East Java Economic Journal Vol. 2 No. 2 (2018): 118-138

ejavec JOURNAL

EAST JAVA ECONOMIC JOURNAL

https://ejavec.id

EAST JAVA'S PRODUCTIVITY GROWTH: EVIDENCE OF INDUSTRIAL-IZATION OR DEINDUSTRIALIZATION IN THE JAVA ISLAND?

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ABSTRACT

This study estimates Technical Efficiency (TE) and Total Factor Productivity (TFP) to analyze the sources of growth in the province of East Java in Indonesia. Technological progress, technical efficiency change, and scale effects are estimated through a stochastic frontier analysis (SFA) to break up different sources of growth within manufacture. This study looks at patterns of output expansion by differentiating gains from conventional sources –input growth and technological progress- and non-conventional sources–technical efficiency change and scale effects-. Results are aggregated based on tech-intensity, firm size, capital to output ratio employed, and labor skills. It also compares East Java with the other five provinces in the Java Island, the manufacturing corridor of the country. As expected, manufacturing sector is growing through input growth effects and tech progress - conventional sources- but underperforming in productivity by having negative efficiency change and negative scale effects. Labor has the largest elasticity to output (0.436), capital and raw materials have a much lower elasticity, and energy has a large negative one (-3.097) also causing a sharp increase in the cost of production. Low-tech firms, higher skills, and medium in size perform 72% better than average (TFP). MLT firms with labor-intensive and medium-size firms perform 58% better than average. However, champion industries have lower skills, good access to materials, and are less intensive in energy use. Some features of firm performance are: firm with larger portions of human skills capture the largest TE and higher TP values; those under high skills report larger losses due to negative scale effects; labor-intensive firms have larger TFP (less efficient but less exposed to energy prices).

Keywords: Total Factor Productivity, Technical Change, Manufacturing Industry, Indonesia

JEL Classification: D24, R11, L25, L60

ABSTRAK

Studi ini memperkirakan Technical Efficiency (TE) dan Total Factor Productivity (TFP) untuk menganalisis sumber-sumber pertumbuhan di provinsi Jawa Timur di Indonesia. Kemajuan teknologi, perubahan efisiensi teknis, dan efek skala diperkirakan melalui analisis stochastic frontier (SFA) untuk memecah berbagai sumber pertumbuhan dalam manufaktur. Studi ini melihat pola ekspansi output dengan membedakan keuntungan dari sumber konvensional –pertumbuhan input dan kemajuan teknologi dan sumber non-konvensional perubahan efisiensi teknis dan efek skala. Hasil dikumpulkan berdasarkan intensitas teknologi, ukuran perusahaan, rasio modal terhadap output yang digunakan, dan keterampilan tenaga kerja. Ia juga membandingkan Jawa Timur dengan lima provinsi lain di Pulau Jawa, koridor manufaktur negara itu. Seperti yang diharapkan, sektor manufaktur tumbuh melalui efek pertumbuhan input dan kemajuan teknologi - sumber konvensional, tetapi berkinerja buruk dalam produktivitas dengan memiliki perubahan efisiensi negatif dan efek skala negatif. Tenaga kerja memiliki elastisitas terbesar terhadap output (0,436), modal dan bahan baku memiliki elastisitas yang jauh lebih rendah, dan energi memiliki elastisitas negatif yang besar (-3,097) juga menyebabkan kenaikan biaya produksi yang tajam. Perusahaan berteknologi rendah, keterampilan yang lebih tinggi, dan ukuran sedang berkinerja 72% lebih baik daripada rata-rata (TFP). Perusahaan MLT dengan pe-

East Java Economic Journal, p-ISSN: 2597-8780, , DOI: 10.53572/ejavec.v2i2.16, Open access undera Creative Commons Attribution- 4.0 International Public License (CC - BY 4.0)
dipublikasikan oleh Kantor Perwakilan Bank Indonesia ProvinsiJawa Timurin Collaboration withFaculty of Economics and Business, Universitas Airlangga

rusahaan padat karya dan menengah berkinerja 58% lebih baik dari rata-rata. Namun, industri unggulan memiliki keterampilan yang lebih rendah, akses material yang baik, dan penggunaan energi yang kurang intensif. Beberapa fitur kinerja perusahaan adalah: perusahaan dengan porsi keterampilan manusia yang lebih besar menangkap nilai TE terbesar dan TP lebih tinggi; mereka yang memiliki keterampilan tinggi melaporkan kerugian yang lebih besar karena efek skala negatif; perusahaan padat karya memiliki TFP yang lebih besar (kurang efisien tetapi kurang terkena harga energi).

Kata Kunci: Produktivitas Faktor Total, Perubahan Teknis, Industri Manufaktur, Indonesia

JEL: D24, R11, L25, L60

Introduction

The province of East Java in Indonesia is second in population size (more than 39 million people in 2016) and second in contribution to national GDP (15.75% of Indonesian GDP in 2013). The average growth of East Java province from 2000 to 2013 reached 5.73% while industrial activity (excluding oil and gas) expanded at an average rate of 4.13%. The province highly relies on activities within trade, hotels, and restaurants (31.3%), places second on industry (26.5% of GDP); and has lower (and falling) share on agriculture (14.9%). However, the share of industrial activity of East Java to regional GDP was contracted by -3.56% to 26.6% in 2013. Agriculture also contracted from nearly 20% of total output to less than 15%. Contrary, trade, hotels, and restaurants expanded to 31.3% from previous 23.1% in 2001. From 2000 to 2013, out of seven main industrial sectors (excluding oil and gas), five of them decreased their contribution to regional GDP, while the other four expanded less than 0.20 percentage points. Food, drinks, and tobacco activities are particularly important to the industrial and agricultural sector which accounted for nearly 57% of total industrial output.

Amid economic turmoil and a reshape of economic activity in the East Java province, the region experiences strong economic growth giving signs of resilience. East Java (henceforth JATIM) enjoys a large and expanding labor force of nearly 20 million people, while the participation of gross fix capital formation as a percentage of GDP reached 27.45% in 2013 (though below national figures 32.79%). The growth of inputs of production suggests a possible backup in a more rapid expansion of regional output. However, the slow down of manufacturing activities in East Java, main economic sector until year 2012, might indicate a possible slow down in productivity. Labor absorbed by the manufacturing sector in 2017 remained at nearly 15%, similar to than that of 2000.

More recently, with the aim to accelerate and expand the national economy, the Indonesian government developed a Masterplan for Acceleration and Expansion of Indonesia's Economic Development (MP3EI 2011-2025). The government designed several economic corridors across the archipelago. Java was defined as the industrial corridor to serve manufacturing and services from the largest and most advanced island of the country.

However, at the national level, industry faces important challenges with input factors. Labor costs to output increased 27% in the last five years, the price index (year 2000 based) for electricity skyrocket to more than 342 in 2014 while coal price reached 996.66. Aside from higher prices, electricity consumption almost duplicated from 2000 to 2015 from more than 34GWh to nearly 66GWh respectively. On the other hand, nine sectors; metallurgic, automotive, electronics, chemicals, food and drinks, animal feeds, textiles and textile products accounting for nearly 80% of industrial output in East Java depend on intermediate imports, estimated by the ministry of industry at 64% of the total manufacturing sector.

While for the last three decades the largest source of growth in the Indonesian and in the developing Asian World arises from larger amount of inputs (Lee and Hong, 2010), it is expected that, as the country moves to higher economic development, the source of growth shifts to productivity gains. Several champion industries in Indonesia rely on low production cost and labor intensity which makes it crucial for manufacturing activities to shift models from labor – natural resource intensities (Esquivias Padilla, Sari, & Handoyo, 2017; Equivias, 2017) to higher productivity. The vast majority of firms in the country are small and medium, commonly suffering from lower efficiency in production and excerpting pressure on the need to revitalize the sector.

This paper addresses the question if industry in East Java is recording a shift towards higher gains in scale and efficiency as important determinants in output expansion, and as alternative sources of growth to that of expanding mainly by input growth and technological absorption. This paper also explains sources of growth in East Java manufacturing sector, extending the classical Solow (1957) model input growth (labor, capital, raw materials and energy) and technology role, and effects due to scale component and technical efficiency.

Productivity is highly relevant as it is considered as a primary determinant of output growth (central point of the MP3EI), key to faster GDP growth, higher incomes, and bigger labor demand (jobs). By employing the SFA, the elements of Total Factor Productivity (TFP) are estimated -technological change (TP), scale component (SEC) and change in technical efficiency (TEC)-. The elasticity of output with respect to four inputs of production; labor, capital, raw materials, and energy is also estimated. Energy is seldom employed while it offers important implications considering the large government subsidy, the increase in prices, and consumptions over time. A cost-share analysis also captures the impact of input price change. Another contribution of this paper is that it allows capturing differences at a firm level based on size (large and medium), the degree of human resource intensity (labor intensive or high skills), the degree of capital to output, and technological intensity. The study also compares across six provinces in Java Island, the largest Island (population and GDP) in Indonesia.

Empirical Review

Three issues become a special interest of this study. The first is related to evidence on productivity as one of the primary sources of output growth with mixed results in sources of growth and impact dimension. The second issue focuses on empirical evidence on Indonesian productivity and manufacturing sector which appears to be dynamic across time, and diverse in findings. The third issue arises as outcomes in studies related to TFP and TE which commonly encounter differences in performance as firms-industry characteristics vary.

Related to the first issue, empirical studies frequently coincide with input growth and firm productivity, particularly technological progress, as main source of output growth as noted in Liu and Li (2012). For the Chinese case, Li and Liu (2011) found input growth contributed 63% of the economic expansion from 1985 to 2006 (equal to 6.4% out of 10.1% GDP growth rate), where physical capital plays a primordial role. However, while technical progress contributed positively to TFP (86%), scale effects were smaller (16%), and TEC was negative. Lee and Hong (2010) who employed growth accounting claimed that capital accumulation strongly supported the vigorous growth of emerging Asian countries, and at some degree, by labor, while higher income nations tend to rely more on productivity gains to expand output. While not conclusive, empirical studies on productivity notice higher pressure on countries towards non-conventional sources of growth as their income rise. Shifts in inputs where traditional labor is being substituted by more abundant capital to reach higher productivity or shifts towards human capital rather than only growth in labor as mentioned by Hill and Kalirajan (1993) and Liu and Li (2012) might support the new path experience by countries. In some cases, even conventional sources are at stake as noticed by the evidence of technological progress hindering growth in Indonesia as stated by Margono and Sharma (2006). Felipe, J (1999) also found that for the last three decades (1970-1990's), East and South East Asian economies had experienced decreasing returns in their growth rates. Han et al. (2002) noted that from 1987 to 1993 larger inputs and, to some extent tech progress has supported the growth in developed Asian countries. However, there is less evidence of TEC.

Evidence on TFP growth for the Indonesian manufacturing case also show mixed results. Timmer (1999) through a growth accounting method observed a 2.8 percent of TFP growth from 1975 to 1995. Similar results are supported by Aswicahyono and Hill (2002) with evidence of TFP grew averagely at a rate of 2.3 percent from 1975 to 1993. However, in more recent studies, Margono et al. (2011) found TFP growth across Indonesian provinces declined by 7.5 percent mainly supported by technical inefficiency (1993-2002). Results from Widodo et al. (2014) also supported a decline in TFP performance, towards the end of the 1990's, as well as technical progress as the main driver of productivity growth while scale efficiency and technical efficiency (non-conventional sources) played a less important role in TFP growth. Margono and Sharma (2006) also supported TP as main driver in some provinces, but stronger effects via technical efficiency changed in most Indonesian provinces.

Findings from Lee and Hong (2010), Saliola and Seker (2011), Sugiharti et al. (2017), Park (2012), among others, signal of possible change in the sources of growth of manufacturing in Indonesia as well as changes experience in input contribution to output growth, causing variations in the Indonesian growth pattern and changes in contribution of inputs of production.

Some other previous empirical studies have observed disparities in TFP and TE performance presumably arising as differences in firms' characteristics. Evidence on the firm's age, total output, capital intensity, and legal status were found to affect the technical efficiency in Australian textile and clothing industries, as noted by Wadud (2004). Margono and Sharma (2006) observed that location and size could affect the inefficiency positively on several industries in Indonesia, claiming evidence of decreased TFP in particular strategic industries in Indonesia -food, textile, and metals. Larger firms also experienced an average larger TFP in some industries as well as differences in TP and TEC performance across provinces. On a similar line, Sheng and Song (2011) studied TFP at firm level for China's iron and steel industry which found evidence of productivity improvements with firms differing in size, location, capital/labor ratio, and ownership. Oh et al. (2014) who analyzed the Republic of Korea's manufacturing sector from 1987-2007 found signals of large size firms achieving larger TFP growth (2.59) than medium size (1.92), and micro (1.75), while high-tech firms experienced larger TFP (3.39). Liu and Li (2012) also observed differences on firm performance in China by tech-groups as they are associated with different input intensities; labor is putting pressure on cost forcing shifts from intensive labor manufacturing activities to other more capital or capital-intensive human ones. Inputs gain higher efficiency and the largest growth. Reforms and special programs are also sources of productivity change, as those found in China's agricultural sector by Kalirajan et al. (1996) and those of Oh et al. (2014) who found evidence on effects due to policies for South Korea's case (1987-2007).

The three issues considered; tendencies of TFP growth, the mixed results in previous studies on TFP in Indonesia, and the multiple references on studies looking at firm or industry differences signals that Indonesia might also experience a change in the pattern of output growth, and important changes in TE, TFP and input performance as firms vary in size, skills, location, capital, industry, and technology. The MP3EI policy might also reinforce changes in manufacturing sector.

Data and Methodology

This study employs Stochastic Frontier Analysis (SFA) to segregate the sources of output growth in the Java Island, particularly in East Java province from 2007 to 2013. It also estimates technical efficiency, input growth, and cost share of inputs. The technical efficiency is often measured by Malmquist index, by data envelop analysis technique (a non-parametric model commonly know as DEA), or by parametric estimation as that of a SFA (Coelli, Estache, & Parelman, 2003). The SFA methodology captures standard errors allowing measuring (in) efficiency performance across firms in time (Kumbhakar and Lovell, 2003).

On the other hand, TFP growth estimation is mainly performed via growth accounting approach which assumes the firms enjoy full TE and TP, or through a production function when the full TE assumption can be relaxed and output growth components can be separated (Margono and Sharma, 2006). Productivity-based growth pattern has gained popularity in estimating output expansion over accounting-growth (Park, 2012), among other reasons, as it allows decomposing sources of growth, and measuring technical inefficiency (Aigner, Lovell, & Schmidt, 1977; Kumbhakar & Lovell, 2003).

This study distinguishes the sources of output growth into: the input growth effects, and into three different components of TFP (Kumbhakar & Lovell, 2003); scale effect (SEC); technical progress (TP); and technical efficiency change (TEC). Output expansion through input elements is derived from changes in factors employed. The Hicks-neutral production function was chosen among different production functions (tested in this paper), allowing to relax the assumption of constants returns to scale imposed in the neoclassical Solow growth model. In this way, factors can reinforce the expansion of output through scale effects or due to technology. The SFA model also captures changes in efficiency over time, by allowing for time-varying TE and capturing TEC impacts on output.

Stochastic Frontier Approach

This study follows the estimation of Liu and Li (2012) on the input effects, cost effects, and the TFP decomposition. Technical progress will signal shifts in the production possibility frontier (PPF) under the presence of technological change. Technical efficiency change will capture changes in the position of firms towards or away from the locus of the PPF which will determine the maximum output that can be attained under the existing technology with the available factors. A firm operating on the frontier is considered technically efficient. Technical inefficiency is allowed through the specification of a non-negative random component in the error term. The estimation of the production function and the inefficiency function are carried out at the same time as specified by Battese and Coelli (1995) by the SFA.

The production function is modeled as in Kalirajan and Shand (1994),

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

Where y_{it} is the output of the i'th firm in t period, x_{it} represents a vector of inputs, and β is a vector of estimated parameters. The error term vit is assumed to be independent and follows a normal distribution, N (0). The u_{it} represents the technological (in)efficiency in production which is assumed for this case as a firm specific based on the expected maximum value of Y_{it} conditional on μ_{it}= 0. $v_{it} - u_{it}$ are evaluated at the maximum likelihood estimation (Coelli, Rao, O'Donnell, & Battese, 1998) The conditional expectation of TE is defined as:

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

TE expresses the maximum output a firm can produce based on the distance to the PPF. A fully efficient firm takes the value of one, while a fully inefficient firmtakes that of zero. Time is allowed to affect the production function representing the effect of TP:

$$y_t = f(x_{1t}, x_{2t}, ... x_{kt}, t)\, e^{-ut} \quad (3)$$

The logarithm form of Eq (3) is differentiated with respect to time to estimate the growth of output $(\dot{y}_{jt})$; the growth of each input $(\dot{x}_{jt})$; the output elasticity with respect to each input (e_{jt}); the technical progress $(\dot{A}_t)$; and the technical efficiency change $(T\dot{E}_t)$.

$$\dot{y}_t = \sum_j e_{jt}\dot{x}_{jt} + \dot{A}_t + T\dot{E}_t \quad (4)$$

Following Liu and Li (2012) by inserting e_{jt}(1/ e_{jt}) in Eq. (4) we can obtain:

$$\dot{y}_t = \sum_i \frac{e_{jt}}{e_t}\dot{x}_{jt} + (e_t - 1)\sum_j \frac{e_{jt}}{e_t}\dot{x}_{jt} + \dot{A}_t + T\dot{E}_t \quad (5)$$

The cost share of each input is estimated via cost minimization following Liu and Li (2012),

$$s_{jt} = \frac{e_{jt}}{e_t} \quad (6)$$

Eq (6) is inserted into Eq (5) to fully split output growth into four components: input growth $(\dot{\Phi}_t)$, adjusted scale effect $(e_t - 1)\dot{\Phi}_t$, technical progress, and technical efficiency growth.

$$\dot{y}_t = \sum_j s_{jt}\dot{x}_{jt} + (e_t - 1)\sum_j s_{jt}\dot{x}_{jt} + \dot{A}_t + T\dot{E}_t \quad (7)$$

TFP is further originated from Eq (7) as:

$$TFP_t = \frac{y_t}{\dot{\Phi}_t} \quad (8)$$

Finally, assuming Φ_t as the growth of inputs $(\dot{\Phi}_t = \sum^j s_{jt}\dot{x}_{jt})$, as in Liu and Li (2012),

$$T\dot{F}P_t = (e_t - 1)\sum_j s_{jt}\dot{x}_{jt} + \dot{A}_t + T\dot{E}_t \quad (9)$$

The Functional Form of Study

As explained by Salim, Bloch, and others (2009), the SFA can be estimated by employing a flexible functional form to reduce the risk of errors in the model. This study employs five sub-models (Table 1) and tests them based on each proper null hypothesis considering that the translog model might not fit the data of this study.

Table 1: Functional Form of Production Functions

Sub-Model	Null Hypothesis
Hicks-Neutral technological progress	$\beta_{nt} = 0$
No-technology progress in the production frontier	$\beta_t = \beta_{tt} = \beta_{nt} = 0$
Cobb Douglas with efficiency model	$\beta_{tt} = \beta_{nt} = \beta_{nk} = 0$
Cobb Douglas with efficiency model	$\beta_t = \beta_{tt} = \beta_{nt} = \beta_{nk} = 0$
Cobb Douglas without efficiency model	$\gamma = \delta_0 = \delta_j = 0$

Source: Suyanto and Bloch (2009)

The production function employed in this study is defined as:

$$\ln Y_{it} = \beta_0 + \beta_c \ln C_{it} + \beta_L \ln L_{it} + \beta_{RM} \ln RM_{it} + \beta_{EN} \ln EN_{it} + \beta_{tt} + \frac{1}{2}[\beta_{cc}(\ln C_{it})^2 + \beta_{LL}(\ln L_{it})^2 + \beta_{RMRM}(\ln RM_{it})^2 + \beta_{ENEN}(\ln EN_{it})^2 + \beta_{tt}(t)^2] + \beta_{CL}\ln C_{it}\ln L_{it} + \beta_{CRM}\ln C_{it}\ln RM_{it} + \beta_{CEN}\ln C_{it}\ln EN_{it} + \beta_{ct} t \ln C_{it} + \beta_{LRM}\ln L_{it}\ln RM_{it} + \beta_{LEN}\ln L_{it}\ln EN_{it} + \beta_{Lt} t \ln L_{it} + \beta_{RMEN}\ln RM_{it} EN_{it} + \beta_{ENt} t \ln EN_{it} + \beta_{RMt} t \ln RM_{it} + v_{it} - u_{it} \quad (10)$$

A generalized likelihood (LR) test is employed as $LR = 2[\log L(\hat{\theta}) - \log L(\tilde{\theta})]$, t to choose the best functional form. $(\hat{\theta})$ represents the maximum likelihood estimator for the unrestricted model, and denotes $(\tilde{\theta})$ the maximum likelihood for the restricted one. The decision to reject the null hypothesis is based on (Verbeek 2008, p.183), when LT test is bigger than the χ^2 distribution value.

Table 2: Definition of Variables in the Production Function

Variables	Definitions
Y	Output (in million rupiah) measured by the value of goods produced
C	Capital (in million rupiah) for manufacturing capital
L	Labor measured by total number of workers per working day
RM	Raw Materials (in million rupiah) measured by the value of goods employed as raw material
EN	Energy (in million rupiah) measured by the value of energy employed as inputs for production

Note: Values of Output, Capital, Raw Materials and Energy deflated are at wholesale price index measured at five-digit ISIC level for manufacturing in the year of 2000 constant price

After choosing the general Hicks-neutral and allowing for time-varying TE, the technological progress and scale effect are expressed as Kumbhakar and Lovell (2003):

$$TP = \frac{\partial \ln(y_{it})}{\partial t} = \beta_t + \beta_{tt} t + \beta_{it}\ln c_{it} + \beta_{it}\ln l_{it} + \beta_{it}\ln rm_{it} + \beta_{it}\ln en_{it} \quad (11)$$

$$SC = (e-1)\sum_j \left(\frac{e_j}{e}\right)\dot{X}_j \quad (12)$$

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

$$\epsilon_{nit} = \frac{\partial y_{it}}{\partial x n_{it}} = \beta_n + \frac{1}{2}\sum_{n=1}^{4}\sum_{m=1}^{4}\beta_{nm} x m_{it} \quad (13)$$

Output elasticity with respect to each factor of production is estimated as:

$$el = \beta l + 2\beta ll \ln l_{it} + \beta lc \ln c_{it} + \beta lrm \ln rm_{it} + \beta len \ln en_{it}, \quad (14)$$

$$ec = \beta c + 2\beta cc \ln c_{it} + \beta cl \ln l_{it} + \beta crm \ln rm_{it} + \beta cen \ln en_{it}, \quad (15)$$

$$erm = \beta rm + 2\beta rmrm \ln rm_{it} + \beta rml \ln l_{it} + \beta rmc \ln c_{it} + \beta rmen \ln en_{it}, \quad (16)$$

$$een = \beta en + 2\beta enen \ln en_{it} + \beta enl \ln l_{it} + \beta enc \ln c_{it} + \beta enrm \ln rm_{it}, \quad (17)$$

Based on Khalifah and Abdul Talib (2008, p. 93) TEC can be derived from equation (2) as:

$$TEC = \frac{TE_{i(t+1)}}{TE_{it}} \quad (18)$$

The splitting of output growth $\dot{Y}_{it}$ components is further derived by adding input growth $(\dot{\Phi}_t)$, the effect of adjusted scale $(e_t - 1)\dot{\Phi}_t$, the technical progress, and the technical efficiency growth. TFP growth captures the output growth after removing the input growth as,

$$T\dot{F}P = TP + SC + TEC \tag{19}$$

Input growth and the adjusted scale derive from the input growth variables $(\dot{C}, \dot{L}, R\dot{M}, E\dot{N})$ as:

$$\dot{\Phi}_{it} = \frac{e_{Cit}}{e_{it}}\dot{C}_{it} + \frac{e_{Lit}}{e_{it}}\dot{L}_{it} + \frac{e_{RMit}}{e_{it}}R\dot{M}_{it} + \frac{e_{EN}}{e_{it}}E\dot{N}_{it}$$

The return to scale variable and the output elasticity computed in Eq. (14) to Eq. (16) as,

$$Scale_{it} = (e_{it} - 1)\left(\frac{e_{Cit}}{e_{it}}\dot{C}_{it} + \frac{e_{Lit}}{e_{it}}\dot{L}_{it} + \frac{e_{RMit}}{e_{it}}R\dot{M}_{it} + \frac{e_{EN}}{e_{it}}E\dot{N}_{it}\right) \tag{20}$$

Data

This study looks at 12,016 manufacturing firms in Java Island (3,812 in East Java) from 323 five-digit ISIC categories for the period of 2007-2013. The data were collected on yearly basis by the National Statistics Bureau of Indonesia, or Badan Pusat Statistik (BPS), under the national survey for medium and large manufacturing enterprises. This period is characterized by global turbulence, fluctuation on global commodity prices, and by the new industrial policy under the MP3EI.

The paper classifies firms based on five different criteria to allow a more precise comparison. Location includes six provinces in Java Island. Size reveals the scale, large (L more than 100 workers) or medium enterprise (ME). 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 labor is higher than 30%, and companies that are Labor 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). MHT includes transport, machinery, chemicals, while MLT are highly related to natural resource base (paper, wood, rubber, coke, basic metals, non metallic minerals).

Table 3: Statistical Performance of the National Manufacturing Industry (2009 and 2013)

	Total No of firms		Total No employees (10,000)		Industry Value Added (Billion Rupiah)		Worker Productivity (1,000 Rupiah)	
	2009	2013	2009	2013	2009	2013	2009	2013
LT	**16.855**	**16.024**	**293**	**337**	**358.164**	**713.174**	**1.452.461**	**2.213.365**
L	4.171	4.401	246	291	331.139	665.266	1.599.210	2.396.900
SME	12.684	11.623	46	46	27.023	47.908	699.326	1.152.173
MLT	**4.553**	**4.646**	**70**	**80**	**132.331**	**243.035**	**1.373.875**	**2.136.434**
L	1.371	1.483	58	66	119.872	216.499	1.546.756	2.400.088
SME	3.182	3.163	13	14	12.46	26.538	862.637	1.420.877
MHT	**2.557**	**2.943**	**67**	**82**	**304.898**	**516.497**	**3.559.452**	**3.941.711**
L	1.143	1.199	61	73	290.793	477.844	3.801.077	4.112.900
SME	1.414	1.744	6	9	14.104	38.653	1.213.515	2.813.645
TOTAL	**23.965**	**23.613**	**431**	**499**	**795.393**	**1.472.706**	**6.385.788**	**8.291.510**

Note: Low Technology (LT), Medium-Low Technology (MLT), Medium-High Technology (MHT), High Technology firms included within MHT. Large size (L), Small and Medium Enterprise (SME). National Data, not only Java Island.

Source. Data from BPS, Badan Pusat Statistik Indonesia, arranged by the author.

Empirical Results

The industrial performance of manufacturing in Indonesia from 2009 to 2013 is reported in Table 3 which shows a decrease in the number of firms and a fall in efficiency in 8% (input to output ratio). The period is of particular interest as it covers years of favorable global demand, high commodity prices, strong national economic growth, and the introduction of a national economic strategic plan MP3EI. Overall employees, value-added output, worker productivity, and production to installed capacity improved. While labor had expanded, it costs firms 27% more, with worker productivity increasing only dimly above the rise of labor cost. As most industries in Java are labor-intensive, raises on labor cost influence firm value-added. A particular aspect denoting a shift in manufacturing is that among low tech and medium low tech firms the number of SME enterprises fell and the total number of employees remained at nearly same level as 2009. Large enterprises experienced a larger expansion in number of workers and industry value added. Manufacturing might be shifting towards higher capitalization and lower reliance on labor. Although the results do not capture the effect of higher capital, it is also possible that labor productivity had been supported by larger amounts of capital and more energy available.

Production Function Interpretation

Regression estimates for the whole Java Island are displayed in Appendix. Technical efficiency was estimated by employing a Translog, Cobb Douglas, and Hicks-Neutral, and tested for LR best fit. Hicks-Neutral model is the most robust model with the parameter of labor, capital, and raw materials appearing positive and significant when being tested at 1 percent level, indicating that output expands when those three inputs raise. Likewise, the coefficient of squared inputs is also positive and significant suggesting that labor, capital, and raw material inputs experience increase returns with a positive marginal product supporting output growth. However, in the case of energy, the coefficient is negative which experiences diminishing returns but not significant. Javanese firms still have plenty of resources to expand as the abundant labor and the increasing capital positively contribute to output expansion.

The cross effect of the inputs is examined through the estimated coefficient for interacting input variables following Ogundari and Brummer (2011 p. 67). The positive sign in the second order for cross-effect inputs between labor-capital and labor-energy indicates a substitution effect between inputs. In contrast, labor-raw material has complementary effects (negative cross-effect). Those findings have implications in the shifts from labor to equipment exemplified in the form of larger capital, and larger energy use, a possible automation experience in manufacturing as labor cost rise and pressures on competitiveness arise. It also implies that labor and materials mainly support the patterns of Javanese manufacturing. On the other hand, raw materials complement with capital and energy support the above argument of labor being replaced by capital-energy, but not materials.

Maloney and Molina (2016) show that operations work force in Indonesia is falling while higher numbers of technicians and service occupations are on the rise, indicating latent polarization in the labor market and possible flying geese pattern where labor intensive jobs might be relocated to lower cost destinations. The data provided by the Indonesian bureau of statistics employed in this paper allows capturing production and non-production labor, but does not allow to capture skills (education or experience) on workers.

Technological progress has a positive link with output, captured by the significantly positive coefficient of time. The parameter estimated for time squared (positive and statistically significant) also suggests that the effect of time on output will keep a positive track.

In addition, interactions between inputs and time variables offers important implications. The interaction between capital and time exhibits a non-neutral technological regress (negative and significant). On the contrary, the relationship between raw materials and time exhibits TP improves across time, possibly denoting higher quality of inputs, either as better access to material inputs (imports) or increase in local quality.

Production Function Interpretation

This study captures differences in TFP performance across enterprises under factors like location (province), size (large and medium), degree of Human Resource intensity (labor or skill intensity), degree of capital to output, and technology intensity. In fact, the more specific the groups allowing factors to agglomerate firms, the clearer the differences in performance.

Table 4 shows the estimates of the elasticity of output with respect to each input, the cost share to total cost by each factor, the input growth effect in output, and the scale effect. The cost share shows the effect of each input cost in the total cost of production.

Concerning the contribution of factors to output growth, labor is by far the most important input contributing with 0.450; however, below the Java's 0.463 average. Capital reports a low impact to output with only 0.004 (in line with Saliola and Seker, 2011), while raw materials have a higher impact at 0.030. This supports the pattern of a manufacturing sector which highly supported by labor to continue expand as the most critical input of production. While capital and materials have positive elasticity towards output, their support to output growth is rather small. On the other hand, energy reports a negative output elasticity of -2.488. Compared to other provinces, East Java relies less on labor and more on the other inputs with particularly smaller negative elasticity with respect to energy. East Java might have advantage in better energy supply (access) versus other provinces. The total output elasticity is negative when energy is included as it pulls down the output elasticity effects created by other inputs. However, isolating energy, the contribution to inputs is highly unbalanced and still displaying a dependence on labor while it has low effects on capital and materials.

Table 4: Growth Decomposition for Three Industrial Groups East Java (Average 2007-2013)

	Output Elasticity					Cost Share			
	e_L	e_K	e_{RM}	e_{EN}	e_{Total}	s_L	s_K	s_{RM}	s_{EN}
LT	0.437	-0.004	0.038	-2.900	-2.429	-0.1527	-0.1621	0.0592	1.2556
MHT	0.339	-0.017	0.001	-3.235	-2.913	-0.0808	0.2722	-0.0133	0.8219
MLT	0.581	0.063	-0.013	-3.366	-2.735	-0.1889	-0.0140	0.0125	1.1904
HT	0.363	-0.047	0.026	-2.684	-2.343	-0.0958	0.0507	0.0050	1.0401
Total	0.450	0.004	0.030	-2.972	-2.488	-0.1536	-0.1062	0.0460	1.2138

	Input Growth Effect					Scale Effect (%)		
	$s_L\dot{L}$	$s_K\dot{K}$	$s_{RM}R\dot{M}$	$s_{EN}E\dot{N}$	$\dot{\phi}$	e-1		$(e-1)\dot{\phi}$
HT	-0.028	0.010	-0.434	0.275	-0.177	-3.429		-1.796796
LT	-0.034	-0.004	0.017	0.417	0.3961	-3.913		-1.05651
MHT	-0.030	-0.001	-0.002	0.524	0.4902	-3.735		-2.86848
MLT	-0.020	-0.008	-0.054	0.078	-0.0035	-3.343		-0.50145
Total	-0.032	-0.005	0.004	0.377	0.3441	-3.488		-0.990592
	$\dot{\phi}$	Scale	$T\dot{E}$	$\triangle\delta_t$	$T\dot{F}P$	$Estimated\,\dot{Y}$	$Actual\,\dot{Y}$	$Y-\dot{Y}$
	1	2	3	4	(2+3+4)	6	7	(7-6)
HT	-0.1770	-1.0369	-0.008	0.048	-0.997	-1.222	0.159	1.381
LT	0.3961	-1.3957	-0.012	0.045	-1.361	-1.011	0.134	1.145
MHT	0.4902	-2.5499	-0.007	0.049	-2.507	-2.067	0.234	2.301
MLT	-0.0035	-0.8870	-0.010	0.046	-0.850	-0.901	0.154	1.055
Total	0.3441	-1.3777	-0.011	0.046	-1.342	-1.045	0.141	1.186

$T\dot{F}P$ = adjusted scale effect (Scale) + technical progress $\triangle\delta_t$ + change in technical efficiency $T\dot{E}$.
Estimated growth of output $(\dot{Y})$ = input growth $\dot{\phi}$ + $T\dot{F}P$. $(\dot{Y})$ is the actual output growth $Y-\dot{Y}$
e_K Elasticity of Output with respect to capital, e_L elasticity with respect to labor, e_{RM} elasticity with respect to raw materials, eEN elasticity with respect to energy, e Total Elasticity of Output

Looking at the cost share analysis, the largest increase in cost in East Java manufacturing is under energy. Both prices and quantity of energy have increased, responsible for 1.213 times the total surge of cost. In fact, both prices and industrial consumption of energy inputs had nearly duplicated from 2000 to 2015 in Indonesia. Average electricity prices in the industry grew from US$/BOE 41.43 in 2000 to US$/BOE 128 in 2014 and electricity consumption almost duplicated from 34.013GWh in the year 2000 to 65,909GWh in 2014. Base on year 2000 reference prices, both the price index for electricity increased to 342.44 in 2014, as well as the price index for coal reached 996.66 (2014). Sectors particularly affected by the rise in energy prices (more than 100%) are within: instruments (medical, optical, precision); wood, pulp and paper; manufacturing (recycling); textiles, leather and footwear; motor vehicles and basic metals.

Raw materials also cause the cost of production to rise by 0.046 times. Labor is reported to decrease amid the increase in wages. Possibly, it indicates a shift from labor to energy (machinery) inputs. Capital contributes a negative share, which means that savings rises as the input experiences capital-saving stage. The impact of changes in cost structure might indicate a change in pattern of manufacturing in East Java which relies more on non-labor factors and enjoys capital-saving. However, the effect of capital on output is still rather small.

While energy is accounted for the largest increase in cost, it also represents the largest contributor to output expansion (0.344). Other inputs are experiencing a decline as contributors to output. This is an important finding considering that labor has been the main input of manufacturing growth. Albeit abundant endowments and input expansion, factors add little or even cause output to contract. The effects of each input varies across tech groups, with high-tech groups benefiting from capital saving and energy supply, but being in trouble with materials and labor. For the low tech firms (labor-intensive), labor experiences the largest negative effect to output while expansion via materials (probably imports or lower prices of resources) and energy.

The scale estimations reveal that inputs in all tech groups experience negative contribution to output via scale effects. Particularly, medium MLT firms have the largest negative scale effect. Unfortunately, East Java has more inputs but the complementation might be poor, missing possible gains via scale, or perhaps caused by low quality inputs.

The lower section of Table 4 indicates the decomposition of TFP. All the four groups experienced negative TFP growth, on average -1.342%. East Java performs below Java's productivity, however, in high-tech and medium-low tech where the TFP has smaller negative effects. East Java manufacturing firms report positive technical progress in all tech groups, but only LT and MHT report positive sign due to the expansion of inputs. These two concepts are the conventional sources of output expansion. However, all four tech groups in East Java report negative impacts in output growth through scale and technical efficiency, alternative sources of growth more related to the quality and efficiency of inputs. The largest negative source of growth is scale, calling for manufacturing to look at improvements in input quality. It is highly possible that effects from input growth might get smaller over time, putting pressure on the country to imporve skills, technological capability, and efficiency. While a large pool of inputs could allow the region to gain due to scale, manufacturing is, in fact, slowing down.

Industrial actual output estimation is positive in East Java, 0.141% with MHT experienced the largest growth. The estimated expansion of output is negative (- 1.045%) with lower estimations for HT and MHT groups, somehow worried some as they also experienced almost double rates of output growth versus low tech groups.

Table 5 presents the average Technical efficiency (TE) and the main element of TFP by firm size and technological group. TE ranges from a highest level in medium-high tech firms of 0.745 to the lowest equal to 0.636 in the low-tech firms.

East Java's firms register an average TE of 0.648 (35.2% inefficiency), a rather low level, offering possibilities for efficiency increase. Large firms report a slightly larger TE over medium ones. Technical efficiency change records -0.011, meaning firms are less efficient in employing factors overtime.

Table 5: Growth Decomposition for the Aggregates and Three Industrial Groups East Java

		TE	TEC	TP	SEC	TFP Avrg	TFP 07-08	TFP 12-13
Size	Medium	0.648	-0.011	0.044	-1.211	-1.178	-0.878	-2.723
	Large	0.650	-0.011	0.054	-2.103	-2.060	-2.231	-3.273
Technology	HT	0.713	-0.008	0.048	-1.037	-0.997	-2.639	-3.928
	LT	0.636	-0.012	0.045	-1.396	-1.361	-1.041	-2.892
	MHT	0.745	-0.007	0.049	-2.550	-2.507	-4.325	-1.589
	MLT	0.691	-0.010	0.046	-0.887	-0.850	-0.231	-2.931
Average Total		0.648	-0.011	0.046	-1.378	-1.342	-1.066	-2.844

By size, large firms reported larger negative TFP growth with -2.060 versus - 1.178 in MEs. While TEC between both groups of firms are rather similar (nearly - 0.011) there are important differences in technological progress (TP) and scale (SEC). Large firms experienced higher gains in TP but lower in scale, possibly mirroring a larger technological gains more often observed in MEs and a larger challenge in management (scale) observed in large firms. Over time the scale effect signals a deterioration towards the end of the period (2012-13).

Larger differences in performance across groups are shown in the scale component, with largest negative figures on large firms (-2.103) and MHT. The low tech, less skill intensive, and smaller firms have the smallest negative SEC and smallest negative TFP. Large firms experienced larger negative TFP mainly as a result of large negative scale effects supported by adverse prices in energy inputs. While TE and TP is superior in large firms, the effects are cancel out by outsized negative effects in scale. In Sari et al. (2016) large firms in Indonesia were found to have lower technical efficiency over small firms. Large firms are more likely to possess higher technology and capital and for instance higher technological progress, consistent with this paper finding. However, large firms have greater negative effect in scale affecting the TFP, mainly as scale is highly influence by disruptions in energy, more important within large firms.

Most of the Indonesian firms are within LT and MLT, signaling an advantage in Indonesia within labor-intensive firms and relatively low technological capability. However, with MEs employing the vast majority of workers in the country and experiencing a negative scale, it questions the capability of ME enterprises to continue absorbing the large new workforce.

Table 6 illustrates the average TE values of firms when firms are agglomerated based on factors like size, skills, and capital ratio. TE is higher in low capital-intensive firms. Particularly good performance (22% higher TE than average) is noticed in HT firms, with low capital intensive, large in size, and employing higher skill share of workers. In general, HT and MHT firms report higher TE values over low tech and medium low-tech indicating a potential field for TE efficiency within those groups. A higher share of skill workers (HRI) in firms reported higher TE values over LI firms; skills might be an important contributor to higher TE in firms characterized by competing in low production cost. Size seems to matter depending on proportions of skills, tech, and capital employed. The lowest TE performance comes from Low Technology (LT) firms, particularly among those employing High-Capital intensive ratio. In fact, a majority of manufacturing firms in Java belong to these groups (low tech and labor-intensive). Low-Tech firms alone account for 72% of the total sample.

Table 6: Technical Efficiency (TE) and TFP components by Industrial Groups at Capital Intensity, Firm Size, and Skill Level East Java

	Low Capital Intensive				**High Capital Intensive**				
	SME		**Large**		**SME**		**Large**		
	LI	**HRI**	**LI**	**HRI**	**LI**	**HRI**	**LI**	**HRI**	**Avg**
HT	0.815	0.786	0.703	0.856	0.671	0.775	0.664	0.712	0.690
LT	0.674	0.690	0.654	0.686	0.615	0.656	0.610	0.648	0.624
MHT	0.797	0.773	0.816	0.781	0.701	0.771	0.714	0.740	0.731
MLT	0.729	0.715	0.737	0.705	0.696	0.696	0.623	0.635	0.686
Total	0.680	0.702	0.673	0.698	0.630	0.670	0.617	0.657	0.638

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

Overall, Medium High-technological and High-Tech firms report higher TE and whose sector requires higher skills in labor and higher technological capability, a feature still scarce in Indonesia as only 8% of firms are under HT and MHT. As the cost of inputs (labor, and energy) rise, the pressure in keeping comparative advantage is expected to increase.

Table 7 indicates the TE, TEC, TP, SEC, and TFP based on the tech group, firm size, and human resource intensity combined. In general, firms with larger shares of human skills capture larger TE and TP values over those firms' intensive in production labor. Higher skills workers (HRI) might contribute to more efficient manufacturing activity (larger gains via TP) indicating potential output gains in East Java by supporting skills, particularly in LT firms.

Table 7: Estimators Based on Industry Group, Size, and Human Resources East Java

ME		TE		TEC		TP		SEC		TFP		
		L	ME	L	ME	L	ME	L	ME	L	Avg	
HT	LI	0.696	0.670	-0.008	-0.010	0.045	0.054	-0.827	-0.472	-0.790	-0.428	-0.710
	HRI	0.778	0.749	-0.006	-0.008	0.046	0.055	-1.435	-1.890	-1.394	-1.843	-1.632
LT	LI	0.628	0.625	-0.012	-0.012	0.043	0.053	-1.433	-2.383	-1.401	-2.341	
	HRI	0.663	0.659	-0.011	-0.009	0.045	0.054	-0.661	-1.406	-0.626	-1.360	-1.533
MHT	LI	0.717	0.760	-0.008	-0.007	0.046	0.056	-1.676	-2.370	-1.637	-2.321	-0.846
	HRI	0.772	0.750	-0.007	-0.006	0.047	0.056	-2.062	-5.506	-2.021	-5.456	
MLT	LI	0.699	0.652	-0.009	-0.011	0.044	0.053	-0.619	-2.362	-0.584	-2.320	-1.803
	HRI	0.699	0.653	-0.008	-0.024	0.047	0.054	-0.890	-1.022	-0.851	-0.978	-3.258
Average Total		0.648	0.650	-0.011	-0.011	0.044	0.054	-1.211	-2.103	-1.178	-2.060	**-1.489**

Notes. High Technology (HT), Low Technology (LT), Medium-High Technology (MHT), and Medium-Low Technology (MLT). Large Size (L), Medium Enterprise (ME), Labor Intensive (LI), Human Resource base (HRI).

Another finding is that size and skills matter across manufacturing sector and carefully observing the features of industries could help to address productivity challenges better. Firms under HT groups combining labor intensive workforce and large in scale reported 68% larger TFP than average firm. They were supported by TP and lower negative scale effects. In the same line, within Low-tech (LT) firms those employing higher skill workers and medium in size reported a 53% higher TFP performance. MLT firms with labor-intensive and medium size register 56% higher TFP than average firms. However, East Java seems to be specially negatively affected due to scale effects under MHT firms, were both skills and tech are required causing underperforming on all groups. The large majority of Indonesian champions are medium (ME) in size and labor intensive (LI), meaning that HT and MLT tech groups might offer the best gains for them. Policy addressed at particular groups might offer gains: 1) larger number of low skill workers could be absorbed by labor-intensive firms under HT (ME and L) and MLT (ME); 2) increased skills in LT and MLT groups could help increase TFP. 3) Efficiency and TP gains can be achieved in higher skill sectors, especially large size firms.

Considering that LT and MLT are accounted for 92% of the total firms in Java and 81% of the labor force, they deserve special attention. Most workers (75%) are production workers (consider as LI in this paper). This also illustrates that TFP within those characteristics still enjoys the best performance (LI, LI, ME). Somehow, it supports as the advantage of East Java within those sectors, even though output in higher tech groups is growing at more than double speed.

Regarding the change in indicators over periods of time, the performance of East Java manufacturing sector experienced a decline in efficiency and scale (non-conventional output growth sources), while TP increased from 0.043 to 0.05 as expected due to the accumulation of inputs, experience, and tech gains. East Java might be missing the opportunity to reinforce output expansion through scales with the growing labor pool and the larger accumulation of capital over time. While more inputs have been incorporated, they do not support growth.

Table 8: TE and TFP Estimations, First and Last Period East Java

	TE		TEC		TP		SEC		TFP	
	2007-2008	2012-2013	2007-2008	2012-2013	2007	2012-2013	2007-2008	2012-2013	2007-2008	2012-2013
HT	0.724	0.702	-0.009	-0.008	0.047	0.050	-2.680	-3.970	-1.969	-3.719
LT	0.651	0.620	-0.010	-0.012	0.043	0.050	-1.074	-2.931	-0.857	-2.575
MHT	0.760	0.725	-0.006	-0.008	0.047	0.053	-4.365	-1.635	-3.058	-1.329
MLT	0.705	0.677	-0.008	-0.010	0.043	0.051	-0.265	-2.972	-0.165	-2.748
Total	0.724	0.702	-0.010	-0.011	0.043	0.050	-1.099	-2.883	-0.864	-2.545

The negative TEC suggests a contraction of the production possibility frontier due to inability of firms to efficiently absorb new inputs. The large intensive labor and relatively low skills, the availability of low technology, and poor capital complementation might be a cause to the little improvement in the contribution of factors to growth.

The poor input complementation is also supported by the low TP as factors that experience the modest improvement for a long time. Technological Progress can be interpreted as the shifts of the production function over time. While physical capital is expanding fast, the low TP might suggest that other sources of capital as human capital, knowledge, information technology, innovation, among others might be required to support technological change. TP has important implications as it is so far the only TFP component that grows, thought small, though a larger TP might be desirable. The small increase in the rate of TP may suggest a positive recovery of manufacturing activity, possibly as a result of industrial policy. However, a higher TP is a must for Indonesia if the country is to compete in global markets, to substitute imports and to support the expected growth. More investments in innovation, new techniques, higher technological absorption capability, and other factors supporting tech capability may be needed to catch-up.

Scale effects that refer to the proportional contribution of inputs of production is put together to output growth. For East Java, the overall scale element is pushing down TFP and by instance, output growth. Particularly, large negative effects come from energy. The increase with positive elasticity for output growth and larger labor pool, larger and lower capital cost, and higher availability of materials (through imports) are cancelled by the large shift to energy which experiences a large rise in prices. Scale effect is particularly affecting large firms. As MEs are less affected by negative scale effects, they could absorb a larger number of labor over large firms.

While output expanded at 278% (constant prices), the data in this study recorded large increases of inputs: physical capital grown by 157%, labor (cost) raised by 248%, raw materials by 223%, and energy by 256% (the largest). While the expansion of labor, energy, and raw materials are relatively similar to that of output, Indonesia experiences capital saving by being able to expand output although the capital grows at a much smaller share than other inputs. The large growth of inputs also explains the possible low scale effects in inputs (excepting capital).

Total labor forced is expanded by 61%. However, it may be that the increase of labor are not properly supported by the necessary investments, or that the labor is unskilled in taking time before start adding value to industry. While the effects of scale through labor are large and increasing, wages have increased considerably perhaps because of the cancelation of the possible gains in productivity.

As most inputs in manufacturing experience the increase in returns to scale, there are incentives for firms to continue adding inputs until the returns to scale are exploited. In general, smaller firms have larger elasticity of output with respect to labor, capital and raw materials over elasticity from large firms, indicating that intensity of labor rather than skills had contributed more to manufacturing sector in Indonesia than any other factor, particularly in ME firms. MEs enjoys higher contributions to output, and by instance, they can absorb more of the new labor. The fact that all tech groups of firms registers negative elasticity of output with respect to energy calls for a deeper analysis on energy in industrial performance as the increase in prices might be exerting too much pressure on firms.

Manufacturing in East Java is highly dependent on labor to create higher impacts on output. Overall, labor is growing faster (more than 10%) than capital (less than 1%), reinforcing the point that manufacturing is capital saving but intensive in both labor and raw materials. Energy on the other hand causes output to expand but at the expense of high cost. Raw materials could be associated with resource-based industries, in line with findings of Esquivias (2017), or by substitutions of raw materials with foreign and cheaper sources.

Overall, total elasticity is negative at -2.98 and displays an unbalanced contribution of inputs to output growth suggesting a shift of manufacturing towards less labor and higher capital-energy inputs. While labor, capital, and materials might continue expanding, they might not compensate for the large negative effect of energy if policy makers are not coordinated.

Regional Analysis

In general, performance at provincial level across provinces in Java seems to be rather similar in technical efficiency change and technological progress both in dimension and in tendency. However, small changes across provinces are still exist and can still make a difference in productivity. East Java was found with a TE 3% below DYI (highest TE). While it is not displayed in this study, the cost of operating business (including labor) is substantially lower in DYI and Central Java than East Java, but industrial activity in East Java (20%) is far larger than DYI (5%). The largest industrial producer in the sample is West Java with 34%.

East Java is also reported to have the lowest TP among provinces (0.046) compared to DKI Jakarta and West Java that reached the leading TP performance of equal to 0.048. However, the tech improvement across time is rather small to suggest the existence of a big lag across provinces.

Table 9: Estimation of TE and TFP for Six Provinces in Java (2007-2013)

	East Java	DKI Jakarta	West Java	Central Java	DIY	Banten	Total Average
TE	0.65	0.66	0.66	0.67	0.68	0.66	0.66
TEC	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
TP	0.05	0.05	0.05	0.05	0.05	0.05	0.05
SEC	-1.38	-1.18	-1.47	-1.30	-1.17	-0.82	-1.32
TFP	-1.39	-1.19	-1.48	-1.31	-1.18	-0.83	-1.33

The largest differences are found under the scale effects (SEC) as Central Java, West Java, and East Java reports which are relatively more negative in SEC. Meanwhile, Banten is reported a much better SEC estimator. This might have several implications, as the ability of some provinces to absorb larger inputs and get larger effects to the expansion of output. East Java, for example, is reported the lowest gain due to capital-saving -0.09, lower gains in labor, and raw materials, however, better performance in energy cost which is more critical in Java.

In general, medium firms are reported better than TFP across the whole Java Island, except for Jakarta where larger firms have better TFP indicators. Medium– High Tech firms which are underperformed in most provinces are in fact doing well in Jakarta where higher skills and tech is available.

More precise differences in TFP performance are found where industrial groups across provinces vary in size, human resource, and capital-output ratio. East Java makes a difference over other provinces as it enjoys larger elasticity to output with respect to labor and raw materials, while a lower negative elasticity is under energy. For instance, East Java does a better job in HT and MLT firms than the rest of the provinces, however, it is not better in low-tech and MHT industries where DKI has larger labor pool, or DIY and West Java faces lower cost. East Java faces a challenge in labor, where seems that it neither enjoys higher skills, nor lower cost than other provinces. Materials and energy are giving East Java the lead within HT and MHT. DIY better TFP performance over other regions, mainly as they are more actively engaged in LT and MLT sectors were the negative energy impacts are smaller. DIY also has a lower labor rates than other provinces, important as they are mainly labor intensive industries, but enjoys a much higher capital to output ratio on MLT firms (although a much lower in LT). East Java by contrast is more diversify and has a larger manufacturing sector.

At industry level of analysis, East Java is ranked first in TFP in ISIC 19 Textiles, Coke is refined petroleum products (ISIC 23), Office accounting and computing equipment (ISIC 30), and 34 (Motor Vehicles Trailers and Semi-trailers). However, East Java has low participation within those industries except for ISIC 30 where it ranked second in 2013. The top ranking in those four industries is related to the scale effect where East Java also ranks first.

East Java tends to rank low compared to other provinces in most indicators, except for the scale component, mainly due to energy where it ranks high in six industries (out of 22). Surprisingly in tech progress, it tends to rank low in most industries. An exception in performance is electrical equipment which it ranks second in TP. However, it has a share of output.

Table 10: Growth Decomposition for the Aggregates by Province and by Industry East Java

	TE	TEC	TP	SEC	TFP Avrg
By industry (Nine TOP Sectors) East Java					
FOODBT	0.651	-0.011	0.045	-1.204	-1.170
FOODBT	0.679	-0.012	0.046	-0.919	-0.884
TEXTIL	0.653	-0.012	0.046	-0.883	-0.848
Apparel	0.657	-0.011	0.046	-1.134	-1.099
Leather	0.684	-0.010	0.047	-1.213	-1.175
CHMCA	0.644	-0.011	0.046	-1.190	-1.155
Metals	0.665	-0.011	0.047	-0.928	-0.892
FABMTL	0.661	-0.011	0.046	-1.180	-1.144

	TE	TEC	TP	SEC	TFP Avrg
By industry (Nine TOP Sectors) East Java					
ELECTR	0.663	-0.011	0.047	-1.426	-1.390
MTRVHC	0.683	-0.009	0.045	-0.388	-0.352
Average Java	0.648	-0.011	0.046	-1.378	-1.342

Notes. CHMCAL Chemicals, MCHINE Machinery and equipment, ELECTR Electrical equipment and apparatus, MTRVHC Motor vehicles trailers and semi-trailers, METALS Basic metals, FABMTL Fabricated metal products except machinery and equipment, FOODBT Food products, beverage, and tobacco, TEXTIL Textile products leather and footwear

East Java is ranked first in total output (2013) in five industries; Food-tobacco (ISIC 15-16), paper (ISIC 21-22), and shipping building-railway equipment. However, it is noticeable that it has lower TE and TFP in those sectors among Java provinces which means that there might be a loss in competitiveness over time. Once again, the lower negative impact of energy to scale components keeps East Java competitive for now but might not in the future.

Conclusion

This article analyses the elements of growth of industrial sector in Java, the manufacturing, and service corridor of Indonesia. This study employs firm-level data from six provinces in Java Island covering firms from 347 five-digit ISIC from 2007 to 2013. The article estimates the output expansion based on input growth and the three components of Total Factor Productivity, Scale effects, Technological Progress and Technological Change. Manufacturing firms are classified based on location, size, technical-skills level, and labor/capital ratio.

Manufacture experiences output growth due to the two conventional concepts of output expansion; technical progress (0.047) and due to input growth (0.284). Total Factor Productivity is worsening over time (-1.287%), particularly due to negative scale effect. Technical efficiency is also worsening indicating that if not deindustrialization, the industrial corridor is slowing down and possibly compromising the expansion. Industrial output growth suffers due to negative scale (under energy) and negative tech efficiency. Low-Tech and medium-low tech firms experience the lowest rate of output expansion, while high-tech and medium high tech firms experience double rates of output growth. In general, medium firms register 25% better TFP performance than larger firms, as well as larger tech progress. Medium High-tech industries are reported 17% above TE average while low-tech groups are 13% below average. Low-Tech firms alone are accounted for 72% of the total samples (champion firms).

Labor appears as the input with the largest elasticity to output (0.436), while capital (0.002) and raw materials (0.013) have low elasticity. Energy is pulling down the expansion of output due to a large negative elasticity (-3.097), being responsible for 1.214 times the increase of cost in manufacture. Some savings in production cost observed in labor and in capital inputs are canceled by the rise of energy prices. Energy registers the largest impact to output growth. However, energy prices skyrocket.

By firm characteristic, Low tech firms (LT), higher skills (HRI), and medium tech firms perform 72% better than average (TFP). Medium-low tech firms under labor-intensive and medium in size perform 58% better than average. Firms characterized by low-tech, less skill intensive, and medium size are reported to have the smallest negative TFP. Low capital-intensive industries, particularly those employing higher skills (HRI), experience the largest growth in TE and best TEC performance, meaning that skills might be an important contributor to higher TE in firms competing in low production cost. Firms with larger portions of human skills capture larger TE and higher TP over those firms under labor intensive. However, firms under high skills report larger losses due to negative scale effects. Labor intensive firms, by contrast, are less efficient but are less exposed to energy prices. Lower skills industries (Low and Medium Low-Tech) have smaller negative scale effects than high skills and high-tech, reaching a better TFP.

Performance at the provincial level in Java does not seem to differ substantially across the six regions. However, the differences are large enough to mark patterns and give advantage in particular sectors. The larger differences in performance occur under scale effect with Central, West and East Java experiencing lower performance that other provinces. East Java enjoys an advantage over other provinces due to lower cost in input growth, particularly in labor-intensive industries complemented with low energy consumption (textiles and some equipment and computer), as well as in natural-resource industries where materials are key (food, tobacco, and paper) with low energy consumption. A second important gain in East Java is under low tech industries with lower cost increases under energy versus all other provinces.

Recommendation

Scale effects can be achieved through labor intensity and medium in size firms, while TE and technological progress require higher skill workers and size to support larger effects.

It surprises the negative effects of energy and labor cost on productivity. Industrial policy should consider the multiple impacts of each and all price factors in productivity to balance effects and reinforce rather than cancel input effects as it might continue affecting productivity and by instance compromise the expansion and even survival of some key sectors.

While positive impacts might have been achieved in the form of higher wages and a cut in energy subsidies, they might have been imposed at the cost of increases in productivity. A more balanced growth might be preferable, where input prices rise at more similar levels than productivity or efficiency gains (absent in the whole period).

Labor is still accounted for the main factor of production, particularly enjoying larger output elasticity under medium size firms rather than large ones. However, the elasticity with respect to labor experienced a decline of 22% in the period of analysis, challenging the future of manufacturing based on labor-intensive activities. Skillful workers seem to highly contribute to low tech firms, while low skill workers complement higher tech groups. While this might sound contradictory, it reflects the complementation of factors (labor-capital) signaling pressure in low tech firms to increase input efficiency and pressure in high tech firms to control input costs.

Capital and materials play an important role in medium-size firms. However, East Java ranks lower than other provinces in those inputs. Efforts to support deepening capital and alternative sources of materials might allow medium-size firms in East Java to rise productivity.

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