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Indonesian Productivity Growth: Evidence from the Manufacturing Sector in Indonesia

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ABSTRACT

This study estimates Technical efficiency (TE) and Total Factor Productivity (TFP) through a stochastic frontier analysis and decomposes growth into technological progress, technical efficiency change, and scale for the Indonesian manufacturing sector. Global economic slowdown characterises the period of study (2007-2013), as well as peak and fall of commodity prices, massive global integration and development of a Master plan for Indonesia (MP3EI). This study looks at patterns of productivity as important sources of growth. Results are aggregated based on technological intensity, firm size, capital/output ratio, labour skills, and location. The findings show that companies perform differently as those factors vary, and while larger companies are more efficient, smaller ones have higher rates of TFP growth, mainly through technological progress and scale. The TFP had moved from initial negative levels to positive ones. Firms with low tech, low capital/output ratio, and more skilful workers have the highest TFP.

Keywords: Indonesia, manufacturing industry, technical change, total factor productivity, technical efficiency

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INTRODUCTION

The Indonesian economy expanded significantly in the last three decades. The GDP annual growth rate averaged 5.3 percent from 2000 to 2017; industrial production grew an average of 3.21 percent annually from 1994 to 2017 and accounted for more than 60 percent of total exports. In addition, the country's abundant natural resources and huge labour force (more than 120 million workers and huge natural endowments) allow for more strategic allocation of factors, but it also calls for a more efficient employment of them. In line with this, in 2011, the Indonesian government developed the Masterplan for Acceleration and Expansion for Indonesian Economic Development (MP3EI) for the next 15 years (2011 to 2025), a particular effort to strategically divide up the country into several economic corridors. Java, the most populous island and biggest contributor to the national GDP, is defined as the industrial corridor, a driver for manufacturing and service industries. However, regardless of its rapid industrialisation, Indonesia is plagued by low competitiveness, increase in labour costs to output (27% since 2011), increase in energy prices, global uncertainty affecting key exporting commodities, instability of government regulatory framework, dependency on imported raw materials, and low efficiency. This situation raises the question if the country would be able to compete globally as it liberalises its economy and if the growth rates are sufficient to support its strategic and ambitious expansion plan for the coming decades.

Some empirical studies suggest the Indonesian manufacturing industry suffers from deindustrialisation (Aswicahyono & Hill, 2015), small capitalisation and sluggish growth calling. Despite these, industrial production in Indonesia averaged 3.21 percent (1994-2016), and employment increased by 16% (2009-2013).

It is worth mentioning SMEs are vast majority of firms and generate growth in employment and business by low production methods and low capitalisation to generate profit (57.2 million, 2016 Databoks, Katadata Indonesia). Additionally, they employ mainly labour with low skills. This raises the question if size, capital, and skills matter for high productivity in Indonesia.

This study applies a Stochastic Frontier Approach (SFA) to measure efficiency and to estimate the different components of Total Factor Productivity (TFP) and output growth to address growth challenges, the central points of the MP3EI. As Indonesia is experiencing a demographic boom, it also raises the question to what extend its labour is supporting its growth. This paper uses a *Translog* production function and the SFA to estimate and break down the growth in output of the manufacturing industries in Java Island, Indonesia, from 2007 to 2013.

The SFA helps break down the growth base on changes in inputs (capital and labour), scale effects, technical progress or by technical efficiency changes. This study also aims to capture differences in TE and TFP across enterprises as factors such as location, size, human resources, and the degree of capital to output, and technology intensity, which may vary across the sample.

LITERATURE REVIEW

This study estimates TE and TFP for manufacturing at firm level, allowing size, skills, capital, technology, and location to determine changes in the firm's performance. Past studies have focused on Technical

Efficiency, Total Factor Productivity, and factors affecting output expansion as size, location, ownership and skills. Empirical studies such as by Mokhtarul Wadud (2004) found TE in Australian textile and clothing firms depended on firm's age, output size, capital intensity, and legal status. Sheng and Song (2013) found that larger companies in China had better TFP performance, and that the capital/labour ratio were related negatively to TFP. Oh, Heshmati and Lööf (2014) (1987-2007) found that large firms in Republic of Korea experienced more significant TFP growth (2.59) than the medium (1.92) and micro (1.75) firms, while high-tech enterprises undergo more substantial TFP (3.39). Liu and Li (2012) using SFA and a *translog* function found human capital as a primary source of growth versus labour and capital in China. While Scale Component (SEC) was large, TEC was rather small. Labour had pushed costs up but had provided the least effect on input growth. Only high-tech enterprises saw marked improvements in TE. Sari, Khalifah and Suyanto (2016) found that foreign owned enterprises enjoyed higher TFP but lower efficiency than the local ones in Indonesia.

Studies on TFP growth at sector level in Indonesia (Margono & Sharma, 2006) showed size, location, and ownership were positively related to TE, while size but not location influenced TFP. Interestingly, TE and TFP values vary across firms with notable difference in performance across firm groups. The TP was found to hinder growth while TE supported it. Different TFP growth rates estimations, i.e. (Timmer, 1999), TFP based on growth accounting indicates 2.8 % increase (1975-1995). Aswicahyono and Hill (2002) reported TFP at 2.3 % (1975-1993) while (Margono et al., 2011) found a 7.5 % drop in TFP due to TE (1993-2002).

Saliola and Seker (2011) who conducted macro level analysis for manufacturing industries in 80 countries found Indonesia having one of the largest aggregated TFP productivities (0.27), and average TFP (0.05) in between 2008 and 2009. However, the elasticity of output with respect to capital was among the lowest (0.02). Park (2012) concluded that TFP growth was supported by human capital, the primary source of growth for Asia. These findings opens the possibility of a change in industrial pattern in Indonesia, from a TFP initially supported by TEC due to labour, then to capital (initial technological upgrade), but lately the slow growth due to skills, materials and other resources needed to complement labour and capital and allow for positive TEC, SEC and TP effects. While labour and capital may support industrial output growth, the expansion is thought to be below potential.

The Technical Efficiency (TE) can be measured by Malmquist index, Data Envelope Analysis (DEA) and Stochastic Frontier Analysis (SFA) (T. Coelli, Estache, & Parelman, 2003). The SFA is a parametric estimation while DEA is non-parametric one. Furthermore, the SFA provides standard errors of production coefficients whereas the DEA cannot do so (Bera & Sharma, 1999; Margono & Sharma, 2006). The error term in the stochastic frontier estimation shows the level of efficiency (inefficiency) and from that, to figure out if the use of available inputs is supporting or worsening output levels (Kumbhakar & Lovell, 2003).

The TFP growth can be estimated either by growth accounting or by production function. The growth accounting approach assumes full TE and uses TP and TFP growth synonymously. On the contrary, the production function method estimates TFP growth without the assumption of full TE and decomposes its components (Margono & Sharma, 2006).

METHODS

The Total Factor Productivity (TFP) growth is decomposed into a rate of technological progress (TP), a scale component (SEC), and a change in technical efficiency (TEC). The TP is measured by the partial derivative of the production function with respect to the time, the SC is the elasticity contribution to the TFP growth, and the TEC is the derivative of TE with respect to time. The model also estimates the elasticity of output with respect to labour and capital.

The frontier production function indicates the maximum output that can be obtained considering existing technology and available inputs of production. If firms operate on the frontier, they are technically efficient. The production function and an inefficiency function are simultaneously estimated by the SFA using a functional form of the production function.

The specification for a non-negative random component in the error term is allowed for technical inefficiency. According to Battese and Coelli (1995, p. 329), a production function and an inefficiency function can be estimated simultaneously by the SFA (Kalirajan & Shand, 1994, p. 15) modelled as:

$$Y_{it} = f(x_{it}, t; \beta).\text{Exp}(v_{it} - u_{it}) \quad (1)$$

Where y_{it} is the output of the i'th firm in t period, x_{it} is a vector of inputs, and β is a vector of the parameters to be estimated. The error term v_{it} is assumed to be independently and identically distributed, N (0,). The u_{it} is technological inefficiency in production assumed as a firm-specific, non-negative, and independently distributed but truncated at zero of the normal distribution.

The technical efficiency of each firm is based on the expected maximum value of Y_{it} conditional on $\mu_{it}= 0$, and the values of $v_{it} - u_{it}$ are evaluated at the maximum likelihood estimation (Coelli, Estache & Parelman, 1998, cited in Kompas 2004, p. 1634). F as E is defined as the expectations operator, the conditional expectation of TE can be defined as:

$$TE_{it} = \frac{E(Y_{it}|u_{it}, X_{it})}{E(Y_{it}|u_{it} = 0, X_{it})} = e^{-u_0} \quad (2)$$

This study uses a Translog production function based on functional form under time-varying technical efficiency model. Salim et al. (2009, p.1866) argue that a flexible functional form –translog- can be used, helping to reduce the risk of errors in the model specification. The Translog model allows for non-constant returns to scale and allows a nonlinear production function. This study defines the translog production function as:

$$\ln y_{it} = \beta 0 + \beta c \ln c_{it} + \beta l \ln l_{it} + \beta tt + 1/2[\beta cc (\ln c_{it})^2 + \beta ll (\ln l_{it})^2 + \beta tt (t)^2] + \beta cl \ln c_{it} * \ln l_{it} + \beta ct\, t * \ln c_{it} + \beta lt\, t * \ln l_{it} + vit - uit\neg \quad (3)$$

Table 1
Definition of variables in the production function

Variables	Definitions
Y	Output (million rupiahs) measured by the value of goods produced which is deflated by wholesale price index for five-digit ISIC industries based in constant year 2000 prices
C	Capital (million rupiahs) deflated by wholesale price index for manufacturing capital goods in constant year 2000 prices
L	Labour which is total workers per working day

From this definition, for a general *translog* model and time-varying technical efficiency, technological progress and scale component are expressed as (Kumbhakar & Lovell, 2003):

$$TP = \frac{\partial \ln(y_{it})}{\partial t} = \beta_t + \beta_{tt} t + \beta_{ct} \ln c_{it} + \beta_{it} \ln l_{it} \quad (4)$$

$$SC = (e-1) \sum_j \left(\frac{e_j}{e}\right) \dot{X}_j \quad (5)$$

Where e_j is the elasticity of output with respect to input, and $\dot{X}_j$ is growth rate of input. The elasticity of output with respect to each input measures the relative change in each input owing to a relative change in output. Elasticity can be expressed as (Verbeek, 2008, p. 56):

$$el = \beta l + \beta ll \ln l_{it} + \beta cl \ln c_{it} \quad (6)$$

$$ec = \beta c + \beta cc \ln c_{it} + \beta cl \ln l_{it} \quad (7)$$

In this study, elasticity is estimated as the value of input at i'th firm in t time.

From TE results from equation (2), the TEC can be defined as (Khalifah & Abdul Talib, 2008, p. 93):

$$TEC = \frac{TE_{i(t+1)}}{TE_{it}} \quad (8)$$

From equation 7 to 8, the TFP growth decomposition is calculated by

$$T\dot{F}P = TP + SC + TEC \quad (9)$$

This study looks at 14,783 manufacturing firms in Java Island from 347 five-digit ISIC for the period of 2007-2013. Data was collected on yearly basis by the national Statistical Bureau of Indonesia, Badan Pusat Statistik (BPS), under the national survey for medium and large manufacturing enterprises. This paper classifies firms based on five different criteria to allow a more precise comparison of the four different growth components and its inputs. Location indicates the province where the businesses operate. Size reveals the scale, large (L) more than 100 workers or small and medium enterprise (SME). A Capital/Output ratio distinguishes companies with low capital (LK) if the ratio is less than 10%, and firms which are Capital Intensive (HK) otherwise. Human resource intensity distinguishes between firms that are Human Resource based (HRI) if non-production to production labour is higher than 30%, or if companies are Labour Intensive (LI) if the ratio is below 30%. Finally, firms are grouped based on Technology Intensity Definition Classification (Rev 3) based on R&D intensities: Low Technology (LT), Medium-low Technology (MLT), Medium and High Technology (MHT), and High Technology (HT). Considering R&D in Indonesia, the HT and the MLT are then grouped.

Table 2
Statistical performance of the Manufacturing Industry (2009 and 2013)

	Total number of Firms		Total number of employees (10,000)		Industry Value Added (Billion Rupiah)		Worker Productivity (1,000 Rupiah)	
	2013	2009	2013	2009	2013	2009	2013	2009
LT	16,855	16,024	292.883	336.865	358,164	713,174	1,452,461	2,213,365
L	4,171	4,401	246.459	291.169	331,139	665,266	1,599,210	2,396,900
SME	12,684	11,623	46.424	45.696	27,023	47,908	699,326	1,152,173
MHT	2,557	2,943	67.322	81.733	304,898	516,497	3,559,452	3,941,711
L	1,143	1,199	60.905	72.664	290,793	477,844	3,801,077	4,112,900
SME	1,414	1,744	6.417	9.069	14,104	38,653	1,213,515	2,813,645
MLT	4,553	4,646	70.419	80.132	132,331	243,035	1,373,875	2,136,434
L	1,371	1,483	57.763	66.191	119,872	216,499	1,546,756	2,400,088
SME	3,182	3,163	12.655	13.940	12,460	26,538	862,637	1,420,877
Total	23,965	23,613	430.623	498.729	795,393	1,472,706	6,385,788	8,291,510

Note: Low Technology (LT), Medium-Low Technology (MLT), Medium-High Technology (MHT), Large size (L), Small and Medium Enterprise (SME)

RESULTS

The technical performance of manufacturing industries in Indonesia shows mix results. While the number of enterprises and efficiency (input/output) contracted from 2009 to 2013, the number of total employees, industry value added, worker productivity (Rp output/worker), and production to installed capacity increased. Larger labour costed 27% more, while expansion and output were slow. The worker productivity rose only slightly above the growth in employment cost meaning that the real worker productivity was minimum. As most industries are labour-intensive, the cost of labour highly influences the value added. The decrease in efficiency (-8%) indicated that even though there were more available inputs, the ratio of input to output had declined over time. It is worth mentioning that prices in particular sectors (i.e. food) experienced sharp rises in several periods as commented by (Esquivias, 2017, p. 43) influencing output value and productivity indicators.

The estimates of the *Translog* model show that the parameter of capital is positive and significant when tested at 1 percent level, confirming a corresponding increase in output with capital injection. Furthermore, the coefficient of capital squared is positively significant at 1 per cent level denoting that a diminishing return to capital does not exist. Similarly, both the parameters of labour and the estimate of the squared level of labour are positive and significant, meaning that the diminishing return law does not hold in labour. While this study found increasing returns to scale for both labour and capital in overall manufacturing, (Margono & Sharma, 2006) found negative or constant returns to scale in three top manufacturing industries, concluding that those sectors are more capital rather than labour-material oriented. The results of this study differed as industries are found to be more labour oriented. However, a possible explanation is that industries experienced larger capital expansion in the 1990s; the expansion after that period was due to increase in labour and skilled labour (not only labour force, but also higher skills).

The coefficient of the interaction in variables helps in the analysis of the cross effect of the inputs. For labour and capital, the coefficient is negative and significant at 1 percent level meaning that labour and the capital have a complementary effect. Time (squared time) as a technological progress indicator is significant and shows a positive relationship with the output.

Table 3
Regression estimates

	Coefficient	Standard-error	t-ratio
Constant	8.559	0.138	61.818
Labour	1.683	0.032	51.315
Capital	0.207	0.014	13.982
ln*L* x ln*L*	0.002	0.002	0.737
ln*k* x ln*k*	0.008	0.001	13.691
ln*L* x ln*k*	-0.048	0.002	-23.929
T	0.045	0.013	3.350
ln*L* x t	0.004	0.001	3.118
Ln*k* x t	-0.017	0.001	-17.840
t x t	0.041	0.000	54.438
sigma-squared	2.073	0.026	79.404
Gamma	0.718	0.002	296.907
Mu	2.440	0.023	101.906
Eta	-0.023	0.001	-17.618
Number obs	103,481		
Log likelihood function = -141544.53			
LR test of the one-sided error = 50 020.92			

The parameter showing interaction between capital and time was negative and highly significant meaning that the former exhibited a non-neutral technological regress. Additionally, input exhibited technological progress with a positive and significant material-time parameter indicating that producers can keep similar output with relatively less inputs from labour.

DISCUSSION

This study's aggregate results in addition to TE estimates and TFP growth are based on location (province), size (large and medium-small), the degree of human resource intensity (labour or skill intensity), the level of capital to output, and technological intensity. By aggregating the results, it is possible to capture how the TE and the TFP vary when firm characteristics change. With factors largely differing across the sample, average values of firms aggregated only at one (or few) particular aspect will offer an incomplete picture. Table 4 shows the estimates of the elasticity of output with respect to capital and labour, input growth, technical efficiency (TE), and the three components of Total Factor Productivity (technical efficiency change, technological progress, and scale component). All estimates are aggregated based on technological intensity.

Technical efficiency ranged between 0.08 to 0.46 for the 22 industries, and on average registered 0.1471, a small and falling TEC. About 90% of the firms registered TEC below 0.33, indicating they are far from the frontier, 7% are between 0.33 and 0.66 and only 3% within 0.66 to 1.

All 22 analysed industries (ISIC at 2-digit) ended the period with lower TE values, from average TE of 0.16 in the first period to 0.13 in the last period, indicating a general loss of efficiency in industrial activity. While lower TE was also noted in other empirical studies, the results differed as TE was dragged down TFP, contrary to what Margono and Sharma (2006) reported. At three-digit ISIC level, only 5 out of 67 sub-industries registered positive changes in TE. A possible interpretation is that more inputs are available; however, the output is not growing correspondingly as inputs are not balanced.

Table 4
Growth decomposition for three industrial groups (2007-2013)

	Output elasticity				Input growth (%)	
	eK	eL	e Total		K	L
Low Technology	0.091	1.025	1.116		0.065	-0.004
Medium-Low tech	0.093	1.005	1.098		0.068	0.007
Medium-and high-tech	0.085	1.005	1.090		0.047	-0.007
Average	0.090	1.018	1.108		0.063	-0.002
			TFP Components 2009-2015			
	TE	Scale	TP	TEC	TFP	YGrowt
	(1)	(2)	(3)	(4)	(2) + (3) + (4)	(6)
Low Technology	0.142	-0.000	-0.009	-0.054	-0.043	0.116
Medium-low tech	0.149	0.000	-0.017	-0.054	-0.050	0.135
Medium-and high-tech	0.162	-0.001	-0.016	-0.050	-0.047	0.138
Average	0.147	0.000	-0.012	-0.054	-0.046	0.124

Notes: Elasticity of Output with respect to capital (eK), Elasticity with respect to labour (eL), Total elasticity (eTotal). Technical Efficiency (TE), Technological Progress (TP), Technical Efficiency Change (TEC), Total Factor Productivity (TFP)

In terms of firm characteristics, big businesses have 40% larger TE values. Companies with a high Human Capital share (more than 30% of labour in non-production positions) registered 38% higher TE than that of labour-intensive firms (predominant production workers). Firms with low capital/output ratios recorded 38% larger TE estimators. The combination of these three factors allows companies within these groups to improve their average estimates to 0.335 rather a general average of only 0.147; these results are similar with other empirical studies where only top industries were selected (Margono & Sharma, 2006) .

Table 5
Growth decomposition for aggregates and three industrial groups

	TE	TEC	TP	SEC	TFP Avg.	TFP 07-08	TFP 12-13
By Size							
Large	0.204	-0.046	-0.027	0.005	-0.048	-0.147	0.049
Small	0.120	-0.057	-0.006	-0.002	-0.045	-0.144	0.054
By Technology							
LT	0.142	-0.054	-0.010	-0.000	-0.044	-0.142	0.054
MHT	0.162	-0.050	-0.017	-0.001	-0.048	-0.148	0.052
MLT	0.150	-0.055	-0.017	0.000	-0.051	-0.151	0.049
By Province within JAVA Island (Industrial corridor)							
DKI Jakarta	0.163	-0.050	-0.021	-0.000	-0.051	-0.150	0.050
West Java	0.166	-0.051	-0.015	-0.000	-0.046	-0.146	0.054
Central Java	0.095	-0.063	-0.005	-0.000	-0.047	-0.142	0.047
DIY	0.074	-0.065	-0.005	-0.002	-0.052	-0.150	0.054
East Java	0.138	-0.055	-0.008	0.000	-0.042	-0.142	0.054
Banten	0.220	-0.042	-0.027	0.000	-0.049	-0.149	0.051

The LT industries also account for 60% of the firms with high TE. Out of the 462 companies with high TE, 80% of them have a low capital to output ratio. Both LT and low capital to output ratio indicate an important pattern in the light manufacturing industry, labour intensive rather than skills base, and sectors with low capital formation. Even though on average, firms with higher human capital indexes perform better, more than 60% of the firms with high TE belong to industries with low human capital index. The striking point is that 12% of firms enjoying high TE in 2007 (out of 525) lost high TE index. A similar effect prevails among medium level TE (0.33 <TE> 0.66) with 25% of them losing their TE value from 2007 to 2013. Only 4% of firms enjoyed high TE in 2007 and 3% in 2013, while only 8% enjoyed medium TE in 2007 and 6% in 2013.

Table 6
Technical Efficiency by industrial groups based on capital intensity, firm size and skills level

	High Capital Intensive				Low Capital Intensive				All Avg
	Large		SME		Large		SME		
	HRI	LI	HRI	LI	HRI	LI	HRI	LI	
LT	0.256	0.128	0.133	0.085	0.358	0.194	0.246	0.141	0.142
MHT	0.238	0.156	0.124	0.087	0.319	0.246	0.205	0.147	0.162
MLT	0.216	0.159	0.132	0.067	0.287	0.234	0.247	0.162	0.150
Total	0.245	0.140	0.131	0.081	0.335	0.214	0.240	0.146	0.147

Notes: Low Technology (LT), Medium-High Technology (MHT), Medium-Low Technology (MLT). Large Size (L), Small and Medium Enterprise (SME), Labour Intensive (LI), Human Resource base (HRI)

In terms of TFP estimations, the overall average TFP experienced by manufacturing industries within Java is negative (-0.045), indicating a contraction of the production possibility frontier. The different components of TFP are unable to shift the frontier towards an expansion, and in fact have caused it to contract by inefficiencies on inputs or lack of technological development. However, for the Years 2011, 2012, and 2013 of analysis, the TFP registered positive values for all industrial groups (average of 0.014 and 0.05 for 2011-12 and 2012-13 periods). Low Technology industrial group and SMEs tend to perform better overall.

Table 7
Estimators based on industry group, size, and human resources

	TE		TEC		TP		SEC		TFP		Avg
	L	SME	L	SME	L	SME	L	SME	L	SME	
Low Technology (LT)											
LI	0.167	0.110	-0.050	-0.059	-0.022	-0.002	0.007	-0.003	-0.045	-0.043	-0.043
HRI	0.312	0.189	-0.035	-0.049	-0.034	-0.012	0.002	-0.002	-0.049	-0.044	-0.046
Medium-High Technology (MHT)											
LI	0.211	0.118	-0.045	-0.055	-0.029	-0.007	0.004	-0.004	-0.050	-0.046	-0.047
HRI	0.286	0.166	-0.037	-0.049	-0.034	-0.016	0.003	-0.004	-0.048	-0.050	-0.049
Medium-Low Technology (MLT)											
LI	0.204	0.106	-0.045	-0.062	-0.030	-0.009	0.005	-0.001	-0.050	-0.051	-0.050
HRI	0.257	0.194	-0.040	-0.047	-0.033	-0.019	0.003	-0.004	-0.052	-0.051	-0.051
Avg	0.204	0.120	-0.046	-0.057	-0.027	-0.006	0.005	-0.003	-0.048	-0.045	-0.046

Notes: Large (L), Small and Medium Enterprises (SME), Labour Intensive (LI), Human Resource base (HRI)

Technical Efficiency Changes (TEC) indicate the rate at which an entity moves towards or away from production frontier. The TEC experienced negative and decreasing value for the whole period and it is related to the productive use of factors of production; for instance, it indicates the combined inputs are unable to produce efficiently, remaining far from the frontier and below potential. The TEC had worsened over time, from an average -0.050 in 2007-2008 to -0.056 in 2012-2013 period (equivalent to 12% deterioration). The results are in line with other empirical studies which pointed showed a deterioration of the TE across time (Margono & Sharma, 2006; Margono et al., 2011).

An overall low technical efficiency changes (TEC) of -0.053 caused the contraction of the production possibility. The significant presence of labour-intensive manufacturing and relatively low capitalisation may support the fact that there is little improvement in the use of inputs. Even though more factors are available in the industry, the technical improvements needed for the expansion of the frontier are not present. It is also possible that idle resources are being discharged (higher unemployment) or discouraging capital formation.

The Technological Progress (TP) is related to shifts in the production function over time. Improvements in information technologies, technological disruptions or absorption, new production techniques, improvements due to research and development, as well as other factors can support technological change. It has implications in the increase of productivity related to factors of production. Overall TP registered is -0.0123 for the whole period. The best performance in TP is the LT industrial group. Interestingly, all three industrial groups improved their TP values significantly, bringing it from -0.134 in 2007 period to 0.109 (positive) in 2013. These results are also in line with the technical performance shown in general statistics in Table 2, where the real production to installed capacity improved from 71% in 2009 to 77% in 2013. A positive trend in TP indicates that inputs become more productive, for instance they increase the output per factor, pushing the production possibility frontier outwards. However, as reported by (Margono et al., 2011, p. 670), a larger inefficiency offsets the growth in TP. The worker productivity (Rupiah / worker) in industrial statistics (Table 2) is reported to be almost 25% higher from 2009 to 2013. Labour in manufacturing increased by 15% while total value added increased more than 50%, indicating a period characterised by an increase in the units in labour/output.

The increase of the rate of TP in the last years indicates an effective path towards the recovery of industrial activity. Industrial policy actions started in 2006 to positively affect the technological improvements that could help to maintain its comparative advantage, creating a new edge for competition, a more efficient allocation of factors, and improvement in the quality of factors of production.

Economies of scale refers to the contribution of factors of production (due to changes) to output growth. New factors or better use of factors are expected to drive the growth. However, other components need to complement them, as shown in Table 3. Savings in the use of factors (particularly capital) also help firms to increase output per unit of inputs. However, it may need to be complemented by resources (i.e. higher skills, techniques or materials). Even though industries performed differently, overall SEC is negative, -0.00012. At particular periods, LT and MLT industrial groups registered positive SEC values supporting the idea that when low technological industries employ a right proportion of inputs, they can successfully push forward the output per input. The MLT performance in average is better than others, positive for the whole period, even though subtle at 0.00077. It coincides with the only industrial group that experienced positive growth in input labour and the largest input capital growth as seen in Table 4. It is worth mentioning that almost 15% increase in manufacturing labour force from 2009 to 2013 give relatively small SEC as a contributor to TFP. This represents a loss of potential industrial growth with the so-called "demographic dividend", as perhaps investment did not adequately support increases in labour. New workers may not have required skills or take time to adapt, or shift to higher skill industries was slow.

Positive and moderate increasing returns to scale in labour represent a pro-cyclical behaviour in the use of factors, as with increases in scale corresponds with that of labour supply, but negative when there is a decline in the share of the input. However, since the economies of scale are moderate, increases in labour are not able to strongly influence TFP growth. In fact, manufacturing output has been growing slowly despite the increase in labour.

Table 8
Elasticity of output with respect to labour and capital by technology, size and skill

	EL			EK			E		
	Large	SME	Avg	Large	SME	Avg	Large	SME	Avg
Low Technology (LT)									
LI	0.977	1.054	1.032	0.019	0.120	0.091	0.996	1.174	1.123
HRI	0.936	1.021	0.989	0.035	0.121	0.088	0.971	1.142	1.077
Medium-High Technology (MHT)									
LI	0.961	1.038	1.009	0.028	0.120	0.085	0.989	1.158	1.094
HRI	0.938	1.009	0.978	0.041	0.118	0.085	0.979	1.127	1.063
Medium-Low Technology (MLT)									
LI	0.954	1.036	1.010	0.036	0.121	0.094	0.991	1.157	1.104
HRI	0.936	1.004	0.978	0.039	0.122	0.090	0.975	1.126	1.069
Avg	0.963	1.044	1.018	0.027	0.120	0.090	0.990	1.164	1.108

The elasticity of output with respect to labour (EL) and capital (EK) at industry level show a larger contribution of labour over capital. The overall average of capital is surprisingly small. Increases in labour allow higher returns in output versus increases in capital. The EL increased slightly from 1.015 to 1.020, showing a similar pattern for all industries. Additional units of labour then foster the expansion of output by more than one in the whole industry, supporting the model of manufacturing in Java mainly oriented to labour-intensive industries and capital saving. It can be concluded that manufacturing industries are supported primarily by large pool of labour pool rather than by skills. While this offers the positive side of being able to absorb large workforce, the downside is it low value-added. In fact, large labour force with better practices and larger capital may spur stronger growth. As EL values decrease over time, it may indicate labour productivity to be below required levels as there are not significant increases in capital or skills. Indonesia may be losing the potential of a demographic dividend by low productivity, lack of investment, low-tech capability and increasing labour costs. This pattern indicates that the country must upgrade its industry if it is to continue absorbing large labour force. In this line, SME enjoying 8% higher EL over large firms.

In relation to EK, the SMEs showed 4.5 times (450%) larger elasticity than big businesses. However, as the value of the EK is small (0.12), it does not make such a significant impact. Overall, the SMEs enjoyed 15% higher EK than the large companies indicating its potential to gain in productivity and efficiency with larger (and better) additions of labour and capital.

Manufacturing in Indonesia shows high dependence on labour inputs to create greater impacts on output while it is saving in capital. The estimator of elasticity of output with respect to capital felt from 0.10 to 0.071, meaning the returns of capital experienced a negative trend concerning the contribution to output by almost 30%. The industries are still dominated and supported by labour.

While it is expected that labour-intensive industries may experience growth with improvements in capital, each additional unit of capital adds less and less to output with an opposite effect. Manufacturing is continuously expanding due to rapid growth of labour (more than 10% in the period) rather than capital (less than 1%), indicating a manufacturing which is capital saving, but also showing that both labour and capital are becoming less productive over time. This indicates that the industry is slow to upgrade, losing productivity and compromising the target needed to keep growing.

Overall, the total output elasticity felt from 1.12 to 1.09 showing an unbalanced growth of inputs. Even though additional labour is absorbed, they do not compensate for the lack of investment, confirming that inputs are complementary rather than substitutes.

CONCLUSION

This study estimates Technical Efficiency and Total Factor Productivity focusing on its three main components (TEC, TP and SEC) to find patterns of productivity growth in Indonesian manufacturing sector. As Indonesia aims for higher growth rates to spur employment and development, promote national welfare and improve competitiveness, productivity is at the heart of achieving this dream. The production function shows that both capital and labour are experiencing increasing returns offering possibilities for expansion of output and efficient absorption of new inputs. Both labour and capital appear as complementary factors, though labour plays a far more critical role and is experiencing larger expansion than capital. On the other hand, capital has been falling although capital is experiencing saving technological progress, allowing the country to keep output levels with relatively less capital inputs. However, the growth of labour requires higher capital injection to increase output. The time variable indicates positive tech-progress. However, the rapid growth of absolute number of labour requires higher amounts of capital to continue increasing output.

The results of the estimations of TE and TFP are aggregated based on technological intensity (low, medium-low, and medium-high), the size of a firm (large or SME), capital/output ratio (low or high), labour skill intensity (labour intensive or skill), and location (province). Overall, it was found that TE was rather small for 90% of the firms and the TFP was negative. Interestingly, larger firms reported 42% higher TE estimations compared with SMEs and positive scale component (0.0052). However, the SMEs (large majority) enjoyed better technological progress.

Companies with higher shares of skilled workers (HRI ratio) registered 38% higher TE than the labour-intensive firms. Similarly, businesses with low capital/output ratios recorded 38% larger TE estimators. The combination of these two factors plus technological intensity allows firms to improve their average TE estimates to 0.335 rather a general average of 0.147 (125% better results) indicating a pattern of productive firms in the country. Among those with better performance are firms characterised by low technology, representing 60% of firms with high TE, and out of them, 80% have low capital/output ratio, indicating the important role of labour-intensive firms. Low-tech firms also registered the largest TFP.

However, efficiency performance (TE) in the country experienced a slowdown, as on average, companies ended up the period of analysis with 18% lower TE. It was also found that the Average TFP was negative for all industries. However, in the last three periods, all industries experienced positive TFP, mainly promoted by TP and small-scale component improvements, indicating a possible catch up process after the implementation of MP3EI. There is evidence of TEC following a negative trend with factors less productive over time, indicating Indonesia relies more on technological changes as well as higher capital to push its frontiers. There was significant technological progress over the last few years, and responsible for the main changes in TFP. Low TEC indicates that inputs are not adjusting with the changes in technology, possibly related to low technological absorption of labour. Scale component is improving, but its contribution to TFP growth is rather small, meaning that the demographic boom is not causing a multiplier effect in output growth.

Labour contributions to output growth are larger than inputs from capital. Output has low elasticity on capital indicating a capital saving manufacturing. The heavy dependency on labour-intensive activities and the spiralling labour cost may slow down productivity.

The SMEs registered more important TFP improvements compared with large firms. In 2013, the TFP in small capital/output ratio performed 50% better than that of high capital/output ratio, mainly low technology. Differences in size, quality of human resources, technological capability and capital/output ratio influence the way companies perform, while location only at a lesser degree.

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