. The dummy variable for each sector is also included. We use industry effects and year effects separately in order to ensure acceptable degrees of freedom.

6.4 Alternative approach: difference-in-difference

Following De Loecker (2007), we also apply a strategy that matches exporting firms with their resemblant non-exporters then combine it with a difference-in-difference technique. We compare the results with the main model as a robustness check. The identification strategy is as follows. Firstly, we group exporting firms based on their exporting ages. These separate export age classifications are our treatment groups. We pooled all exporting firms that have export age equal to 1 year in the first treatment groups, exporting firms that have export age equal to 2 years in the second treatment groups, and similarly for the export age 3 years until 5 years. Therefore, we have several treatment groups that contain firms that have exported for one year, two years, until five years. Subsequently, we pooled all firms that never export during the period of observations into one control group. Then, we employ propensity score matching (PSM) and match each treated group with the control group based on their similar characteristics in the last year. The matching procedure includes 1-year lagged productivity, 1-year lagged firms' characteristics to reduce the selection bias. The year dummy and the industry dummy are also included to make sure each treated firm is well matched with its controls and reduce possible omitted variable bias at the year- and industry level. Thus, every exporting firm in a treated group is matched with non-exporters with similar productivity level, similar characteristics, and in the similar year and industry:

$$\Pr\{Export_{i,age} = 1\} = \phi\{h(\omega_{i-1,} Z_{i-1,} year, industry)\} \quad (4)$$

The outcomes are the total factor productivity in terms of level and growth. We also check for both year-on-year productivity growth as well as *t*-years productivity growth. For the latter outcome, if the exporting firms in the treated group are those with 1-year export experience, then the outcome is the 1-year productivity growth. Also, if exporting firms in the treated group have 2 years of export experience, then the outcome is 2 years productivity growth. Similarly, for treated group with export age 3 years, 4 years, and 5 years, we construct the respective outcome variables.

The matching strategy uses the standard technique of one-to-one matching. The number of treated and controls decreases due to resampling of the future productivity since we estimate the probability of exporting after 1 to 5 years. For each year of exporting, the number of off-support observations in the treatment group is relatively low, less than 15 observations for each matching estimation.

The results are shown in Table 8. Note that these results have different interpretation from the previous model. The productivity level of firms after 1 year of exporting is 0.13 percent higher compared to their counterfactuals of non-exporting firms. In the following years, the difference of productivity level between exporting firms and control firms are 0.07 percent, 0.17 percent, 0.13 percent and 0.18 percent after 2, 3, 4 and 5 years of exporting, respectively. However, the difference becomes insignificant after 6 years of exporting. This might be due to the diminishing effects of export, or the decline in the number of observation for the treatment

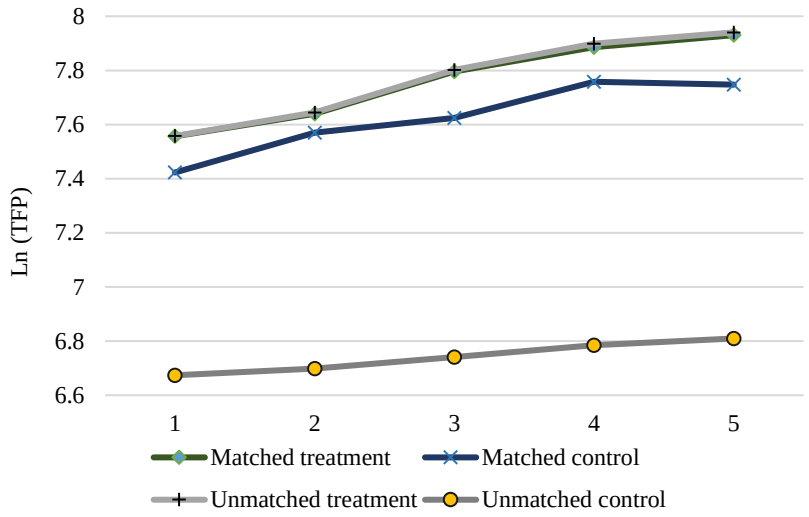
group after resampling. Meanwhile, the difference in productivity growth between both groups is 0.02 percent in the first year of exporting. Compared to the base year, the difference in productivity growth becomes larger as the export age increases. The year-on-year productivity growth of the treatment group is also significantly higher than that of the control groups, except in the second year of exporting. Figure 7 compares the productivity level between treatment and control groups before and after the matching procedures. It shows that the productivity level for exporting firms in various exporting age is higher than their counterfactual. To sum up, the results from all outcomes confirm the presence of the learning-by-exporting mechanism in Indonesian firms.

Table 8. Estimated learning-by-exporting effects

Export age	1	2	3	4	5
Outcome: Productivity					
β1	0.133***	0.069*	0.171***	0.128**	0.183***
	(0.0253)	(0.0403)	(0.0484)	(0.0598)	(0.0714)
Outcome: Productivity growth (compared to base year)					
β2	0.019***	0.053***	0.051***	0.088***	0.188***
	(0.0029)	(0.0076)	(0.014)	(0.029)	(0.066)
Outcome: Productivity growth (year-to-year)					
β3	0.019***	0.008	0.022***	0.016***	0.033***
	(0.0029)	(0.0009)	(0.005)	(0.005)	(0.007)
No. treated	8,211	3,082	2,306	1,667	1113
No. controls	95,405	78,370	63,410	50,554	39,186

Note: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Figure 7. Comparing treatment and control groups after export



7. Concluding remarks

By analysing firm-level firm level data from 2000 to 2012, we find that exporting firms have higher performance than those only serve the domestic market, and this difference is already present before starting to export. There is also evidence that more experienced exporting firms identified in terms of the exporting age exhibit better export performance.

Using these basic understanding, this study further explores the learning mechanism of exporting firms. Using export age as the proxy for experience, we test if export experiences affect firm productivity. Employing the fixed effects as well as propensity score matching techniques, we find that export experience does matter. Yet, it is only applicable for firms that have high productivity from the beginning; a support for self-selection hypothesis.

From the fixed effect technique, we find that an increase in the export age increases the productivity of firms, but the effect diminishes as the age increases. A series of robustness checks confirms these findings. Moreover, we find that export sales affect productivity positively, which may imply the channel for learning. As exporting firms become more experienced, have a better understanding of the foreign markets and succeed to increase they revenues, their productivity also increase. Furthermore, we also find that learning-by-experience is more likely to happen in the relatively bigger firms and firms in footloose capital intensive sectors.

The result from the PSM-diff-in-diff technique shows, also, that firms' performance increases as their export experience increases. Both productivity level and productivity growth of exporting firms are higher than their matched non-exporters control group. The difference is significant until 5 years of exporting, but turns insignificant afterward, which may imply diminishing effects of learning.

Whether or not exporting promotes firm productivity is a central issue in the assessment of the effectiveness of export-promotion development policy. However, it has remained an unresolved issue, as previous studies failed to detect significant learning-by-exporting effects. Our study finds that export experience affects performance, which suggests that exporting is good for firms. But we also detect the presence of self-selection effect. After carefully isolate the latter, we can still confirm that learning-by-exporting effect is evident in Indonesian manufacturing sector.

General policy to make exporting easier, such as simplifying export procedures, or providing information about export market might be beneficial for firms. However, we have to be careful with the policy implication of our findings. It is true that there is gain from export, but not all firms are able to export. Therefore, export promotion policies may mistarget firms in the economy. For example, a certain policy is formulated to promote export, but since we do not know which firms have the capabilities to learn and grow in the export market, that policy may pick firms that are not able to do so. On the other hand, the finding that exporting may increase productivity provides a basis for policy to relax trade restrictions. However, it remains unclear why many firms stop exporting after several years of doing so, even though they gain benefits from exporting. Further works are needed to investigate this.

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Appendix A

Table A1. Export participation and export intensity

	Sector	Average export participation	Export intensity * (%)		
			Average	2000	2012
15	Manufacture of food products and beverages	10%	71.1	76.5	65.2
17	Manufacture of textiles	14%	56.0	65.6	53.1
18	Manufacture of wearing apparel	16%	80.4	88.2	73.1
19	Tanning and dressing of leather	21%	68.1	65.0	60.4
20	Manufacture of wood and of products	39%	79.8	83.9	72.1
24	Manufacture of chemicals and chemic	19%	42.7	51.3	37.1
27	Manufacture of basic metals	27%	57.1	49.3	61.5
28	Manufacture of fabricated metal	12%	40.8	43.3	40.1
29	Manufacture of machinery and equipment	18%	40.8	43.3	40.1
31	Manufacture of electrical machinery	29%	56.8	64.7	53.0
32	Manufacture of radio, television	38%	79.1	85.0	78.7
34	Manufacture of motor vehicles	17%	48.1	58.5	37.5
36	Manufacture of furniture	45%	85.7	91.7	78.7
	The average of export participation	18%	73.6	79.0	71.5

Note: * the shares of output that are exported among only exporters
Sources: *Statistik Industri*, calculated

Table A2. Industry classification

Group	ISIC 4 digit sector	
Unskilled labour intensive industries (ULI)	3610	Manufacture of furniture
	1711	Preparation and spinning of textile fibres; weaving of textiles
	1920	Manufacture of footwear
	1810	Manufacture of wearing apparel, except fur apparel
Resource-based labour intensive industries (RLI)	2021	Manufacture of veneer sheets; manufacture of plywood, laminboard, particle board etc
	2022	Manufacture of builders' carpentry and joinery
	2023	Manufacture of wooden containers
	2029	Manufacture of other products of wood; manufacture of articles of cork, straw etc
	2691	Manufacture of non-structural non-refractory ceramic ware
	2695	Manufacture of articles of concrete, cement and plaster
	2699	Manufacture of other non-metallic mineral products n.e.c.
	2692	Manufacture of refractory ceramic products
	2693	Manufacture of structural non-refractory clay and ceramic products
	3691	Manufacture of jewellery and related articles
Resource-based capital intensive industries (RCI)	2101	Manufacture of pulp, paper and paperboard
	2511	Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres
	2710	Manufacture of basic iron and steel
	2411	Manufacture of basic chemicals, except fertilizers and nitrogen compounds
Electronic industries (ELE)	3000	Manufacture of office, accounting and computing machinery
	3140	Manufacture of accumulators, primary cells and primary batteries
	3150	Manufacture of electric lamps and lighting equipment
	3190	Manufacture of other electrical equipment n.e.c.
	3210	Manufacture of electronic valves and tubes and other electronic components
	2922	Manufacture of machine-tools
	3220	Manufacture of television and radio transmitters and apparatus for line telephony etc
	3230	Manufacture of television and radio receivers, sound or video recording etc
	3120	Manufacture of electricity distribution and control apparatus
Footloose capital intensive industries (FCI)	3410	Manufacture of motor vehicles
	3420	Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers etc
	3430	Manufacture of parts and accessories for motor vehicles and their engines
	2520	Manufacture of plastics products

Table A3. Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Ln($TFP_{i,t}$)	153,890	6.87	1.29	-1.86	17.13
Ln (Output per $worker_{ikrt}$)	153,963	5.41	1.37	-1.66	14.54
Ln (Value added per worker $_{ikrt}$)	153,963	4.38	1.30	-4.97	14.38
Ln (Average wage of production worker $_{ikrt}$)	153,729	3.32	1.09	-5.79	11.03
Ln (Capital $_{ikrt}$)	155,421	12.79	2.05	-1.16	26.39
Ln (Total Worker $_{ikrt}$)	153,964	3.95	1.05	3.00	10.63
Ln (Export $value_{ikrt}$)	19,831	15.02	2.30	0.35	24.78
Export $Age_{i,t}$	155,423	0.40	1.24	0.00	12.00
FDI $Share_{i,t}$	153,964	4.66	20.12	0.00	100.00
Firm $Age_{i,t}$	155,423	11.11	13.86	1.00	112.00
Import $Share_{i,t}$	153,958	5.98	20.32	0.00	100.00
Number of $exporters_{k,t}$	155,423	40.95	133.66	0.00	846.00
Number of $exporters_{r,t}$	155,423	37.46	119.66	0.00	705.00

Table A4. The number of firms that stay exporting in *t* years

t	The number of export starter	Firms that can stay for *t* years	Percentage
12	610	32	5.25%
11	1,544	99	6.41%
10	2,058	137	6.66%
9	3,040	204	6.71%
8	3,374	244	7.23%
7	5,299	712	13.44%
6	5,999	1003	16.72%
5	7,403	1670	22.56%
4	8,215	2330	28.36%
3	9,353	3250	34.75%
2	10,559	5175	49.01%

Sources: *Statistik Industri*, calculated

Table A5. The construction of the TFP variable

	OLS	Olley-Pakes	Levinsohn-Petrin - Revenue	Levinsohn-Petrin - VA	Levinsohn-Petrin - VA*
Capital	0.118	0.076	0.035	0.096	0.096
Labor	0.269	0.261	0.224	0.428	0.406
Material	0.617	0.609	0.788		

Note: * represents estimation using intermediate input material used and electricity used.
Source: Results from regressions

Appendix B: Preliminary analyses

Before investigating the LBE hypothesis, we conduct some preliminary analyses of the behaviour of exporting firms. These analyses can give more understanding about how exporting firms behave and may help us to interpret the main results better. First, we needed to ascertain that exporting firms are not similar to firms that serve only the domestic market. we conducted an analysis of the differences of exporting firms compared to non-exporting firms in various firm-level outcome performance, such as productivity, employment, wages and capital per worker. Second, we examined the hypothesis of self-selection into export. As explained in an earlier section, the high performance of exporting firms can be explained because it is only higher performance firms that are able to make profits in the more competitive international markets. This test is important in order to check for the reverse causality relation between exporting and productivity. Third, we investigated the export experience, the variable of interest that we used in the main model. In this analysis, we checked how export experience and export sales are related in order to facilitate the investigation of the learning channel.

To test if exporting firms are different from non-exporting firms, we follow a model by Bernard and Jensen (1999):

$$x_{ikrt} = \alpha + \beta EXP_{ikrt} + \delta Emp_{ikrt} + \sum_k \gamma_k Ind_k + \sum_r \vartheta_r Prov_r + \sum_t \tau_t Year_t + \varepsilon_{ikrt} \quad \text{(B1)}$$

where x_{ikrt} is a measure of performance of firm i in industry k and region r at period t; EXP is an export dummy equal to 1 when the firm is an exporting firm and 0 otherwise; and Emp_{ikrt} is the log of the number of employees of firm i. We control for industry k, province r, and year t effects. The interest lies in the coefficient β that defines whether the relevant firm performance is different for exporting firms compared to those that only serve the domestic market.

Next, to test the self-selection hypothesis we follow Alvarez and Lopez (2005) to examine factors affecting the probability of exporting:

$$\Pr(EXP_{ikrt} = 1 | EXP_{ikrt-1} = 0) = F(\beta' Z_{ikrt-1} + \tau_t + \kappa_k + \varepsilon_{ikrt}) \quad \text{(B2)}$$

where EXP_{ikrt} is a dummy variable equal to 1 if firm i in industry k and region r starts exporting at period t and 0 otherwise. Z_{ikrt-1} is a vector of firm characteristics at time $t-1$, including productivity as measured by total factor productivity (TFP), foreign ownership share (Sjöholm & Takii 2008), import share (Aristei, Castellani & Franco 2013), firm age, and capital; and τ_t and κ_k are the dummies for year and industry fixed effects. For comparison, we follow Yi & Wang (2012) who include the last year export status in the model to control for sunk cost.

Further, to test whether greater export experience associated with higher export revenue, we follow Timoshenko (2015):

$$ln\, X_{ikrt} = \alpha + \beta AGEX_{ikrt-1} + \gamma Z_{ikrt-1} + \vartheta Ind_{kt-1} + \zeta Prov_{rt-1} + \tau_t + \kappa_k + \varepsilon_{ikrt} \quad \text{(B3)}$$

where $\ln X_{ikrt}$ is the log of export sales of firm i in industry k and region r exported at period t; $AGEX_{ikrt-1}$ is the export age in period $t-1$; Z_{ikrt-1} is a vector of firm characteristics at time $t-1$, including foreign ownership share, import share, firm age; ϑInd_{kt-1} and $\zeta Prov_{rt-1}$ are measures of spillover effects (Clerides, Lach and Tybout (1998) at industry- and province level (respectively, they are the number of exporting firms in industry k at time $t-1$ and the number of exporting firms in the province r at time $t-1$) – the lag structure is adopted because the initial level of productivity before exporting might influence the performance after exporting; and τ_t and κ_k are year- and industry dummy, respectively. To account for the possibility of self-selection, we run a Heckman two-step selection model. The first step is basically the regression with equation (2) above. We then choose only the selected firms from this step to be included in the second step regression.

Table B1. Selection into export

	Export Starter$_{ikrt}$		Export Status$_{ikrt}$	
VARIABLES	probit	dy/dx	probit	dy/dx
Ln(TFP$_{i,t-1}$)	0.120***	0.0091***	0.115***	0.0122***
	(0.0067)	(0.0005)	(0.0059)	(0.0008)
FDI Share$_{i,t-1}$	0.0022***	0.0002***	0.004***	0.0004***
	(0.0003)	(2.23e-05)	(0.0003)	(0.0006)
Firm Age$_{i,t-1}$	-0.0064***	-0.0005***	-0.0073***	-0.0007***
	(0.0011)	(8.21e-05)	(0.0010)	(0.0001)
(Firm Age$_{i,t-1}$)^2	6.35e-05***	4.81e-06***	6.33e-05***	6.72e-06***
	(1.25e-05)	(9.49e-07)	(1.19e-05)	(1.26e-06)
Import Share$_{i,t-1}$	0.0020***	0.0002***	0.0026***	0.0003***
	(0.0003)	(2.27e-05)	(0.0003)	(3.07e-05)
Ln(Capital$_{i,t-1}$)	0.0773***	0.0059***	0.0774***	0.0082***
	(0.00445)	(0.0003)	(0.0038)	(0.0004)
Export Status$_{i,t-1}$			2.299***	0.244***
			(0.0146)	(0.0013)
Constant	-3.650***		-3.606***	
	(0.0595)		(0.0554)	
Industry fixed effects	Yes	Yes	Yes	Yes
Year Fixed effects	Yes	Yes	Yes	Yes
Observations	127,751	127,751	127,751	127,751

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table B2. Heckman selection model of the relation between export age and sales

VARIABLES	Ln (Export value$_{ikrt}$)	Export Status$_{ikrt}$	Mills ratio
Export Status$_{i,t-1}$		2.069***	
		(0.0236)	
Export Age$_{i,t-1}$	0.0792***		
	(0.0221)		
(Export Age$_{i,t-1}$)^2	-0.000460		
	(0.00251)		
FDI Share$_{i,t-1}$	0.00429***	0.00371***	
	(0.000384)	(0.000270)	
Ln(TFP$_{i,t-1}$)	0.698***	0.116***	
	(0.0109)	(0.00593)	
Firm Age$_{i,t-1}$	-0.000926	-0.0104***	
	(0.00218)	(0.00107)	
(Firm Age$_{i,t-1}$)^2	-2.49e-05	8.97e-05***	
	(2.50e-05)	(1.25e-05)	
Import Share$_{i,t-1}$	0.00399***	0.00251***	
	(0.000491)	(0.000289)	
Ln(Capital$_{i,t-1}$)	0.315***	0.0659***	
	(0.00658)	(0.00373)	
Number of exporters$_{k,t-1}$	0.000278***	0.000599***	
	(0.000104)	(6.30e-05)	
Number of exporters$_{r,t-1}$	-0.000225***	0.000857***	
	(8.18e-05)	(6.52e-05)	
Lambda			-0.117***
			(0.0349)
Constant	5.449***	-3.406***	
	(0.159)	(0.0550)	
Industry effects	Yes	Yes	
Year effects	Yes	Yes	
Observations	126,555	126,555	126,555

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1