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The Effects of Market Concentration, Trade, and FDI on Total Factor Productivity: Evidence from Indonesian Manufacturing Sector

(*Kesan Konsentrasi Pasaran, Perdagangan dan FDI terhadap Jumlah Produktiviti Faktor: Bukti dari Sektor Pembuatan Indonesia*)

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ABSTRACT

This study empirically examines the effects of exports, imports, market concentration, and foreign direct investment (FDI) on total factor productivity (TFP). We use a sample of 18,002 Indonesian manufacturing firms, categorized according to technology intensity of low, medium, and medium-high over 2010-2014. TFP and its sub-components, e.g., technical efficiency, technological progress, and scale effect, are estimated using a Malmquist Productivity Index (MPI). The estimation results indicate that market concentration, trade, and FDI positively impact technical efficiency and production scale, but reduce technological progress, which inhibits sectoral development. FDI inflows in Indonesia increase technical efficiency but negligibly enhance technological competencies and the scale of operation in recipient sectors. Increasing firm size is crucial in achieving greater productivity. An increase in market concentration has a negative effect on TFP. This negative impact increases as the share of exports, imports, and FDI in the sector intensifies. Investment and export promotion policies should be tailored based on the technology intensity (low, medium, and medium-high) as the effects of FDI and export participation differ across industries.

Keywords: Total factor productivity; market concentration; foreign direct investment; energy efficiency; decent work

ABSTRAK

Kajian ini memeriksa kesan eksport, import, konsentrasi pasaran, dan pelaburan langsung asing (FDI) terhadap jumlah faktor productiviti (TFP). Sebanyak 18,002 firma pembuatan dikategorikan berdasarkan intensiti rendah, sederhana dan sederhana-tinggi sepanjang tahun 2010-2014.TFP dan sub-komponennya seperti kecekapan teknikal, kemajuan teknologi, dan kesan skala dianggarkan menggunakan Indeks Produktiviti Malmquist (MPI). Hasil menunjukkan bahawa konsentrasi pasaran, perdangangan, dan FDI memberi kesan positif kepada kecekapan teknikal dan skala pengeluaran, tetapi mengurangkan kemajuan teknologi, yang memberi kesan kepada pertumbuhan sektor ini. Aliran masuk FDI di Indonesia meningkatkan kecekapan teknologi tetapi meningkatkan kompetensi teknologi dan skala operasi sektor ini dengan perlahan. Sementara itu, konsentrasi pasaran memiliki pengaruh negatif pada TFP. Kesan negatif ini meningkat karena eksport, impot, dan FDI dalam sektor meningkat. Polisi pelaburan dan promosi eksport perlu disesuaikan berdasarkan intensiti teknologi (rendah, sederhana dan sederhana-tinggi) kerana kesan FDI dan penyertaan FDI berbeza mengikut industri.

Kata kunci: Jumlah produktiviti faktor; konsentrasi pasaran; pelaburan langsung asing; kecekapan tenaga; kerja layak

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INTRODUCTION

Since the late 1990s, Indonesia has benefited from a boom in demand for commodities and from high global prices for raw materials that has steered the country to focus on its natural resource sectors. New policies have emerged to revitalize the manufacturing activities, as the manufacturing sector still provides 13% of employment, accounts for a quarter of the national output, and generates a third of total exports (Rahardja et al. 2012; Sugiharti et al. 2017). Changes in policies following the practice of picking up the winner have been common for the last two decades in Indonesia (Suyanto et al. 2021). The practice has not yet been effective in curbing the decreasing trend in the share of the manufacturing sector in the Growth Domestic Product (GDP).

In 2018, the government launched the "Making Indonesia 4.0" roadmap, which aimed at providing an integrated guideline for stakeholders in Indonesia in executing the Industry Revolution 4.0. The implementation of the roadmap will focus on five subsectors that have the largest share of outputs, exports, and employment. The five subsectors are 1) food and beverages, 2) textiles and garments, 3) automotive, 4) electronics, and 5) chemicals. The government later added two more sectors as priorities, which were pharmaceutical and medical devices. The challenge, however, was whether focusing on the seven priority subsectors will provide a boost for higher productivity growth and exports. Some studies (e.g. Esquivias & Harianto 2020) showed that neither technical efficiency nor total factor productivity (TFP) in these seven sectors is superior to the efficiency and productivity of other industries. Although electronics, machinery and textile sectors in Indonesia experienced TFP growth in 1990-2010 (Javorcik et al. 2012), the effectiveness of Indonesia's industrial and trade policy needs to be further evaluated.

Changes in terms of investment openness, business environment, and competition rules in Indonesia over the last two decades have established a new playing field for firms (Suyanto et al. 2021). In an environment of increasing global interconnectedness, exports, imports and foreign direct investment (FDI) are of much interest (Sugiharti et al. 2022). In 2019 Indonesia was engaged in more than 25 free trade agreements, ranked top 20 in terms of best investment destination, and actively participated in global value chains (Purwono et al. 2020). Indonesian exports expanded more than three times over the last two decades. On the other hand, Indonesia faces stronger foreign competition for labour-intensive activities, where formerly it was a champion, and now lags behind Asian neighbors in the higher technological sectors. Competitiveness is falling while wages and cost of energy are rapidly increasing (Sugiharti et al. 2019). Access to capital remains a key challenge (Javorcik et al. 2012; Sugiharti et al. 2022).

It is interesting to explore how the recent changes in business environment and competition in Indonesia can support higher productivity and export, driven by the seven priority subsectors in the Making Indonesia 4.0 roadmap. Previous studies have examined the links between exports and productivity (Khalifah 2022; Fu 2005; Kimura & Kiyota 2006; Sun & Hong 2011) and FDI and productivity (Huang & Zhang 2017; Javorcik et al. 2012; Kimura & Kiyota 2006; Orlic et al. 2018; Sari et al. 2016; Sun & Hong 2011; Xu et al. 2022). Other studies have examined links between exports and efficiency (Lemi & Wright 2020) and FDI and efficiency (Esquivias & Harianto 2020; Sari 2019; Setiawan & Lansink 2018). This study builds on past literature to empirically analyze the links between exports, imports and FDI in terms of efficiency and TFP in the context of Indonesia.

This study elucidated whether more export-import oriented firms and those with higher FDI inflows experience larger productivity gains via either, technical efficiency change (TEC) or technological progress (TP), or effect of scale. Common studies were conducted based on the Solow growth model which derives the output expansion of firms from gains in input growth and technological progress. Effects arising from technical efficiency and scale were assumed to be constant. This study relaxed the Solow assumptions, and conducted test on whether there was evidence of alternative sources of growth via technical efficiency and scale. External factors such as exposure to foreign markets, investment, exports, imports, or related activities (Huang & Zhang 2017; Orlic et al. 2018), could also influence firm performance. Access to a wider variety and quality of inputs could lead to higher efficiency and growth (Ben Yahmed & Dougherty 2017). In addition, access to global markets may allow companies to achieve higher productivity (Trachuk & Linder 2018).

The study first estimated technical efficiency and the three components of total factor productivity (technical efficiency change, technological progress and scale effects) for 18,000 manufacturing firms, from 2010 to 2014. Technical efficiency and the production function were estimated using Stochastic Frontier Analysis. The Malmquist Productivity Index (MPI) was subsequently applied to segregate the sources of productivity growth.

A panel data regression model (fixed and random effects) was then employed to explore whether firm size, foreign ownership, market concentration, export performance and import penetration were determinants in the growth of TFP in firms. The analysis on foreign corporations was expected to shed light on whether their presence in Indonesia produced positive impacts on the hosting sector (horizontal spillovers). The study also drew its assumptions from evidence that firm heterogeneity influences the way companies face market competition, and how they handle liberalization on trade-investment (Esquivias & Harianto 2020; Javorcik et al. 2012; Li & Lv 2021). Other evidence from imperfect markets such as China, (Fu 2005), that should also be considered, suggests that well-developed markets are necessary for firms to benefit from positive links ranging from exports or FDI, to their business efficiency and productivity. With regard to the adoption of technology at the centre of the Making Indonesia 4.0 roadmap, the study considered three groups of industrial firms according to technological intensity, namely, low technology, medium-technology, or medium-high technology firms. Overall, the study contributes to the literature by providing evidence on the extent to which liberalization of trade (via exports and imports), larger FDI and market competition influence the productivity performance of manufacturing firms in Indonesia.

The following sections proceed as follows. The second section presents a literature review on the nexus between exports and productivity-efficiency, the nexus of FDI-efficiency, and empirical studies on TFP in Indonesia. The third section covers data and methodology. The fourth section presents empirical results and findings. The last section concludes.

REVIEW OF LITERATURE

EXPORT LINKS WITH TECHNICAL EFFICIENCY AND PRODUCTIVITY

It is common to find that export-oriented enterprises experience higher levels of efficiency, although the channels via which exports support technical efficiency differ across firms (Ben Yahmed & Dougherty 2017; Sari et al. 2021). Two approaches were generally presented in the literature; namely self-selection and learning by exporting (Lemi & Wright 2020; Vu et al. 2016; Amornkitvikai et al. 2022). In an extensive survey of past studies, Wagner (2012) found robust evidence for the self-selection hypothesis, but only mixed evidence for learning by exporting. The self-selection approach suggests that most efficient firms self-select themselves to engage in exports (Xu et al. 2022; Helpman et al. 2004; Vu 2016). Firms targeting export markets have the drive to improve productivity by increasing investment, training, technological improvements, and make a better choice of inputs so as to be competitive in global markets. By contrast, learning by exporting supports the contention that firms improve efficiency through a learning process while engaged in exporting (Trachuk & Linder 2018).

Fu (2005) noted that export orientation in firms may contribute to higher productivity via three channels; namely by economies of scale, by improving firms' efficiency and by technology spillovers. The three channels are theoretically clear, but the empirical evidence is somewhat mixed. Fu (2005) argued that the three channels are proposed under assumptions of perfect market situations, where entry-exit is allowed, information is perfect, there are no market monopolies, and players behave rationally. Nevertheless, the imperfections commonly present in actual markets result in a non-efficient transmission mechanism.

Under imperfect markets, resource relocation may not be efficient effects of competition (Esquivias & Harianto 2020; Bournakis et al. 2022). It may also be limited since inefficient firms may remain in the market through intervention or informality, and public incentives may not work. These conditions are common in developing countries (Trachuk & Linder 2018). In the Indonesian case, a sub-optimal allocation of factors across firms is commonly found (Javorcik et al. 2012; Sari et al. 2016; Yasin & Esquivias 2023), leading to low productivity growth and gains only occurring in specific sectors (Setiawan & Lansink 2018; Abdul et al. 2022; Suyanto et al. 2012).

FOREIGN DIRECT INVESTMENT AND TECHNICAL EFFICIENCY

Firms' technical efficiency can also be influenced by FDI in the form of access to superior technology, advantages in the production process, and access to global networks (Vernon 1966). Efficiency gains can result from spillover effects (externalities) within the host country (Newman et al. 2015; Orlic et al. 2018; Sari 2019; Sari et al. 2021). Foreign ownership also positively affects firms' efficiency and productivity (Suyanto & Salim 2011), although some produced inconclusive results (Lemi & Wright 2020).

FDI could also provide direct and indirect benefits in the host country (Sari et al. 2016), with productivity gains transmitted in the form of intra-industry (horizontal) spillovers and inter-industry (vertical) spillovers. The former could be in the form of demonstration effects, labour mobility and competition (Newman et al. 2015). Inter-industry effects mainly occur in forward spillovers (downstream sectors) and backward spillovers (upstream sectors).

Past studies on Indonesian firms suggested that globally oriented enterprises and foreign-owned firms tend to experience higher productivity growth than domestic ones (Javorcik et al. 2012). Sari (2019) reported that foreign-owned firms experienced higher technical efficiency than domestic ones, and FDI supports efficiency gains for firms within the same sector (horizontal spillovers) and downstream players (forward spillovers). At the sectoral level, Suyanto et al. (2012) also found positive effects from FDI for technical efficiency and TFP components of the garment sector, while finding negative effects from FDI to TFP, TEC, and scale effects in the electronics industry. The presence of foreign firms induces higher efficiency levels in domestic players through the competitive effects that arise as local firms learn from and imitate foreign ones, and thus reduce their innovation costs (Esquivias & Harianto 2020; Sari et al. 2016).

On the other hand, Sari et al. (2016) found that foreign-owned firms were less efficient than local firms, although foreign firms showed higher productivity levels. Foreign-owned firms in Indonesia may also exert negative effects on domestic players' efficiency (e.g., on the pharmaceutical industry, in Suyanto & Salim 2011, or on high-tech industries in Sari et al. 2021), similar to the case in Vietnam (Newman et al. 2015). There is also a less clear link between FDI-supporting firms buying inputs in Indonesia and the performance of domestic exporting firms (Sari 2019; Sugiharti et al. 2017; Yasin 2021). Indonesian firms may not benefit from the presence of foreign-owned firms due to low technological absorptive capability, as spillover effects often depend on the firm's capacity to absorb technology (Orlic et al. 2018).

The evidence on how foreign players could generate higher efficiency and productivity has increased the interest of policymakers in supporting FDI inflows and global orientation. Policy to promote openness however could lead to static gains arising from a more efficient relocation of resources. More dynamic gains can ensue as greater exposure, either through investment or exports, allows firms to upgrade technological capabilities, improve skills, reach bigger markets, innovate and accumulate knowledge (Fu 2005; Lemi & Wright 2020).

TOTAL FACTOR PRODUCTIVITY IN INDONESIA

According to Sugiharti et al. (2017, 2019), manufacturing in Indonesia could possibly experience de-industrialization as TFP growth was decreasing over time. Manufacturing firms enjoy positive output growth through technical progress and increasing production factors (conventional growth sources). However, the sector faces negative growth in scale effects and technological efficiency (alternative sources). The disproportionate growth in the cost of inputs (labour and energy) and the low gains in productivity have cancelled out prospective gains in TFP.

More export-oriented firms and FDI inflows may help firms to increase TFP. Suyanto et al. (2012) found positive effects from FDI on TFP components in the garment sector. Setiawan and Lansink (2018) found similar results for Indonesia's food and beverage sector, with higher performance shown among globally exposed. Empirical studies at the industry level, which address exports and FDI effects on productivity, however remain rudimentary.

A major challenge experienced by manufacturing industries is that a large number of firms are labour-intensive but with falling productivity despite rise in wages (Javorcik et al. 2012; Sugiharti et al. 2019). In some key sectors, there is a large dependency on imported raw materials, thus raising the question of whether or not imports help sectors to be more competitive (Ing & Putra 2017). Manufacturing activities are also predominantly low technology, which most likely limits the benefits arising from FDI, exports and competition (Bournakis et al. 2022; Ben Yahmed & Dougherty 2017; Sari et al. 2016). The broad liberalization of markets drives more opportunities for exports, but simultaneously places substantial pressure on domestic firms due to competition with imported products. Government incentives under the Indonesia 4.0 strategy also risk favouring large and more competitive firms, leaving smaller and less globally oriented firms under high market pressure.

DATA AND METHODOLOGY

There are two well-known methods to measure efficiencies and productivity at the firm level; i.e., Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). The debate on selecting the proper approach remains inconclusive (Coelli et al. 2005; Panwar et la. 2022; Parman & Featherstone 2019). Stochastic production frontier has been applied with inefficiency function to capture the effect of competition, export, import, FDI and other exogenous variables. The stream of approaches employing SFA can be separated into two groups; the two-stage approach and the one-stage approach (Coelli et al. 2005). This study applies the one-stage approach for two reasons. Firstly, there is a tendency for correlation between technical efficiency and production inputs, leading to inconsistent estimates of the production frontier. Secondly, the Ordinary least squares (OLS) application in the two-stage approach, technical efficiency distribution is assumed to be one-sided thus increasing potential bias (Lema et al. 2022). Being aware of these limitations, we adopt the one-stage SFA proposed by Battese and Coelli (1995) expressed as:

$$y_{it} = f(x_{it}; \alpha, \beta). exp\{v_{it} - u_{it}\} \quad [1]$$

y_{it} stands for output of firm i at time t; x_{it} is a corresponding $(1 \times k)$ vector of inputs used by firm i at time t; α and β are $(k \times 1)$ unknown parameters to be estimated; v_{it} and u_{it} are random errors and technical inefficiency effects respectively, and independent of each other. The v_{it} denotes a time-specific and stochastic component, with $iid\ N\ (0, \sigma_v^2)$. u_{it} is the technical inefficiency, which follows a normal distribution but is truncated at zero with mean $z_{it}\delta$ and variance σ_u^2. Technical inefficiency is written as:

$$u_{it} = Z_{it}\delta + \varepsilon_{it} \quad [2]$$

where u_{it} (technical inefficiency) is a function of Z that denotes a vector $(1 \times m)$ of observable non-stochastic explanatory variables. δ is a set of unknown parameters to be estimated, and ε_{it} is an unobservable random variable, defined by the truncation of the normal distribution with zero mean and variance (σ_u^2), truncated below zero $(-Z_{it}\delta)$. This assumption implies that $\varepsilon_{it} \geq -Z_{it}\delta$.

We apply the maximum-likelihood method for simultaneously estimating the parameters of the stochastic frontier and technical inefficiency effects in Equations (1) and (2), following Battese and Coelli (1995). The maximum-likelihood function can be expressed in terms $of\ \sigma_s^2 \equiv \sigma_v^2 + \sigma_u^2$ and $\equiv \sigma^2/\sigma_s^2$, where γ takes a value between 0 and 1. If γ equals zero, the model reduces to a conventional production function, involving z variables in the production function. However, a frontier model is appropriate if the γ is closer to unity.

Besides the distinct advantage of SFA in measuring efficiency in the presence of statistical noise, this parametric method requires a specific and flexible functional form to reduce the risk of error in the model. This study employs a flexible translog (transcendental logarithmic) for the production function in Equation (1). The translog model is more flexible and imposes fewer restrictions on the structure of production than in other models. The translog function is tested against four sub-models, such as Hicks-Neutral technological progress, no-technology progress, Cobb-Douglass, and no-inefficiency production functions as in Suyanto et al. (2009). The functional form of the translog production function is as follows:

$$y_{it} = \alpha_0 + \sum_{k=1}^{K} \beta_k x_{kit} + \frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{L} \beta_{kl} x_{kit} x_{lit} + \sum_{k=1}^{K} \beta_{kt} x_{kit} t + \beta_t t + \frac{1}{2}\beta_{tt} t^2 + v_{it} - u_{it} \qquad [3]$$

where α_0 is the intercept, y and x are output and inputs and all express deviation from their geometric means, as in Sari et al. (2016). The translog functional form is determined by input variables, including those for capital, labour, material, and energy $(K = 4)$. The subscript i is firm, and t represents time. u_{it} is defined as:

$$u_{it} = \delta_0 + \sum_{j=1}^{J} \delta_j Z_{jit} + \varepsilon_{it} \qquad [4]$$

δ_0 is the intercept in the inefficiency function, Z represents a vector of explanatory variables explaining technical inefficiency, and ε_{it} is a random variable. Technical inefficiency is estimated as a function of firm/sector characteristics (Table 1). We estimated Equations (3) and (4) simultaneously.

A generalized log-likelihood ratio test was employed, formulated as follows:

$$\lambda = -2[l(H_0) - l(H_1)] \qquad [5]$$

where $l(H_0)$ denotes the log-likelihood value of the sub-various production functions, and $l(H_1)$ stands for the log-likelihood value of the translog model expressed in Equation (3).

The coefficients of the translog stochastic production frontier have no direct economic connection with output. The output elasticity for each input can be expressed as follows:

$$\varepsilon_{nit} = \frac{\partial y_{it}}{\partial xnt} = \beta_n + \frac{1}{2}\sum_{n=1}^{4}\sum_{n=1}^{4} \beta_{nm} xm_{it} + \beta_{nt} t \qquad [6]$$

The translog functional form and its subsequent Malmquist Productivity Index (MPI) are applied to segregate productivity growth sources in the Indonesian firms, namely technical efficiency change (TEC), technological progress (TP), and scale efficiency change (SEC).

Given Equations (3) and (4), the conditional expectation of technical efficiency (TE) for the i-th firm at t-th year can be written as:

$$\begin{aligned} TE_{it} &= \frac{y_{it}}{\check{y}_{it}} = E[(v_{it} - u_{it})] \\ &= E[(-z_{it}\delta - w_{it})|(v_{it} - u_{it})] \end{aligned} \qquad [7]$$

In Eq (7), TE_{it} is defined as the actual output ratio (y_{it}) with potential output $(\check{y}_{it})$. If the TE value equals one, the firm is technically competent. In contrast, inefficient firms have TE values below one. We follow Coelli et al. (2005) in estimating TEC between period $t + 1$ and t expressed as:

$$TEC_{it,t-1} = ln\ ln\ TE_{it+1} - ln\ TE_{it} \quad [8]$$

SEC is obtained by calculating production elasticity for each input from Eq (6), written as follows:

$$SF_{it} = (\varepsilon_{Tit} - 1)/\varepsilon_{Tit} \quad [9]$$

Where ε_{Tit} denotes a return to scale elasticity at i-th firm and t-th year. Given the Eqs (6) and (9), the index of scale efficiency change can then be calculated as follows:

$$SEC_{it,t-1} = \frac{1}{2}\sum_{n=1}^{N}[SF_{it}\varepsilon_{nit} + SF_{it-1}\varepsilon_{nit-1}](xn_{it} - xn_{it-1}) \quad [10]$$

TP is calculated based on the coefficient of time, time squared, and the interactions of time with the inputs from the estimated parameters in Eq (3). Following Kumbhakar and Lovell (2003), TP is expressed as:

$$TP_{it} = \frac{\partial y_{it}}{\partial t} = \beta_t + \beta_{tt}t + \beta_{nt}xn_{it} \quad [11]$$

Then, $TP_{it,t-1}$ can be expressed as:

$$TP_{it,t-1} = \frac{1}{2}\left[\frac{\partial y_{it-1}}{\partial t} + \frac{\partial y_{it}}{\partial t}\right] \quad [12]$$

Following Orea (2002), TFP growth is decomposed into three elements; TEC, SEC, and TP, written as:

$$TFP_{it,t-1} = TEC_{it,t-1} + SEC_{it,t-1} + TP_{it,t-1} \quad [13]$$

The sub-elements of total factor productivity from Equations (8), (10) and (12) are used as the dependent variables in the analysis of determinants. The empirical model can be expressed as:

$$MPI = \alpha_0 + A_{it}\delta + \varepsilon_{it} \quad [14]$$

where MPI is the measure of productivity growth, $MPI =$ (TFP, TP, SC, TEC). The subscripts i and t respectively, denote firms and time. A captures other factors affecting productivity growth (Table 1). Both $\alpha\ and\ \beta$ are parameters to be estimated, while ε denotes the error term. We regress Equation (14) using random effect, fixed effects, generalized least squares (GLS), and least squares dummy variables (LSDV). We further conduct the Hausman-test to choose the most suitable model between random effect (or GLS) and fixed effect (or LSDV) models. In Table 1, we have presented the description of the variables

TABLE 1. Description of the variables

Name and symbol of the variables	Measurement of variables	
Firm Size (FSize)	Share of output of firm i-th to total sub-sector (ratio) j-th	
Concentration (HHI)	Sub-sectoral concentration - Herfindahl-Hirschman Index (HHI). Share of output of a firm i-th to the total sub sectoral j-th output (s) per year t (ratio)	$HHI_{jt} = \sum_{i\in j} s^2ijt$
Foreign ownership (FDI)	Binary variable taking the value of 1 as Foreign Status if a firm is at least 10% owned by foreigners; zero otherwise	
Horizontal Spillovers (Hspilljt)	Ratio of output of foreign-owned firms (FShareit) to total sub-sectoral j-th output at year t (ratio)	$Hspill_{jt} = \frac{\sum_{i\in j} FShare_{it} * Y_{it}}{\sum_{i\in j} Y_{it}}$
Export Performance (EP)	The fraction of value of exports (Xjt) to the total value of output per industry j-th (yearly variable)	$EP_{jt} = \frac{X_{jt}}{Y_{jt}}$
Import penetration (IP)	Ratio of imports (Mjt) to total output (Yjt) and balance between imports (Mjt) and exports (Xjt)	$IP_{jt} = \frac{M_{jt}}{(Y_{jt} + M_{jt} - X_{jt})}$

DATA

Data for this study were sourced from the annual survey of Indonesian medium and large manufacturing establishments obtained from Statistics Indonesia (Badan Pusat Statistik, or BPS 2014 onwards). The survey provided information regarding firm characteristics, ownership structure, production (gross output, number of workers, raw materials, fixed capital and energy consumption) and trade, including the share of exports and value of material imported. Establishments employing 20 to 99 workers were categorized as medium-size, and those employing more than 100 workers, as large ones. The wholesale price index (WPI) published by BPS was used to deflate output and input values into the constant price of 2010.

The samples covered a balanced panel dataset of 18,002 manufacturing firms operating from 2010 to 2014. We commenced by using the 2010 dataset as the BPS reclassified the manufacturing sectors with the new version of International Standard Industrial Classification Revision 4 (ISIC) in that year. Manufacturing firms were classified by technological intensity using ISIC Rev. 4, defined by the UNIDO (2016) into three groups: Low-Technology (LT), Medium-technology (MT), and Medium-high and High-technology (MHT). The highest number of observations was reported for LT (62,045 observations), and the lowest reported for MHT (10,840 observations).

EMPIRICAL RESULTS AND FINDINGS

We first provided estimates of Output Elasticity and Input growth effects for three groups of firms namely LT, MT and MHT as mentioned earlier. Table 1 presents the elasticity of output to each of the four inputs employed in the production function. The largest output elasticity was related to materials ε_m for all four groups, with an average of 0.45. As expected, the elasticity of output with respect to labour (ε_l) was larger for LT than for MT and MHT groups. On the contrary, MT and MHT firms have larger elasticity with respect to energy (ε_e), relying to a larger extent on intensive energy use in contrast to LT. Surprisingly the elasticity of output to capital (ε_k) was similar across the tech groups.

The input growth effects indicated that capital experienced the largest contribution to growth, with low technology firms increasing capital inputs to a greater extent than the other groups. Substitution of labour inputs to capital in low tech firms was ongoing. Surprisingly, the contribution of labour inputs to total output was the smallest of the four input factors, signaling a possible shift in Indonesia's competitiveness, previously supported by an abundant labour pool. Sugiharti et al. (2017) pointed out the rapid growth in labour cost triggered the substitution of labour inputs for capital and energy. While labour input growth effect was smaller in low tech sectors, the effect was however greater in MT and MHT groups, indicating a larger expansion in labour productivity and employment in high technology sectors. As a consequence, the demand for energy inputs was increased thus requiring consideration from policymakers.

In Table 2, the components of total factor productivity growth are presented. All groups recorded negative TFP growth in the 2011-2014 period. Technical efficiency changes and scale effects are mainly positive, supporting the expansion of TFP. Nevertheless, technological progress is decreasing, thus reducing TFP growth rate for manufacturing. Following the measurement of output elasticities, input growth, and the different components of TFP, we proceeded with analyzing its determinants and sub-components. We estimated Equation (14) through employing fixed effects, random effects, GLS and LSDV. According to the Hausman specification test, fixed effects are preferred for all estimations. Due to space limitations however we only present fixed effects results. The full results are available on request.

TABLE 2. Output elasticity and input growth effects

Technology Classifications	Output Elasticity				
	ε_k	ε_l	ε_m	ε_e	ε_{Total}
Aggregates	0.2174	0.1581	0.4520	0.2112	1.0386
LT	0.2144	0.1733	0.4583	0.1997	1.0458
MT	0.2191	0.1449	0.4523	0.2051	1.0214
MHT	0.2146	0.1081	0.4295	0.2569	1.0091
	Input Growth Effects				
	$S_K\dot{K}$	$S_L\dot{L}$	$S_M\dot{M}$	$S_E\dot{E}$	$\dot{\phi}$
Aggregates	0.3953	0.0010	0.3770	0.0254	0.7986
LT	0.4112	0.0003	0.3893	0.0195	0.8203
MT	0.4050	0.0025	0.4035	0.0266	0.8375
MHT	0.3428	0.0028	0.3387	0.0285	0.7127

Source: Data obtained from Statistics Indonesia (BPS, 2014) and processed by the authors
Note: Low-technology firms (LT). Medium-technology (MT). High and Medium-high technology (MHT).

TABLE 3. TFP growth decomposition

Year		2011	2012	2013	2014	2011-2014
LT	TEC	0.009	-0.001	0.002	0.001	0.003
	SEC	0.013	0.003	-0.002	0.018	0.008
	TP	-0.049	-0.114	-0.072	-0.189	-0.106
	TFPg	-0.028	-0.112	-0.072	-0.170	-0.096
MT	TEC	0.006	-0.001	0.008	-0.007	0.001
	SEC	0.013	-0.001	0.001	0.009	0.005
	TP	-0.034	-0.104	-0.076	-0.194	-0.102
	TFPg	-0.014	-0.106	-0.068	-0.192	-0.095
MHT	TEC	0.003	-0.003	0.006	-0.006	0.000
	SEC	-0.002	0.002	0.000	0.000	0.000
	TP	-0.032	-0.114	-0.088	-0.217	-0.113
	TFPg	-0.031	-0.115	-0.082	-0.223	-0.113
Full Sample	TEC	0.009	-0.002	0.002	-0.002	0.002
	SEC	0.010	0.004	-0.001	0.015	0.007
	TP	-0.040	-0.111	-0.078	-0.199	-0.107
	TFPg	-0.021	-0.109	-0.077	-0.185	-0.098

Source: Data sourced from Statistics Indonesia (BPS, 2014) and processed by the authors
Note: Arithmetic average of annual change rate in percentage. Technical Efficiency Change (TEC), Scale Effects (SEC), Technological progress (TP), Total Factor Productivity (TFP). Low Technology intensity (LT), Medium Tech (T), and Medium High Tech (MHT).

TABLE 4. Descriptive statistics indicators

	ISIC	FDI Shares	% of Foreign Firms	HHI	H Spill	Export	Import
	MHT	22.234	25%	0.128	0.326	17%	23%
20	Chemicals	16.77	20%	0.119	0.255	15%	19%
21	Pharmaceutical	10.55	12%	0.082	0.148	7%	21%
26	Computer, electronic, optical	49.425	53%	0.138	0.598	34%	36%
27	Electrical	23.919	27%	0.172	0.363	18%	26%
28	Machinery	24.389	27%	0.231	0.365	16%	19%
29	Motor vehicles, trailers	20.138	23%	0.05	0.328	15%	22%
30	Other transport	17.128	18%	0.096	0.315	17%	23%
	MT	8.078	9%	0.096	0.177	20%	16%
22	Rubber and plastics	8.773	10%	0.056	0.175	23%	16%
24	Basic metals	20.605	26%	0.164	0.242	25%	27%
32	Other manufacturing	13.374	15%	0.157	0.396	47%	37%
	LT	5.888	7%	0.069	0.156	26%	13%
10	Food products	3.438	4%	0.078	0.078	17%	4%
11	Beverages	7.342	9%	0.082	0.269	3%	6%
12	Tobacco	0.765	1%	0.062	0.089	17%	10%
13	Textiles	5.092	6%	0.072	0.111	19%	13%
14	Apparel	8.852	9%	0.028	0.34	50%	36%
15	Leather	9.11	10%	0.086	0.285	26%	16%
16	Wood and cork	6.554	7%	0.097	0.149	53%	12%
17	Paper	7.698	9%	0.086	0.109	8%	11%
18	Printing, recorded	2.118	2%	0.056	0.046	4%	6%
19	Coke petroleum prO	13.803	18%	0.202	0.185	16%	10%
25	Fabricated metal	12.055	14%	0.116	0.29	13%	19%
31	Furniture	7.527	8%	0.026	0.141	47%	11%
	Total	8.273	9%	0.081	0.18	24%	15%

Source: Data sourced from Statistics Indonesia (BPS, 2014) and processed by the authors
Note. Total MHT Firms 2,168, total observations 10,840. MT Firms 3,425, observations 17,125. LT Firms 12,409, observations 62,045.

DOES FIRM SIZE CONTRIBUTE TO TFP AND TE?

The results indicate that size of firm contributes to productivity growth (TFP), with larger effects on TFP from low and medium technology firms. Firm size is significant but has a lower impact on medium-high and high technology enterprises. Firm size positively affects TFP via technical efficiency change (TEC), while no evidence is found on firm size contributing to technological progress (TP), in line with Yasin et al. (2021). Firm size supports scale effects (SEC) and technical efficiency in low tech firms, suggesting that low tech firms may exploit new sources of productivity by increasing size. For medium and medium-high tech, size is mostly relevant for achieving higher technical efficiency levels, while it has a negative effect on scale effects.

TABLE 5. Determinants of TFP and sub-components

	TFPg			TEC		
	MHT	MT	LT	MHT	MT	LT
$Constant$	-0.147***	-0.092***	-0.175***	0.003	-0.028***	-0.028***
$FSize$	0.313***	0.417***	0.345***	0.404***	0.443***	0.254***

HHI	-0.302***	-0.359***	-0.189***	-0.297***	-0.052***	-0.157***
$Foreign$	0.037***	-0.011	0.021***	0.042***	0.034***	0.037***
$HSpill$	0.166***	-0.058***	0.168***	-0.027**	0.041***	0.266***
EP	-0.069**	0.181***	0.069***	0.055***	0.144***	-0.044***
IP	0.079*	-0.114***	0.375***	0.046**	-0.083***	0.063***
$HHI \times Hspill$	-0.384***	0.215***	-0.172***	-0.093***	-0.064**	-0.385***
$HHI \times EP$	0.284***	-0.288***	-0.065**	0.031	-0.169***	0.101***
$HHI \times IP$	-0.134	0.981***	-0.495***	-0.108**	0.172***	-0.099***
R–Squared	0.003	0.009	0.003	0.063	0.020	0.043
Obs	8,672	13,700	49,636	8,672	13,700	49,636

		SEC			TP	
	MHT	MT	LT	MHT	MT	LT
$Constant$	-0.001	0.007***	0.023***	-0.148***	-0.071***	-0.170***
$FSize$	-0.100***	-0.035***	0.111***	0.008	0.008	-0.020
HHI	0.023**	0.008	-0.081***	-0.029	-0.315***	0.049***
$Foreign$	-0.001	-0.003	0,000	-0.003	-0.042***	-0.016***
$HSpill$	0.017**	-0.030***	-0.003	0.176***	-0.069***	-0.094***
EP	0.022**	0.014**	-0.041***	-0.147***	0.022	0.155***
IP	-0.019	-0.000	-0.016*	0.054	-0.030	0.327***
$HHI \times Hspill$	-0.067***	0.051***	0.020	-0.223***	0.228***	0.192***
$HHI \times EP$	-0.032	-0.021	0.054***	0.285***	-0.097	-0.221***
$HHI \times IP$	0.053*	0.020	0.013***	-0.080	0.788	-0.409***
R–Squared	0.012	0.004	0.000	0.000	0.012	0.006
Obs	8,672	13,700	49,636	8,672	13,700	49,636

Source: Data sourced from Statistics Indonesia (BPS, 2014) and processed by the authors
Note. Technical Efficiency Change (TEC), Scale Effects (SEC), Technological progress (TP), Total Factor Productivity (TFP). Low Tech intensity (LT), Medium Tech (T), and Medium High Tech (MHT). * p<.1 ** p<.05 *** p<.001

TABLE 6. Determinants of TFP and sub-components (all sample)

	TFPg	TEC	SEC	TP
$Constant$	-0.152***	-0.036***	0.013***	-0.129***
$FSize$	0.398***	0.366***	0.036***	-0.005
HHI	-0.231***	-0.098***	-0.035***	-0.096***
$Foreign$	0.027***	0.049***	-0.001	-0.021***
$HSpill$	0.102***	0.195***	0.008**	-0.101***
EP	0.024***	-0.019***	-0.019***	0.062***
IP	0.285***	0.057***	-0.013**	0.241***
$HHI \times Hspill$	-0.027	-0.277***	-0.008	0.259***
$HHI \times EP$	-0.077***	-0.055***	0.018	-0.039*
$HHI \times IP$	-0.212***	-0.039***	0.015	-0.188***
R–Squared	0.008	0.033	0.000	0.003
Observations	72,008	72,008	72,008	72,008

Source: Data sourced from Statistics Indonesia (BPS, 2014) and processed by the authors
Note. Technical Efficiency Change (TEC), Scale Effects (SEC), Technological progress (TP), Total Factor Productivity (TFP). * p<.1 ** p<.05 *** p<.001

These findings are consistent with Jovanovic's (1982) theory of noisy selection and indicate that bigger firms experience larger efficiency than smaller ones. Recent evidence by the World Bank supports the key function of firm size in achieving higher efficiency, productivity, and survival rate (Ciani et al. 2020), in line with these findings.

LINKS BETWEEN COMPETITION AND PRODUCTIVITY

The estimate for market concentration (HHI) on TFP is negative and significant for aggregated and all disaggregated samples. Theoretical models generally predict that lower market concentration leads to higher productivity (Aghion et al. 2005). Kato (2009) noted that raising levels of market competition compels firms to be more productive. The negative effect of market concentration on TFP is relatively large for MHT and MT firms. While it is significant it produces lower impact on LT firms. Larger market concentration is found more generally in sectors within MHT and MT than in LT. Sectors such as chemicals, computers, electrical, machinery and metals have larger HHI values than sectors within LT (Table 3). For firms within MHT, high market concentration harms technical efficiency, but has a positive contribution to scale effects. For MT firms, competition policies are highly relevant as an increase in market concentration may lead to greater market power rather than to higher firm performance, in line with the quiet-life hypothesis (QLH).

On the other hand, a higher level of market concentration positively impacts the technological progress of

LT firms. However the results do not connote that less competitive structures are beneficial for technological progress. Moreover, firms within LT sectors may need to hold a minimal market share (size) to be able to push the technological frontier. Surprisingly, higher market concentration levels are associated with lower technological progress in MT firms, thus proposing that low competition in markets may lead firms to experience technological regress. MT firms may have little incentive to engage in R&D to fuel TP, where leading players hold a substantial share of the market. Our results corroborate findings by Aghion et al. (2005), in maintaining that competition has a greater impact on industries where firms are technologically similar than on industries where competitive technological capabilities are uneven. MT sectors are more diverse in technological intensity, while LT firms are more homogeneous in technological know-how, ability, and knowledge.

THE IMPACT OF FOREIGN DIRECT INVESTMENT ON TOTAL FACTOR PRODUCTIVITY

The results on foreign ownership signal a positive effect on TFP except for MT firms. FDI mainly supports TFP via technical efficiency change, in line with previous studies in Indonesia (Esquivias & Harianto 2020; Sari 2019; Suyanto & Salim 2011). Nevertheless, FDI has negative effects on technological progress for MT and LT firms, suggesting that FDI may not have the intended effects of raising technological competencies in the recipient firms within those sectors. FDI inflows do not have a significant impact on scale effects in any of the groups.

FDI plays a more substantial role in capital investment within MT and MHT activities. More than 20% of investment in these firms is foreign-owned in sectors such as computer, electronic, optical, electrical, machinery, metals and transportation industries. The investment size is nearly three times more than the average share of FDI in LT firms (Table 3).

Horizontal spillover captures the impact of FDI within firms in the recipient sector in the form of externalities (Orlic et al. 2018). The results are mixed across groups. For MHT sectors, the presence of FDI has negative spillovers on technical efficiency. Nevertheless, horizontal spillovers positively impact scale and technological progress for firms within MHT. By contrast, horizontal spillovers can help firms increase technical efficiency in LT and MT groups, although the impact on TP and scale becomes negative. Policy towards FDI cannot follow a "one size fits all" model, since the externalities are substantially diverse.

Foreign firms' presence may not generate positive externalities on technological progress for LT firms within the recipient sector. Winkler and Farole (2012) postulated that insufficient R&D expenditure and limited human capital availability may explain why domestic firms may not fully capture technological benefits. LT firms might be focused on producing at the lowest possible cost with available factors (mainly labour), neglecting the importance of updating technology. Increasing domestic firms' absorptive capacity may help accelerate the technological catch-up channeled via FDI spillovers, in line with findings from Thailand (Amornkitvikai et al. 2022).

Although some sectors experienced positive spillover effects from FDI, market concentration effect exceeds the benefits of horizontal spillovers ($HHI\ x\ Hspill$), in line with Sun and Hong (2011). For low-tech and medium-high tech, the foreign entrance to the market can disrupt competitive sectors. Similarly, FDI inflows in sectors with large market concentration could lead to higher market power in line with Esquivias and Harianto (2020). For instance, investment policies should consider the market structure before launching new policies that could result in higher market concentration.

On MHT and LT firms, the foreign presence could lead to market stealing effects due to crowding-out effect on domestic firms, in line with previous findings (Li & Luo 2019). Sarmento and Forte (2019) suggested that foreign-owned firms may have a lower probability of exiting the market than domestic firms, thus probably leading to the transfer of domestic market shares to foreign owned firms. Foreign firms with advanced technology benefit by entering sectors facing low productivity, high inefficiency, and low concentration (Orlic et al. 2018). Foreign firms can increase their market power by edging out less productive domestic firms from the market.

Contrary to all the above probabilities, FDI inflows help domestic firms to increase efficiency, with larger effects on firms within sectors facing low market concentration, in line with Sari (2019) and Setiawan and Lansink (2018). Our results confirm the argument that the presence of foreign establishments in a competitive market may induce more technological transfers to their subsidiaries, thus increasing potential knowledge spillover (Sun & Hong 2011; Suyanto & Salim 2011). As such, our contention suggests that the presence of the efficient structure hypothesis (ESH) within MHT and LT sectors in Indonesia, as foreign investment, should lead to a higher competitive spirit in a sector where market concentration is low.

The MT firms signal a positive and significant coefficient of $HHIxHspill$ on TFP, scale and technological progress. Within MT, firms with larger market share may benefit more from foreign knowledge, techniques, and other forms of externalities as they have greater absorption capability. Only TEC has a negative and significant relation with $HHIxHspill$, suggesting that foreign-owned firms are more productive, creating larger spillovers via productivity channels, but face lower efficiency.

ROLE OF TRADE ON TOTAL FACTOR PRODUCTIVITY

We incorporated export performance (EP) and import penetration (IP) as proxies for trade openness and global competition. The results are mainly significant, although mixed across groups of firms. Companies operating within lower technology parameters benefit from participating in the export market, proving to be more productive (TFP and TP) than those fully oriented towards domestic markets, in line with past findings (Kimura & Kiyota 2006; Sun & Hong 2011). For LT firms, exporting activities lead to positive technological progress. The collabouration between exporting firms and foreign partners often results in innovation improvements. LT firms gain greater TP via importing activities rather than via exporting ones, signaling that foreign sourcing is the correct channel for improving firms' technological capability.

Export firms within MT and MHT have larger TEC and scale effects than those of domestic firms. TEC and scale are non-conventional sources of productivity growth, indicating similar effects to China's case (Liu & Li 2012). Export activities contribute to productivity growth by encouraging local firms to allocate resources more efficiently, adopting new practices, incorporating higher knowledge, and implementing new technologies to improve efficiency and productivity (Vu 2016).

A unique case in the link between export and firm performance was observed within MHT firms, as export performance has a negative relationship with technological progress. A possible reason for this is that as MHT firms naturally employ higher technology but their exporting activities do not further improve technological capabilities in the way it does for LT sectors. MHT firms in Indonesia have larger foreign shares of ownership, higher import content, and have lower export intensity than firms in its MT and LT sectors (Table 3). As such, the link between exports and MHT firms resembles the theoretical prediction of Helpman et al. (2004) who observed that firms with the highest productivity level engage in FDI, but not necessarily so for their export activities.

Import penetration (IP), a channel proxying foreign competition, is positively related to LT and MHT firms' productivity. LT firms receive a bigger impact on productivity growth from imports than HT ones. For LT firms, import competition may spur productivity through efficiency improvement via TEC channel and TP. As argued by Holmes and Schmitz Jr (2010), higher imports increase competition in the domestic market, inducing domestic firms to operate efficiently in order to survive. Ing and Putra (2017) found that lower import tariffs and higher access to foreign inputs allow labour productivity gains and product variety, similar to the findings of Amiti and Konings (2007).

On the other hand, the low effect of imports (IP) on efficiency in MHT firms may arise as these firms attract larger shares in foreign inputs compared to other sectors (Table 3), thus causing a possible "productivity convergence effect" (Kimura & Kiyota 2006). Large fragmentation in production characterizes MHT firms, which are often dependent on foreign inputs (e.g., computers, electronics, machinery, and transportation). As for MT firms that also employ large amounts of imported goods, the IP's coefficient negatively impacts TFP via technical efficiency. An unfavorable outcome of imports on scale effects is found in LT sectors. In contrast, no significant correlation was found for MT and MHT firms, suggesting that access to foreign inputs can barely support scale effects. Doan et al. (2015) pointed out that exposure to the global market via imports may reduce production and lose scale efficiency.

The interacting variables between trade (*EP* or *IP*) and market concentration (*HHI*) suggest that firms operating in a less competitive environment that are highly exposed to global trade, experience lower efficiency. Nevertheless, the coefficient of $HHI\ X\ EP$ is positively correlated with TFP for MHT and TEC for LT firms. Firms with higher market share experience larger efficiency gains through exporting. Similarly, firms operating in MT industries with larger market share and access to foreign inputs have larger efficiency levels than their smaller counterparts. As such, the positive role of market concentration and global orientation in the firm's performance supports the self-selection argument where the most efficient (and larger) players are those that are also competitive in exporting (Vu et al. 2016).

For LT firms, the interaction between trade variables (export and import) and market concentration (*HHI*) positively influences scale effects but has a negative influence on TP. At high levels of market concentration, LT firms benefit from scale, although as concentration rises, the benefits from access to global markets on rising TP may vanish. Low-tech exporting sectors in Indonesia mainly compete in mass production and labour-intensive products, probably explaining the positive relation in scale (labour) as noted in Javorcik et al. (2012). As for MHT firms, holding a large market share and being export oriented positively relates to TFP, mainly through technological progress. Conversely, MT firms have a positive impact on the interaction between HHI and imports on TFP as well as on TEC and TP. Sectors like basic metal and other manufacturing activities (MT) are highly dependent on imports, indicating that access to foreign inputs is highly relevant for productivity in MT firms.

CONCLUSION AND FINDINGS

This study examined the impacts of exports, imports, market concentration, and FDI on total factor productivity in the manufacturing sector in Indonesia. Manufacturing firms in the country are categorized according to LT, MT, and MHT intensity. TFP and its sub-components (TEC, TP, and scale effects) were estimated using the MPI, from 2010 to 2014.

The major finding of these studies is that firm size is crucial for all groups of firms in achieving greater productivity. Market concentration (proxied by HHI) has a negative effect on productivity (TFP), and could cancel out firms' positive impacts from FDI, export competitiveness, and access to imports. LT sectors necessitate larger firm size and market share to improve technological progress, as FDI and exports mainly support efficiency improvements and scale. MT and MHT firms' larger market concentration leads to lower scale and low technological progress. FDI mainly supports higher levels of technical efficiency change. The findings support Helpman et al's (2004) theoretical proposal that most productive firms are more likely to expand abroad, while the less productive ones remain in the local market. As the Indonesia 4.0 Strategic Plan focuses on firms upgrading their technological capabilities, being foreign oriented, and being globally competitive, the smaller firms, by comparison are locally oriented, and poorly integrated with foreign investment, may thus contribute little to the ambitious industrial program of the plan.

Textiles, apparel, leather, food, and beverages (all LT) were chosen as among priority sectors under the Indonesia 4.0 strategic plan. Technical efficiency within LT sectors could benefit from larger FDI and Horizontal spillover effects. As LT firms face low market concentration levels, there may be some positive effects from FDI on technological progress. Nevertheless, since foreign-owned and larger firms are more efficient, the foreign presence could lead to a market stealing phenomenon by a crowding-out effect on domestic firms. Export-oriented firms and players well integrated with foreign sourcing could improve TFP via technological progress. Nevertheless, foreign investment does not appear to serve as a channel for technological improvements, nor for improvements in scale effects within the LT sectors.

Contrary to the above, however, champion sectors within the MHT (chemicals, pharmaceutical, computer, electrical, transportation) could benefit from larger FDI inflows. Similarly, a larger foreign presence supports higher scale effects and technological progress within those sectors via horizontal spillovers (externalities). Two important challenges for policymakers within the MHT sectors are the need to promote higher competition as concentration is high, and to lower import dependency. Large concentration (HHI) leads to lower TEC and TP, while large import dependency improves TEC but has no significant effect on technological progress or scale. Within MT sectors, rubber, plastics, basic metals, and other manufacturing industries are important contributors to exports. The best performance is found among larger firms that are export-oriented, and recipients of FDI. MT firms could increase non-conventional sources of growth (technical efficiency and scale effects) by supporting firm size, export orientation and increased investment. A downside to MT firms is the sizeable negative role that high market concentration plays in inefficiency (TEC) and technological progress (TP).

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REFERENCES

Abdul, I., Wulan Sari, D., Haryanto, T. & Win, T. 2022. Analysis of factors affecting the technical inefficiency on Indonesian palm oil plantation. *Scientific Reports* 12(1): 1-9.

Aghion, P., Bloom, N., Blundell, R., Griffith, R. & Howitt, P. 2005. Competition and innovation: An inverted-U relationship. *The Quarterly Journal of Economics* 120(2): 701–728.

Amiti, M. & Konings, J. 2007. Trade liberalization, intermediate inputs, and productivity: Evidence from Indonesia. *American Economic Review* 97(5): 1611–1638.

Amornkitvikai, Y., Harvie, C. & Sangkaew, P. 2022. The role of wages, skills development and R&D on productivity: Evidence from Thai manufacturing firms. *Journal of Economic Studies* 50(2).

Battese, G.E. & Coelli, T.J. 1995. A model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical Economics* 20(2): 325–332.

Ben Yahmed, S. & Dougherty, S. 2017. Domestic regulation, import penetration and firm-level productivity growth. *The Journal of International Trade & Economic Development* 26(4): 385–409.

Bournakis, I., Papaioannou, S. & Papanastassiou, M. 2022. Multinationals and domestic TFP: Competition effects, knowledge spillovers and foreign ownership. *The World Economy*.

BPS 2014. Survei Industri Besar Sedang (IBS), Badan Pusat Statistik Indonesia. https://www.bps.go.id/subject/9/industri-besar-dan-sedang.html
Ciani, A., Hyland, M.C., Karalashvili, N., Keller, J.L., Ragoussis, A. & Tran, T.T. 2020. *Making It Big*. World Bank.
Coelli, T.J., Prasada Rao, D.S., O'Donnell, C.J. & Battese, G.E. 2005. Additional topics on data envelopment analysis. *An Introduction to Efficiency and Productivity Analysis* 183–208.
Doan, T., Maré, D. & Iyer, K. 2015. Productivity spillovers from foreign direct investment in New Zealand. *New Zealand Economic Papers* 49(3): 249–275.
Esquivias, M.A. & Harianto, S.K. 2020. Does competition and foreign investment spur industrial efficiency?: Firm-level evidence from Indonesia. *Heliyon* 6(8).
Fu, X. 2005. Exports, technical progress and productivity growth in a transition economy: A non-parametric approach for China. *Applied Economics* 37(7): 725–739.
Helpman, E., Melitz, M.J. & Yeaple, S.R. 2004. Export versus FDI with heterogeneous firms. *American Economic Review* 94(1): 300–316.
Holmes, T.J. & Schmitz Jr, J.A. 2010. Competition and productivity: A review of evidence. *Annual Review of Economics* 2(1): 619–642.
Huang, Y. & Zhang, Y. 2017. How does outward foreign direct investment enhance firm productivity? A heterogeneous empirical analysis from Chinese manufacturing. *China Economic Review* 44: 1–15.
Ing, L.Y. & Putra, C. 2017. Imported inputs on Indonesia's product variety and quality. In *Production Networks in Southeast Asia*. 66–84. Scopus.
Javorcik, B., Fitriani, F., Iacovone, L., Varela, G. & Duggan, V. 2012. *Productivity Performance in Indonesia's Manufacturing Sector*. World Bank.
Jovanovic, B. 1982. Selection and the evolution of industry. *Econometrica: Journal of the Econometric Society* 649–670.
Kato, A. 2009. Product market competition and productivity in the Indian manufacturing industry. *The Journal of Development Studies* 45(10): 1579–1593.
Khalifah, N.A. 2022. Frontier Technology, Trade, FDI, and TFP in the Electrical and Electronic Industries: Exporting or Processing Trade? *Asian Economic Papers* 21(1): 110-132.
Kimura, F. & Kiyota, K. 2006. Exports, FDI, and productivity: Dynamic evidence from Japanese firms. *Review of World Economics* 142(4): 695–719.
Kumbhakar, Subal C. & Lovell, C.K. 2003. *Stochastic Frontier Analysis*. Cambridge university press.
Lema, T.Z., Masresha, S.E., Neway, M.M. & Demeke, E.M. 2022. Analysis of the technical efficiency of barley production in North Shewa Zone of Amhara regional state, Ethiopia. *Cogent Economics & Finance* 10(1).
Lemi, A. & Wright, I. 2020. Exports, foreign ownership, and firm-level efficiency in Ethiopia and Kenya: An application of the stochastic frontier model. *Empirical Economics* 58(2): 669–698.
Li, Z. & Lv, B. 2021. Total factor productivity of Chinese industrial firms: Evidence from 2007 to 2017. *Applied Economics* 53(60).
Li, C. & Luo, Y. 2019. Spillover effect of foreign direct investment: Evidence from the West Midlands of England. *Economic Issues* 24(1).
Liu, T. & Li, K.-W. 2012. Analyzing China's productivity growth: Evidence from manufacturing industries. *Economic Systems* 36(4): 531–55.
Newman, C., Rand, J., Talbot, T. & Tarp, F. 2015. Technology transfers, foreign investment and productivity spillovers. *European Economic Review* 76: 168–187.
Orea, L. 2002. Parametric decomposition of a generalized Malmquist productivity index. *Journal of Productivity Analysis* 18(1): 5–22.
Orlic, E., Hashi, I. & Hisarciklilar, M. 2018. Cross sectoral FDI spillovers and their impact on manufacturing productivity. *International Business Review* 27(4): 777–796.
Panwar, A., Olfati, M., Pant, M. & Snasel, V. 2022. A review on the 40 years of existence of data envelopment analysis models: Historic development and current trends. *Archives of Computational Methods in Engineering* 1-30.
Parman, B.J. & Featherstone, A.M. 2019. A comparison of parametric and nonparametric estimation methods for cost frontiers and economic measures. *Journal of Applied Economics* 22(1): 60–85.
Purwono, R., Esquivias, M.A., Sugiharti, L., Heriqbaldi, U. & Handoyo, R.D. 2020. Value chains, production networks and regional integration: The case of Indonesia. *Jurnal Ekonomi Malaysia* 54(1): 135–151.
Rahardja, S., Winkler, D., Varela, G. & Ing, L.Y. 2012. *Why the Manufacturing Sector Still Matters for Growth and Development in Indonesia*. World Bank.
Sari, D.W. 2019. The potential horizontal and vertical spillovers from foreign direct investment on Indonesian manufacturing industries. *Economic Papers: A Journal of Applied Economics and Policy* 38(4): 299–310.
Sari, D.W., Khalifah, N.A. & Suyanto, S. 2016. The spillover effects of foreign direct investment on the firms' productivity performances. *Journal of Productivity Analysis* 46(2–3): 199–233.

Sari, D.W., Restikasari, W., Ajija, S.R., Islamiya, H.A.T. & Muchtar, D. 2021. The impacts of foreign direct investment and export expansion on the performance of the high-tech manufacturing industry. *Jurnal Ekonomi Malaysia* 55(2): 91-105.

Sarmento, P. & Forte, R. 2019. Does foreign presence induce host country firms' exit? The case of Portugal. *International Advances in Economic Research* 25(3): 323–337.

Setiawan, M. & Lansink, A.G.O. 2018. Dynamic technical inefficiency and industrial concentration in the Indonesian food and beverages industry. *British Food Journal* 120(1).

Sugiharti, L., Purwono, R., Primanthi, M.R. & Esquivias, M.A. 2017. Indonesian productivity growth: Evidence from the manufacturing sector in Indonesia. *Pertanika Journal of Social Science and Humanities* 25(S): 29–44.

Sugiharti, L., Yasin, M.Z., Purwono, R., Esquivias, M.A. & Pane, D. 2022. The FDI spillover effect on the efficiency and productivity of manufacturing firms: Its implication on open innovation. *Journal of Open Innovation: Technology, Market, and Complexity* 8(2): 99.

Sugiharti, L., Purwono, R., Primanthi, M.R. & Esquivias, M.A.P. 2019. Indonesia industrial productivity growth: Evidence of Re-industrialization or De-industrialization? *Periodica Polytechnica Social and Management Sciences* 27(2): 108–118.

Sun, X. & Hong, J. 2011. Exports, ownership and firm productivity: Evidence from China. *World Economy* 34(7): 1199–1215.

Suyanto, S., Sugiarti, Y. & Setyaningrum, I. 2021. Clustering and firm productivity spillovers in Indonesian manufacturing. *Heliyon* 7(3).

Suyanto, Bloch, H. & Salim, R.A. 2012. Foreign direct investment spillovers and productivity growth in Indonesian Garment and Electronics Manufacturing. *Journal of Development Studies* 48(10): 1397–1411.

Suyanto, & Salim, R. 2011. Foreign direct investment spillovers and technical efficiency in the Indonesian pharmaceutical sector: Firm level evidence. *Applied Economics* 45(3): 383–395.

Trachuk, A. & Linder, N. 2018. Learning-by-exporting effects on innovative performance: Empiric study results. *Knowledge Management Research and Practice* 16(2): 220–234.

Vernon, R. 1966. International investment and international trade in the product cycle. *The Quarterly Journal of Economics*: 190–207.

Vu, H.D. 2016. Technical efficiency of FDI firms in the Vietnamese manufacturing sector. *Review of Economic Perspectives* 16(3): 205–230.

Vu, H.V., Holmes, M., Tran, T.Q. & Lim, S. 2016. Firm exporting and productivity: What if productivity is no longer a black box. *Baltic Journal of Economics* 16(2): 95–113.

Wagner, J. 2012. International trade and firm performance: A survey of empirical studies since 2006. *Review of World Economics* 148(2): 235–267.

Winkler, D. & Farole, T. 2012. *Export Competitiveness in Indonesia's Manufacturing Sector*. World Bank.

Xu, J., Liu, Y. & Abdoh, H. 2022. Foreign ownership and productivity. *International Review of Economics & Finance* 80: 624-642.

Yasin, M.Z., Esquivias, M.A. & Suyanto, S. 2021. Does Firm Size Matter? Evidence from Indonesian manufacturing firms. *Economics Bulletin* 41(4): 2401-2417.

Yasin, M.Z. 2021. Technical efficiency and total factor productivity growth of Indonesian manufacturing industry: Does openness matter?.*Studies in Microeconomics* 10(2).

Yasin, M.Z. & Esquivias, M.A. 2023. Spillover effects of foreign direct investment on manufacturing exports and imports in Indonesia. *Studies in Economics and Finance*.

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