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## Article

# Determinants of the palm oil industry productivity in Indonesia

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## GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

# Determinants of the palm oil industry productivity in Indonesia

Tina Herianty Masitah<sup>1\*</sup>, Maman Setiawan<sup>1</sup>, Rina Indiasuti<sup>1</sup> and Adhitya Wardhana<sup>1</sup>

**Abstract:** This paper investigates total factor productivity growth (TFPG) and its determinants in the Indonesian palm oil sector industries. TFPG is estimated using a growth accounting method. This paper applies the fixed effects model to investigate the determinants of the TFPG. The data is sourced from a manufacturing survey of the Indonesian Bureau of Central Statistics (*Badan Pusat Statistika/BPS*) for the period 2000–2017. This paper finds that the TFPG of the Indonesian palm oil industry is relatively low. Moreover, output growth, output per worker, export activity, and wages per worker have significant effects on the TFPG. The effect of output growth, which is dominated by the large use of inputs, raises concerns in the aspect of environmental sustainability due to uncontrolled land expansion.

**Subjects:** Development Studies; Economics and Development; Economics

**Keywords:** output growth; growth accounting; total factor productivity growth; Indonesian palm oil industry

## 1. Introduction

Productivity has an important role in the industrial development (Fernandes, 2008; Nguyen, 2021). By having better productivity, it is possible for the economy to produce more goods and services with the same number of inputs, or with fewer inputs capable of producing the same amount of output. Increasing productivity is the only path to sustainable economic growth in the long run. The ability to increase productivity is important, both on the scale of sectors, and firms, as well as the national and state spheres in determining public policies (Asian Productivity Organization,

## ABOUT THE AUTHOR

The author of this article is currently a student (Ph.D. - Economics and Business) at Padjadjaran University, Bandung, West Java – Indonesia. My research interest focuses on agribusiness study, firm innovation and productivity (growth theories), microeconomic, developments in ASEAN countries and emerging economies. This study is closely related to the broader scope of the authors' research interest area as it focuses on how the development of technology and knowledge in shaping productivity, both on an individual scale in the form of labor capabilities and firm productivity as agents of state economic growth. This study also highlights the importance of human resources quality as the goal of increasing the productivity of the workforce in general in society as an important part of increasing firm productivity.

## PUBLIC INTEREST STATEMENT

Determinants of firm productivity can be categorized into 4 aspects: internal firm, trading activities, investment sources, and human resources. Output growth as a measurement variable has a positive and significant effect on the productivity of palm oil industry firms, this is in line with the large production of palm oil from year to year driven by the government's efforts to increase downstream palm oil products by increasing technical efficiency, technological advances, and increasing efficiency scale. Output per worker and wages per worker are variables that are closely related to improving the quality of humans as workers. Firms can invest in and finance employee training or education. In this way, they will become an asset or the spearhead of the firm in the future with the new knowledge they have acquired. They will become the engine to increase the productivity of the firms.

2020). Although it is known that for the last decade economic growth is considered as a trigger for increasing environmental degradation, even by using renewable energy which will still increase the carbon emissions of households and factories (Dagar et al., 2022; Shahzad et al., 2022; Tang et al., 2022). According to Indiatuti (2016), productivity growth is related to the use of inputs relative to the outputs. Productivity can be measured by total factor productivity (TFP), which can comprehensively use more inputs and more outputs in the calculation.

TFP growth is a comprehensive measure by measuring changes in output relative to changes in labor and capital inputs. TFP growth (TFPG) can be used as an indicator of economic progress from the aspect of technological progress which shows an improvement in production efficiency as well as technological advances and innovations. With respect to that, Kumar and Russell (2002) and Kumbhakar and Wang (2005) stated that productivity growth is shaped by components of efficiency change and technical change, technological progress (convergence), capital deepening, and economies of scale which are very dominant in spurring economic growth.

Currently, Indonesia is the world's largest producer and exporter, along with Malaysia producing 85%–90% of the world's total palm oil production (Oil World, 2018), with a total crude palm oil (CPO) production of 37.96 million metric tons and a total plantation area of 14.05 million hectares (Central Statistic Agency, 2017). However, the size of Indonesia's production is not accompanied by high productivity either. Moreover, the output growth of crude palm oil industry is likely driven by the growth of inputs, not by the growth of productivity (Moomaw & Williams, 1991; Yean, 1997; Setiawan, 2019c; Nguyen, 2021; Sari et al., 2021). In some studies, it is stated that output per worker is a factor that affects productivity (Hsieh & Klenow, 2009; Komare, 2018; Zhi et al., 2003). In research conducted by Gehringer et al. (2013) and Goncalves and Martins (2016), it was stated that a high-productivity workforce will also increase the productivity of companies so that they get higher wages as well. Real wage growth is also strongly correlated with productivity growth in the manufacturing industry (Arai, 2003; Daveri & Filippin, 2002; Garner et al., 2018). Furthermore, there is a significant difference in the relationship between labor wages and the productivity of companies in developing countries and developed countries as can be seen in several studies (Biesebroeck, 2010; Junankar, 2013; Biesebroeck, 2015).

Indonesia's large palm oil production capacity still has weaknesses, so it is still below the productivity of Malaysian palm oil and other palm oil-producing countries both in terms of plantation productivity as well as the CPO-producing industry and its derivative palm oil types, this is due to the weak adoption rate for the development of agricultural cultivation systems and the use of technology used in this industry (Alwaritzi & Chomei, 2015; Balu et al., 2018).

Based on data released by the Ministry of Investment/Investment Coordinating Board (BKPM) stated that oil palm plantations in Indonesia are still dominated by foreign investment firms or foreign investment (FDI). The largest investment portion of oil palm plantations came from Malaysia (15,8%) and Singapore (53,7%) in the 2015-March 2021 period. According to Wheeler and Moody (1992), Arnold and Javorci (2009), Alfaro et al. (2004), Mainali (2018), and Nguyen (2021) revealed that PMA firms although newcomers tend to be better than domestic new producers (PMDN) in terms of productivity. They also tend to be larger (firm size), more capital intensive, and more involved in international trade (Keller & Yeaple, 2009). The influence of firm size in determining the productivity of a firm is found in research conducted by Fernandes (2008), Diaz and Sanchez (2008), Oh et al. (2014), and Black (2020). They agree that the size of the firm affects productivity of the firm, but in the relationship between the two variables each researcher has a specific point of view.

In general, the productivity of the palm oil industry still needs to be improved, although from year to year the number of mills and refiners of fresh fruit bunches (FFB) is growing as an excess of land expansion, where in 2013, 547 units were opened (Rifin, 2017) and in 2014 have 740 units were opened (PPKS, 2015). Large production causes the high export value of this commodity,

the influence of exports on productivity growth is stated in the research of Fernandes (2008), Bernard et al. (2006), and Sheng and Song (2013). However, this commodity also still does not have the capacity to accord with the preferences of foreign consumers, especially in Western European countries, where when it arrives at the importing country (because it has not met international standards) Indonesian CPO must go through a refinery process to be further processed according to their needs. This causes a large number of exports to have a negative impact on the productivity growth of a company, this situation is stated in the research of Havrylyshyn (1990) and Xu and Sheng (2012).

This study aims to investigate the TFP growth and its determinants of the palm oil industry and its derivatives in Indonesia. Measuring the productivity growth of palm oil manufacturing firms is still not widely carried out in Indonesia. TFPG measurement uses the growth accounting method, which applies a more transparent method. Estimating TFPG growth with the growth accounting method is also still not commonly done in Indonesia, which can be the originality of this study.

This paper consists of five main parts. The first part explains the relation between the size of palm oil production and its productivity, this gap will formulate obstacles that arise in the Indonesian palm oil manufacturing industry, both internal and external to the firm. The second part describes a literature review of the conceptual approach to productivity and the factors affecting the TFPG of palm oil firms, the third part describes the methods and data. The fourth part discusses the results and discussions, then the fifth part presents the conclusions and policy implications of the research and highlights the limitations of the research as well as the need for further research in the future.

## 2. Literature review

### 2.1. Productivity in various aspects and approaches to measurement

Input functions such as labor, capital, and raw materials are transformed into the production of output. The determinants of the total factor productivity growth (TFPG) determined by policy-makers at the firm level, can determine the extent to which policies can improve a company's economic and financial performance in order to achieve a higher level of technological efficiency (Goncalves & Martins, 2016). The production function has an important role in understanding productivity and technological changes. In general, the neo-classical production function assumes that the production process using capital input (K) and labor input (L) against time can be formulated as follows:

$$Y_t = f(K_t, L_t) \quad (1)$$

The theory of productivity can be divided into the concept of measurement, that is, partial factor productivity and multifactor productivity or known as total factor productivity (TFP). The concept of the first refers to the ability of one input unit to produce an output level at one production period. This concept measures only one factor of production against output by ignoring the effect of other inputs used in the production process. The weakness of partial factor productivity is that it does not measure the entire productivity contribution of all production factors involved in a production process, even though in the process of measuring the efficiency of the production process, a comprehensive analysis is needed to measure the influence of the total inputs used (Sirait, 2007).

TFP is abstract because it cannot be observed directly, so TFP is measured indirectly, as follows:

$$\frac{\Delta A_t, t-1}{A_t} = \Delta TFP_t, t-1 = \frac{\Delta Y_t, t-1}{Y_t} - \alpha \frac{\Delta K_t, t-1}{K_t} - (1-\alpha) \frac{\Delta L_t, t-1}{L_t} \quad (2)$$

where  $\Delta A/A$  is an output change that cannot be explained by an input change, then TFP growth can be calculated as a residue, i.e. as the amount of output growth remaining after calculating the quantifiable determinant of growth (Herwanda, 2013).

Productivity is known to have various definitions, including based on measurement methods, namely with conventional approaches and frontier (border) approaches, and is distinguished again between parametric and non-parametric. In general, all methods state that the main shapers of productivity growth include changes in engineering efficiency, technological changes, and economies of scale or commonly written as follows:

$$\text{TFP Growth} = \text{Technical Efficiency Change (Catching up Effect)} \\ \times \text{Technical Change (Frontier Effect)} \times \text{Economic Scale} \quad (3)$$

These three components generally affect changes in productivity, although not always at the same time, maybe changes, are only influenced by one or two of those main components. In the frontier method the decomposition of the three main shapers of productivity can be better defined (Kumar & Russell, 2002; Kumbhakar & Wang, 2005).

One of the methods of measuring TFP non-parametrically studied by Kumbakhar (2004) and Sirait (2007) is by using a growth accounting approach, this method is simpler because it does not use econometric rules, but has limitations, namely: this approach only calculates technical efficiency using the assumption of constant return to scale (CRS), cannot calculate elasticity for both input and supply demand. If using an econometric approach, the disadvantages of non-parametric measurement can be overcome by capturing all the components of efficiency (technical efficiency and price), so as to determine the magnitude of the elasticity of demand and supply of output. The simplicity of non-parametric measurement methods is also illustrated in the TFP Index translog (Kathuria et al., 2011; Seker & Saliola, 2018). Based on the thoughts of Solow (1957) and Jorgenson (1991) measurement of TFP based on the growth accounting method using the production function, assuming that in every industry, there is a logarithmic transcendental production function (translog), where output as a function of capital input, labor input and intermediate input (raw material).

In recent years, productivity analysis using micro-level data in various aspects has been widely carried out in both developed and developing countries. This is partly due to the availability of micro-level data and the development of metrology approaches in various kinds of literature. The growth of productivity at the micro level has been considered a key factor in realizing economic growth at the macro level in the long term. To be more specific, increased productivity growth indicates the production of higher output rates through the same or lower inputs. This means that the inputs used are more efficient due to technological advances. This allows companies to reduce costs and improve product quality, thus it is very helpful in maintaining or increasing product power, therefore, understanding productivity at the micro level is very important in order to take more appropriate economic and industrial policies (Giang et al., 2019).

## 2.2. Development of the palm oil manufacturing industry in Indonesia

In terms of development, the processing (manufacturing) industry contributes the most to the composition of Indonesia's GDP. The manufacturing industry is being developed with a focus on natural resource processing, export-oriented, and labor-intensive products, with the goal of becoming an integrated supply chain from upstream to downstream and competitive at the domestic, regional, and global levels. Downstream policies in industrialization activities can provide a broad chain effect for the national economy on a consistent basis, such as increasing the added value of domestic raw materials, absorption of local labor, and foreign exchange receipts from exports and taxes. Currently, as many as 168 types of downstream CPO products have been able to be produced by the domestic industry for food needs, phytopharmaceuticals/nutrients, chemicals/



oleochemicals to renewable fuels/biodiesel In 2011, Indonesia was only able to produce 54 types of downstream CPO products delivered based on a press release from the Indonesian Ministry of Industry.

Downstream products in the form of cooking oil, chocolate, chocolate jam-making materials, margarine and butter, and bakery and cake ingredients (Boestami, 2020). Based on the study of Triajie (2006), it is stated that the role of technology in the processing industry is still not optimal and is still applied in several industrial sectors where growth is still dominated by input factors in the form of raw materials (input driven). This is due to high balance costs for technological advances, as well as a weak national industry in carrying out the technological diffusion process, which is accompanied by substandard human resource quality. This has resulted in a low level of technical efficiency within the firm, resulting in many firms leaving and entering, as well as a high level of profit on palm oil production costs as a result of a large amount of government intervention in the industry during the observation period (Setiawan, 2019a, 2019b). According to Setiawan and Sugiyarto (2017) that capital was the highest input contributing to economic growth during the period 1996–2011 followed by intermediate inputs and average labor. In addition, there are variations in the contribution of inputs to economic growth among economic sectors, this proves that the role of technology has not been a dominant part of the productivity of the manufacturing industry in Indonesia.

### **2.3. Determinant variables of TFPG palm oil manufacturing firms and its derivatives**

The determinants of TFPG which are affected by the output growth of the palm oil industry are approached based on research Moomaw and Williams (1991), Yean (1997), Ismail et al. (2014), and Setiawan (2019c). Output growth that leads to higher market output does not necessarily increase productivity growth if other market characteristics such as market competition and sharing of resources between firms are not going well (Setiawan, 2019c). Studies related to output per worker as an independent variable suggest that the value of output per worker, physical capital, and human capital for each country proves that the growth in average output per worker is directly caused by growth in TFP, in exploring how this relationship will occur, there are substantial differences within a country scale (Zhi et al., 2003; Hsieh & Klenow, 2009). Nguyen (2021)), who has conducted research in Vietnam, states that variations in aggregate input per worker growth and TFP growth are also important in taking into account variations in growth output per worker within firms in Vietnam at the regional and sector levels.

Exports as a determinant of TFP firm growth in the manufacturing industry are known to have a positive contribution between export activities and the firm's TFPG. It is generally stated that exporting firms have a higher productivity growth than firms that sell only in the domestic market (Fernandes, 2008; Bernard et al., 2006; Sheng & Song, 2013; Gehringer et al., 2013; Arranz-Aperte, 2013; Goncalves & Martins, 2016 and Giang et al., 2019). Exporting firms generally have higher R&D-level quality and more computerized machines. In addition, access to bank loans is also preferable for export-import firms (Sari et al., 2021; Yasin, 2021)

Foreign investment is a factor affecting the increase in TFPG firms in the manufacturing industry because these firms have a higher level of efficiency because they use advanced technology machines and equipment through knowledge transfer in the form of knowledge transfer from foreign firms or investors. Entry of foreign firms into a country is considered the main driver of productivity growth (Wheeler & Moody, 1992; Borensztein et al., 1998; Konings, 2001; Oguchi et al., 2002; Alfaro et al., 2004; Keller & Yeaple, 2009; Arnold & Javorci, 2009; Ismail et al., 2014).

Firm size is a fairly important factor in determining a firm's TFPG. Firm size as a variable can reflect the Firm's level of technology, added value, increase in capital, and workforce in line with firm size (Fernandes, 2008; Diaz & Sanchez, 2008; Oh et al., 2014; Black, 2020). Wages per worker are also expected to be a deciding factor in TFPG palm oil firms. It is stated that relative wages are the main determinant of workers' efforts because workers tend to compare their wages, both with colleagues in the same job position and with other employees in the industry (usually top

managers and other staff) by Bester and Petrakis (2003), Biesebroeck (2010), Biesebroeck (2015), Gehringer et al. (2013), Arranz-Aperte (2013), Goncalves and Martins (2016), and Arranz-Aperte (2013). As a result, their perception of wages is an important aspect of firms' policy, even though the literature is divided on the type and impact of wage distribution on worker productivity within firms. The relationship between firm productivity and determinant can be seen in Figure 1.

### 3. Research methods

#### 3.1. Technique and modeling approach

This study used the TFP measurement technique using the growth accounting method. The determinants of TFP is estimated using fixed or random effect model based on the Hausman test. The data is sourced from the Central Statistics Agency. Mahony and Timmer (2009) and Zhi et al. (2003), contain the growth accounting method, where the output function can be seen as follows:

$$Z = f(X, K, L, T) \quad (4)$$

where Z is the output quantity, X, K, L is the number of intermediate inputs, capital, and labor, and T is time. The growth rate of productivity can be defined as the growth rate of output with inputs constantly. Under conditions of constant scale and producer equilibrium, the TFP rate can be expressed as the output growth rate minus the weighted average number of input growth rates:

$$\bar{V}_T = [\ln Z(T) - \ln Z(T-1)] - \bar{V}_X[\ln X(T) - \ln X(T-1)] - \bar{V}_K[\ln K(T) - \ln K(T-1)] - \bar{V}_L[\ln L(T) - \ln L(T-1)] \quad (5)$$

$$\bar{V}_X = 1/2[V_X(T) + V_X(T-1)]$$

$$\bar{V}_K = 1/2[V_K(T) + V_K(T-1)]$$

$$\bar{V}_L = 1/2[V_L(T) + V_L(T-1)]$$

$$\bar{V}_T = 1/2[V_T(T) + V_T(T-1)]$$

$$V_X = \frac{p_X X}{qZ} \quad V_K = \frac{p_K K}{qZ} \quad V_L = \frac{p_L L}{qZ}$$

Where  $\bar{V}_X$ ,  $\bar{V}_K$  and  $\bar{V}_L$  describe the respective shares of intermediate, capital, and labor that is the average input to time T and T- 1, where q,  $p_X$ ,  $p_K$ , and  $p_L$  represent the prices of the outputs and intermediate, capital and labor inputs. Then the equation can be written as Zhi et al., (2003):

$$\Delta \ln(TFP) = \Delta \ln(Z) - \bar{V}_X \Delta \ln(X) - \bar{V}_K \Delta \ln(K) - \bar{V}_L \Delta \ln(L) \quad (6)$$

A fixed effect model or a random effect model is estimated to see the effects of determinant variables on the TFP of manufacturing firms.

$$TFPG_{it} = a_0 + a_1 GMOT_{it} + a_2 MOTL_{it} + a_3 EXstat_{it} + a_4 FIstat_{it} + a_5 FSZE_{it} + a_6 WAGEL_{it} + \varepsilon$$

$$\text{where : } a_1 > 0, a_2 > 0, a_3 > 0, a_4 > 0, a_5 > 0 \text{ and } a_6 > 0, \text{ ceterisparibus} \quad (7)$$

where i and t index mean the subsector and the year, respectively.



### 3.2. Data and variables

The study was conducted on the palm oil-producing industry in the Indonesian Standard Industrial Classification (ISIC)/Klasifikasi Baku Lapangan Usaha Indonesia (KBLI) category C classification 1043 namely 10431 - 10437 (5 digits) in the period 2000 to 2017. The microdata used came from BPS, consisting of 9054 observation data collection including output value, amount of labor, raw materials, capital that is approximated by fixed\_asset, total annual wages, percentage of exports accumulated as export status (dummy), percentage of foreign investment (FI status with dummy) used in palm oil firms. Determinant variables and reference sources are presented in Table 2. TFP is calculated using the Cobb-Douglas production function estimation, which generates the value of a firm's output from a combination of three inputs: capital, labor, and raw materials.

This paper is divided into stages, which are as follows: the TFPG value of the palm oil industry and its derivatives is calculated by cleaning out the empty and incomplete data. The variable value is equalized using the wholesale price index and the consumer price index, TFPG is calculated using the growth accounting method. This method is used in light of the availability and condition of the data released by BPS, wherein the provision of fixed asset (capital) data contains a large amount of blank data, reducing the amount of data that can be processed from observation data within the specified period, the growth accounting measurement method is the most suitable method for these conditions. A growth accounting method is a non-parametric approach, which does not require special assumptions, such as estimation techniques for econometric and statistical calculations which depend heavily on data distribution.

From the description above, it can be obtained an econometric model of the factors that affect the productivity of the palm oil manufacturing industry and its derivatives as follows (7) model of TFPG and Table 1 for variables and their units.

### 4. Results and discussion

The development of the productivity of palm oil firms can be seen from the growth value of the total factor productivity, using the growth accounting method (Table 2 and Table 3). During this research period, the average growth of TFP in the palm oil industry and its derivatives seems to fluctuate every year. Using 2000 as the base year, the highest average value of growth was

**Table 1. Variables description per unit measurement**

Variables	Description	Unit Measurement	Data Source
TFPG <sub>it</sub>	Total factor productivity growth of the palm oil industry	Percent	BPS
GMOT <sub>it</sub>	Palm oil firm's annual output growth	Percent	BPS
MOTL <sub>it</sub>	Output per worker palm oil firm	Rupiah	BPS
FSZE <sub>it</sub>	Classification of palm oil firms based on many workers	Dummy	BPS
EXstat <sub>it</sub>	Status of exports carried out by each palm oil firm	Dummy	BPS
FIstat <sub>it</sub>	Foreign investment status obtained by each palm oil firm	Dummy	BPS
WAGEL <sub>it</sub>	Wage per worker annually of palm oil firm	Rupiah	BPS

Note: BPS is Indonesia's central statistics agency

**Table 2. Descriptive variable**

Variables	Obs	Mean	Std Deviation	Min	Max
<b>(Dependent)</b>					
<b>TFPG</b>	5624	0,021	0,447	−1,931	1,986
<b>(Independent)</b>					
<b>GMOT</b>	5624	0,120	3,347	−9,984	9,997
<b>MOTL</b>	5624	0,291	1,357	2,191	12,924
<b>WAGEL</b>	5624	5,455	0,923	−4,338	10,199
<b>EXstat</b>	5624	0,831	0,374	0	1
<b>F1stat</b>	5624	0,192	0,394	0	1
<b>FSZE</b>	5624	3,739	0,442	2	4

Source: BPS data, processed by the author

achieved in 2016 and the lowest occurred in 2017. The following is the average of TFPG for Large and Medium Industries of Palm Oil and its derivatives.

In the research period, the average growth of the palm oil TFP industry and its derivatives seems to fluctuate every year (Table 3). Using real output and input data and 2000 as the base year, the highest average TFP growth was achieved in 2016 of 0,14496 and the lowest occurred in 2017 of −0,14573 (see Figure. 2). The following is the average amount of growth each year in TFP for Large and Medium Industries of palm oil.

Meanwhile, based on the ISIC group, the highest average TFP growth occurred in the CPO and CPKO separation/fractionation industry sub-sectors in the ISIC 10433 classification. The following is a table of average TFP growth in each subsector. See figure 3

**Table 3. Average of TFPG for large and medium palm oil industries in Indonesia period 2000–2017**

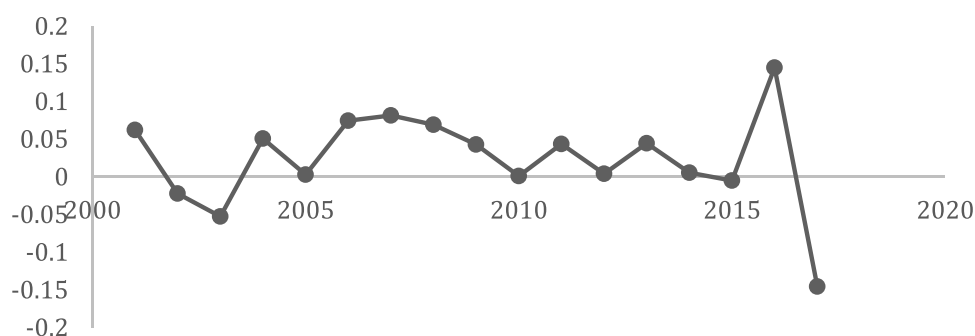
Year	TFPG
2001	0,06199
2002	−0,02237
2003	−0,05286
2004	0,05078
2005	0,00290
2006	0,07435
2007	0,08135
2008	0,06899
2009	0,04288
2010	0,00094
2011	0,04359
2012	0,00389
2013	0,04436
2014	0,00527
2015	−0,00516
2016	0,14496
2017	−0,14573

Source: BPS data, processed by the author

**Figure 1. Determinant TFPG of the palm oil industry**



**Figure 2. Graph of average TFPG of the palm oil industry by year.**



The average value of ISIC for the sub-sector of the CPO/CPKO separation/fractionation industry has a fluctuating value, it does not mean that each of these sub-sectors still requires treatment to be able to increase their productivity, both in terms of technical efficiency, changes or technological progress or from the change side of the efficiency scale. The low TFP growth is also determined by the technological classification of the manufacturing industry, whereas the food sector is still relatively low compared to other sectors, this result is in line with the research conducted by Oguchi et al. (2002) and Yasin (2021). The level of TFPG is determined by the efficiency of the use of inputs, such as labor, capital, and raw materials (semi-finished goods). This of course really determines on how big the value of TFPG in a sub-sector is when compared to other sub-sectors in aggregate. In addition, technological advances/technological readiness used in the sub-sector are also very decisive, whether the technology has been utilized properly by all workers, or can only be operated by a small number of workers.

The results of the estimation using the fixed effect model approach are presented. The Hausman test suggested to apply fixed effect model, instead of random effect model. In addition, the following regression results are the results of instrumental regression variables.

The growth of the firm's output reflects changes in the scale of efficiency in production. From the regression results of Table 4, the coefficient of output growth variable (GMOT) of 0,0459 means that every one percent increase in output growth will increase TFP growth of 0,0459 with a significance level of 1% or 0.01. The effect of output growth on TFPG is also line with research conducted by Moomaw and Williams (1991), Yean (1997), Setiawan (2019c), and Sari et al. (2021), which stated that output growth is an essential variable in productivity, and has a strong relationship as a representation of increased production. However, Sari et al. (2021) who studied the sources of output growth of palm oil firms in Indonesia, stated that output growth in the CPO industry in Indonesia was still experiencing a decline in productivity growth, which was indicated by negative productivity growth. This shows that the high global demand for CPO products from Indonesia has encouraged the exploitation of land for industrial needs, and it is not in terms of increasing productivity.

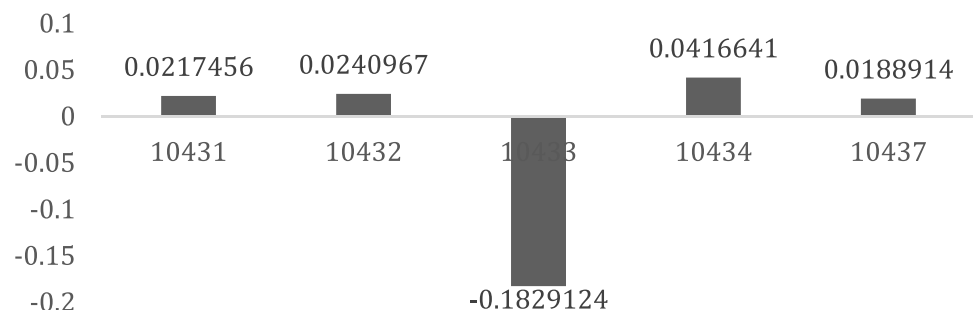
**Table 4. Average of TFPG palm oil industry from 2000 to 2017**

ISIC	Firms Observation	Sub- sector	TFPG Average
10431	4745	Industrial CPO	0,03441
10432	264	CPKO Industry	0,03701
10433	19	CPO/CPKO separation/ fractionation industry	-0,15076
10434	92	CPO/CPKO refining industry	0,06281
10437	205	Cooking oil industry	0,00735

Source: BPS data, processed by the author

The regression results presented in Table 5 shows that output per worker is positive and significant for TFPG, with a coefficient value of the output per worker variable (MOTL) of 0,0417 which means that every increase of one unit of variable output per worker will increase TFPG by 0,0417 unit See figure 3. The effect of the MOTL variable is significant at the 1% or 0,01 significance level. Output per worker combined with physical and human accumulation as well as changes in capital and technology have a positive relationship with TFPG. This finding is similar to the research that has been carried out by Zhi et al. (2003), Sari et al. (2021), and Komare (2018) stated that TFP is an important factor in total output growth which is also determined by output per worker (labor productivity), number of workers and working hours that affect the production process. Labor productivity reflects an increase in the contribution of capital, an increase in the contribution of human resources and an increase in the total efficiency of production (TFP). The contribution of productivity from input factors such as labor and capital that drives the growth of TFP may occur as a result of the use of better technology, the use of more modern mechanisms, improving the quality of management from human resource inputs.

**Figure 3. Graph of average TFPG in subsector based on ISIC 10431–10437.**



**Table 5. Fixed effect estimation results on the TFPG model**

Variables	Dependent TFPG
<b>Independent</b>	
<b>GMOT</b>	0,0459*** (0,0022)
<b>Ln MOTL</b>	0,0417*** (0,0088)
<b>EXstat</b>	−0,0695*** (0,0149)
<b>F1stat</b>	0,0016 (0,0233)
<b>4.FSZE</b>	−0,0198 (0,0224)
<b>Ln WAGEL</b>	−0,0725*** (0,0101)
<b>Constant</b>	0,1421 (0,0793)
<b>Observations</b>	5624
<b>Number of psid</b>	730
	(Dependent)
<b>VARIABLES</b>	TFPG
<b>(Independent</b>	

\*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1

The regression results show no significant effect of firm size on TFPG, with a coefficient of −0,0198. This is because workers in the palm oil industry sector still have relatively low quality, seen from the level of education and training of employees, so very minimal innovation and mastery of technology. This finding is in line with research conducted by Diaz and Sanchez (2008) which stated that firm size and firm productivity have a negative relationship, and there is a burden on employees, lack of motivation of workers, and difficulties in monitoring in medium and large firms compared to small firms. Moreover, the nature of larger firms being able to survive in the market even when they have financial problems, also become one of influencing factor of lower technical efficiency in large firms more than small firms (market imperfections).

The link between exports and productivity is found in the research conducted by Konings (2001), Fernandes (2008), Keller and Yeaple (2009), Sheng and Song (2013), and Goncalves and Martins (2016). The export variable (EXstat) measured the export status of the firm in one year. From the estimation results, it is found that the important export status has a negative and significant relationship to TFPG. Based on Table 5, the coefficient of the variable is −0.0695, which means that for every one-unit increase in exports, the TFPG will decrease by 0,0695 units. The findings stated firms that have exporter status will have lower TFP growth than firms that only trade in the domestic area. This indicates that Indonesia is still dominant in exporting palm oil in a form and quality that does not match the preferences of the importing country, because Indonesian palm oil export goods eventually still have to go through a second refinery in the West European importing country. This opposite relationship is also possible because the export of palm oil from Indonesia is still accompanied by protection carried out by the Indonesian government with the aim of protecting exporters in order to increase Indonesia's palm oil export capacity. According to Havrylyshyn (1990), protection at a moderate level and a moderate period can certainly increase productivity, but the protection provided may exceed the optimal level, thereby reducing the productivity of palm oil firms in Indonesia.

From the results of empirical observations, it can be seen that between 2000 and 2017 palm firms in Indonesia dominantly chose to export their products, both in the form of crude CPO/CPKO

oil and products that were more downstream. From the data presented in Table 6, it can be seen that 83,27% of firms export their products, while 16,73% are only favored domestically.

From the data presented in Table 6, most palm oil firms choose to export their products. This is a reflection that palm oil firms are dominated by firms that have high efficiency scale.

The relationship between the determinant factor of foreign investment and TFPG is positive and not significant, with a coefficient of 0,0016. A Firm's funding consists of various kinds and sources, one of which is funds originating from foreign investment symbolized by FI status (FIstat). The FIstat variable reflects the presence of a foreign investment in a Firm, which can be seen from the advantages of technological change and the effect of technological catch-up. From the estimation results with fixed effect windfall, there are no significant results between FIstat and the dependent variable TFPG even though the relationship is positive. Diaz and Sanchez (2008) stated that firms with foreign investment generally have a larger market share and tend to be large firms, but also have more complex responsibilities in managing the Firm. In terms of controlling market area, single shareholders, the proportion of temporary workers to permanent workers, capital intensity, and legal status of the Firm, it can be concluded that small and medium-sized firms tend to be more efficient than large firms. In addition, Oguchi et al. (2002) also stated that food sector firms (including palm oil firms) have medium and low levels of technology so they tend to have workers with low levels of education as well.

After the observation has been conducted, it showed that 81,49% of palm oil industry firms operating in Indonesia are firms that do not have foreign capital and 18,51% are firms with foreign investments. The amount per subsector can be seen in the following table 7:

**Table 6. Export status of palm oil manufacturing firms**

ISIC	Not Export		Export		Total	
	Number of Firms	Percentage	Number of Firms	Percentage	Number of Firms	Percentage
10431	1357	14,99	6776	7,84	8133	89,83
10432	75	0,83	375	4,14	450	4,97
10433	2	0,02	31	0,34	33	0,36
10434	22	0,24	108	1,19	130	1,44
10437	59	0,65	249	2,75	308	3,40
<b>Total</b>	<b>1515</b>	<b>16,73</b>	<b>7539</b>	<b>83,27</b>	<b>9054</b>	<b>100,00</b>

Source: BPS 2000–2017 data processed

**Table 7. Foreign investment status of palm oil manufacturing firms**

ISIC	With No Foreign Investment		With Foreign Investment		Total	
	Number of Firms	Percentage	Number of Firms	Percentage	Number of Firms	Percentage
10431	6618	73,09	1515	16,73	8133	89,83
10432	392	4,33	58	0,64	450	4,97
10433	23	0,25	10	0,11	33	0,36
10434	92	1,02	38	0,42	130	1,44
10437	253	2,79	55	0,61	308	3,40
<b>Total</b>	<b>7378</b>	<b>81,49</b>	<b>1676</b>	<b>18,51</b>	<b>9054</b>	<b>100,00</b>

Source: BPS data for 2000–2017 (processed)

The low proportion of firms that have foreign investment causes this variable to be unimportant to the TFPG of palm oil firms in Indonesia, which still has a stagnant average trend. This condition thus indicates that the percentage of firms that adopt foreign technology transfer which is expected to encourage increased firm productivity is still relatively low.

Based on the estimation results in Table 5, the variable wage per worker (lnWAGEL) has a significant effect, but has a negative coefficient of  $-0,0725$ , which means that for every one unit increase in the variable wage per worker, the TFPG value will decrease by  $0,0725$  unit. It can be shared that there is a trade-in between the function of workers (wages) and the firm that incurs costs for the production. Normatively, the amount of wages will increase labor productivity which in turn will also increase the TFP in the firm. Empirical studies conducted by Biesebroeck (2010 & 2015) and Junankar (2013) state that there are differences between developed countries and developing and underdeveloped countries, in findings related to the relationship between wages and growth in total factor productivity (TFPG) as is the case in Indonesia. The amount of wages issued by the firm is considered not equivalent to the return on productivity produced by the worker. Therefore the unequal amount of wages will eventually cause the firm to be unable to improve its technology so that the process production runs stagnant and even tends to decline from the aspect of increasing innovation in technological progress. It is assumed that the benefits felt by workers will generally reduce profits for the firm and will subsequently be important in the comprehensive value of production. On the other hand, the calculation of wages also does not differentiate between conditions among workers, namely based on gender, education level, work experience, and age of workers and years of service, all of which influence the size of the wages earned by workers in a firm.

## 5. Conclusions and policy recommendations

### 5.1. Conclusions

The average TFP growth of the Indonesian palm oil industry tends to fluctuate every year, from 2000–2017. The highest average TFPG year occurred in 2016 while the lowest was in 2017. The highest average TFPG occurred in ISIC 10434, namely in the CPO/CPKO refining industry sub-sector, while the lowest was in ISIC 10433 in the CPO/CPKO separation/fractionation industry sub-sector. The trend of which was still fluctuating during the observation period.

Regarding the determinants of TFPG, output growth (GMOT) has a positive and significant effect on the TFPG of palm oil firms. The Output per worker (MOTL) variable proved to have a positive and significant effect on TFPG in palm oil firms. The firm size (FSZE) variable has no effect on TFPG palm oil firms. The export status (EXstat) has a negative and significant effect on the growth of palm oil TFP firms. Foreign investment status (FIstat) has no effect on TFPG. Moreover, wage per worker (WAGEL) has a negative and significant effect on the growth of palm oil TFP firms.

### 5.2. Policy recommendation

In order to increase the growth of the firm's output and output per worker, it can be done through government policies that oversee the program to increase innovation and technology in the production process through technological progress in the form of policies that lead to the adoption of better production techniques. Efficiency technic must be applied in creating innovative products, so as to create labor and firm productivity through total factor productivity (TFP) in a sustainable manner.

In increasing productivity growth through Firm size, it is carried out by increasing the capacity and quality of the existing workforce with policies that regulate clearer rights and obligations between workers and producers, as well as other related business actors so that each party has



a clear road map that leads toward achieving its goals, in order to improve the quality of the products produced by the Firm.

Improving the quality of palm oil to be exported can be done by continuing to make breakthroughs in technology absorption, promotion and cooperation with the international community, especially with the largest consumer countries such as India, China, European countries and the United States as countries that have the largest number of innovations of palm-based products. Export levies and export duties incorporated in the Palm Oil Plantation Fund Management Agency/*Badan Pengelola Dana Perkebunan Kelapa Sawit* (BPDPKS) are expected to be efficient and allocated to improving technology through R&D and improving education in the world of palm oil so that Indonesia can align the results of its derivative products with Malaysia and other developed countries with superior technology and human capital.

Reflecting on Malaysia which has adopted an export-oriented policy, the country is very concerned with product innovation and export diversification, thereby reducing the adverse effects of excess production, which causes the price of these primary commodities to fall. Meanwhile in Indonesia, the control of cooking oil prices for the poor is the main instrument carried out by the government, thus this policy has a negative impact on the industry because the (implicit) subsidy is borne by the producer, not the government. This indicates that Indonesia must improve in formulating policies related to the interests of the community and the advancement of national innovation

The Malaysian government has pursued proactive policies to encourage learning, invention, and innovation with various instruments such as the Malaysian Palm Oil Board (MPOB), Industrial Master Plan (IMP), and various funding programs from grants and coordination networks with universities and other organizations. Indonesia is currently improving in certain schemes, with the hope of catching up with its neighboring countries. Indonesia should be able to promote the development of the palm oil sector which believed to be able to be more useful as effective coordination between the government and industry as a solution to collective problems, expanding its business into international markets, and developing new products.

Capital deepening in the inputs that make up TFPG, can be done by increasing mechanization and automation, both by using drones, robotics, advanced sensors, and digital technology as well as more efficient and easy-to-use machines and equipment so it is hoped that it can become a program to strengthen production scale and in production in the palm oil manufacturing industry.

Ease of licensing in the realization of foreign investment must be done through a strong commitment by the government to managing existing resources in order to achieve the goal of increasing productivity and also the goal of progressing further for the technology catch up process through the advantages of foreign investment.

Increasing the effect of wages per worker which is still negative on TFPG, can be done by increasing education, skills, and training, so that the abilities and performance of employees in this industry are able to absorb technological advances/technological progress to be achieved. The government and all relevant agencies also have an important role in managing and presenting data, both for the public and researchers, so that there are more diverse research topics that can be carried out by the public in Indonesia. Of course, this is related to human resources with their ability to absorb technology and its applications.

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