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The Total Factor Productivity of Malaysia's Food Processing Industry

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Abstract

This study focuses on the total factor productivity (TFP) of Malaysia's food processing industry. Given the industry's declining labor productivity, it may also face challenges with low TFP. The objective of this research is to determine the TFP in Malaysia's food processing industry and examine the factors influencing it. The TFP of both Small and Medium Enterprises (SMEs) and large-scale enterprises (LSEs) in the industry is measured using the Cobb-Douglas production function. Subsequently, the study analyzes the factors affecting TFP through a panel data investigation. The empirical findings reveal that LSEs can increase aggregate outputs by up to 16.1 percent per unit of aggregate inputs. However, the mean TFP for SMEs is significantly lower, as SMEs produce only 0.935 units of output per unit of aggregate input. These results highlight the need for SMEs in the food processing industry to focus on effective resource management-encompassing labor, capital, raw materials, purchased water, electricity, and fuels to optimize productivity. Additionally, the beverage manufacturing industry outperforms other sub-sectors among SMEs and LSEs. This difference is attributed to beverages such as bottled water, soft drinks, and juices having higher value-added than basic processed foods. The study also finds a positive relationship between TFP and factors such as training costs, government infrastructure, and trade openness in Malaysia's food processing industry. The findings imply that Malaysia's food processing industry must prioritize these significant factors to enhance TFP and improve overall productivity.

Keywords: Total Factor Productivity (TFP), Small and Medium Enterprises (SMEs), Large-Scale Enterprises (LSEs), Malaysia's Food Processing Industry

Introduction

The food processing industry (FPI) is intricately linked with the agriculture and manufacturing industries, as the FPI involves transforming raw materials from agriculture into food products or finished goods through manufacturing procedures. Malaysia's food processing has undergone rapid development since the implementation of industrialization policies in the 1960s, continuing to expand significantly to the present day. According to the 11th Malaysia Plan, productivity is pivotal in promoting economic advancement since economic expansion is driven by investments from both public and private sectors across various industries and infrastructure projects (Economic Planning Unit, 2016). Malaysia's FPI is divided into several sub-sectors. This study refers to the Malaysia Standard Industrial Classification (MSIC) 2000 (Department of Statistics Malaysia, 2000) which classifies the FPI into five groups. The first sub-sector (FPI01) covers an

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ample range of economic activities relevant to the production, processing, and preservation of several types of food products. Secondly, the second sector (FPI02) of FPI covers the production of dairy products manufactured. Thirdly, the third sector (FPI03) includes the manufacturing of grain mill products, starches, starch derivatives, and formulated animal feeds. Next, the fourth sector of FPI (FPI04) is other food products. The last category (FPI05) encompasses the production of a diverse range of beverages.

Figure 1 illustrates a continuous increase in the total sales value of Malaysia's FPI from 2005 to 2023, indicating a growing contribution to the country's economy. Remarkably, during the COVID-19 period, the overall sales value surged from RM56.51 billion to RM134 billion. This twofold increase underscores the crucial role of the FPI during times of crisis. The enhancement of FPI not only supports primary products and the workforce but also positions Malaysia as a leading exporter of processed food. In 2022, Malaysia exported processed food and beverage products worth over RM26 billion, making a 7.1% expansion compared to 2021. Furthermore, it ranked as the fifth-largest contributor to investments in the manufacturing industry in 2021, with an investment amount of around RM5.4 billion (Malaysia External Trade Development Corporation, 2023). Additionally, both the agriculture sector and the FPI are equally facilitated to become net processed food exporters through substantial investments in research and development, as well as the implementation of modernization programs. As an example, a government agency, the Malaysian Palm Oil Board conducts research and provides information on oils and fats. It focuses on producing innovative palm-based products with high-value additions for both consumer and industrial purposes through downstream activities (Malaysian Palm Oil Board, n.d.).

Nevertheless, a report from the Ministry of Economy highlights inadequate supply chain management and low levels of automation and mechanization, primarily within small and medium enterprises (SMEs) in the sector (Ministry of Economy, n.d.). Broadly, there are two categories of business establishments: SMEs and large-scale enterprises (LSEs). In many nations, SMEs has been acknowledged as pivotal contributors to economic development, and Malaysia, as a developing country, is no exception. As per SME Corp. Malaysia (2023), Malaysia housed 1.2 million SMEs in 2021, constituting over 97% of the total organizations. This number of SMEs have elevated by approximately 140 thousand compared to 2016. The manufacturing industry in Malaysia accommodated 71, 612 SMEs out of the total number of SMEs in 2021. Furthermore, within the FPI, there were 5,925 SMEs out of a total of 6,069 entities (Ali & Talib, 2013). This is corroborated by IMP (2006), describing that SMEs include over 80% of the total number of companies in the FPI. Additionally, a significant majority of SMEs in the food processing sector are owned by local residents, comprising more than 80% of the overall establishments in the industry in 2018 (Aniza, Jusoh, Rashid, Kepal, & Harun, 2019). Apart from SMEs, LSEs including both foreign and local multinational companies, play a significant role in Malaysia’s FPI (Flanders Investment and Trade Malaysia Office, 2020). This contributes to economic growth as LSEs provide ample job opportunities to residents and generate revenue through export activities. The FPI actively participates in the global market, particularly in palm oil-based goods, which have the highest export value among other processed food products, followed by cocoa products, livestock products, and cereal goods.

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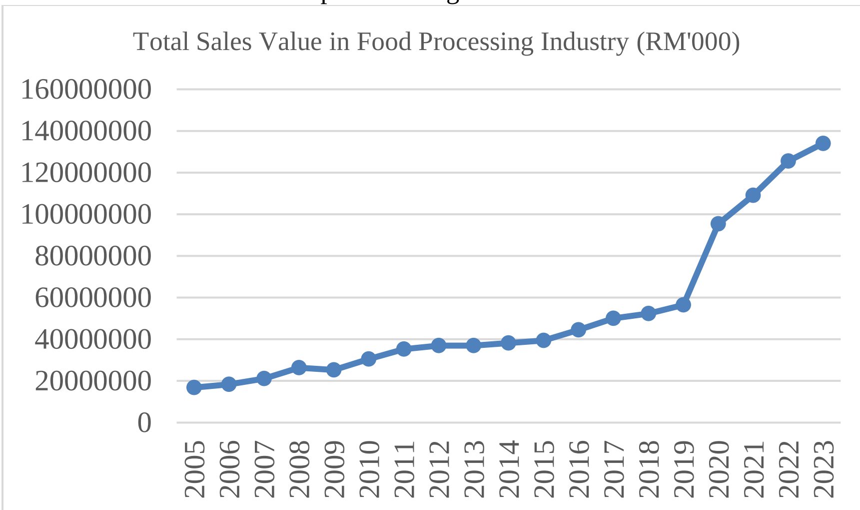

Figure 1: Total Sales Value of the Food Processing Industry
Source: Department of Statistics Malaysia (2024)

Productivity is typically utilized to measure the performance of the firm (Coelli, Prasada Rao, O'Donnell, & Battese, 2005). It is considered a crucial catalyst for economic development and competitiveness, providing essential statistical information for assessing a country's performance, including the productivity employed to assess the impact of labour and product market regulations on economic performance (Krugman, 1994). Figure 2 illustrates the labour productivity of the whole FPI and five sub-sectors of FPI. Firstly, the entire FPI faced a decline in labor productivity during the periods of 2011-2013 and 2019-2020. Although it was increasing in the recent period but it still below the expected level. Besides, labour productivity witnessed a decline from 2011 to 2014 in FPI01 while labour productivity of FPI02 displayed instability and a continued decrease from 2014 to 2023. Furthermore, FPI03 showed an uncertain labour productivity from 2008 to 2017 and a diminishing from 2017 to 2020. Additionally, the decreasing labour productivity from 2011 to 2013, followed by a further decline starting in 2019 were found in FPI04. Next, the FPI05 presented fluctuating labour productivity from 2005 to 2023. The labour productivity of this sub-section has been declining since 2017, reaching its lowest level in 2020.

Labour productivity is typically used because the method is simple and it shows the productivity of a particular single input and output. The issue of low total factor productivity (TFP) may also be linked to these instances of low labor productivity as TFP is employed to gauge productivity by considering the cumulative inputs and outputs. Low labour productivity often indicated that the labour force is not being used efficiently. When labour is not utilized effectively, it also affects the use of other inputs, such as capital and materials, resulting in overall lower productivity. In summary, labour productivity of the Malaysian FPI is ambiguous as the sub-sectors of the FPI consisted of decreasing labour productivity for a certain period, emphasizing the need to evaluate the TFP of the industry. Given the significance of both large-scale enterprises (LSEs) and small and medium enterprises (SMEs) in the food processing industry. As stated above, the manufacturing sector comprises SMEs as well as LSEs, which are classified in different business structures according to their sales turnover or employee count. This study aims to assess the TFP of both SMEs and LSEs in Malaysia's FPI and explore the factors influencing the TFP of

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the industry. Hence, the finding of this study will facilitate the government in policy-making to improve the production performance of the FPI to enlarge the advantage of FPI to economic expansion. This is also extraordinarily important to the stakeholder in designing strategies and plans to enhance their competitive edge and relative advantage in both domestic and global markets.

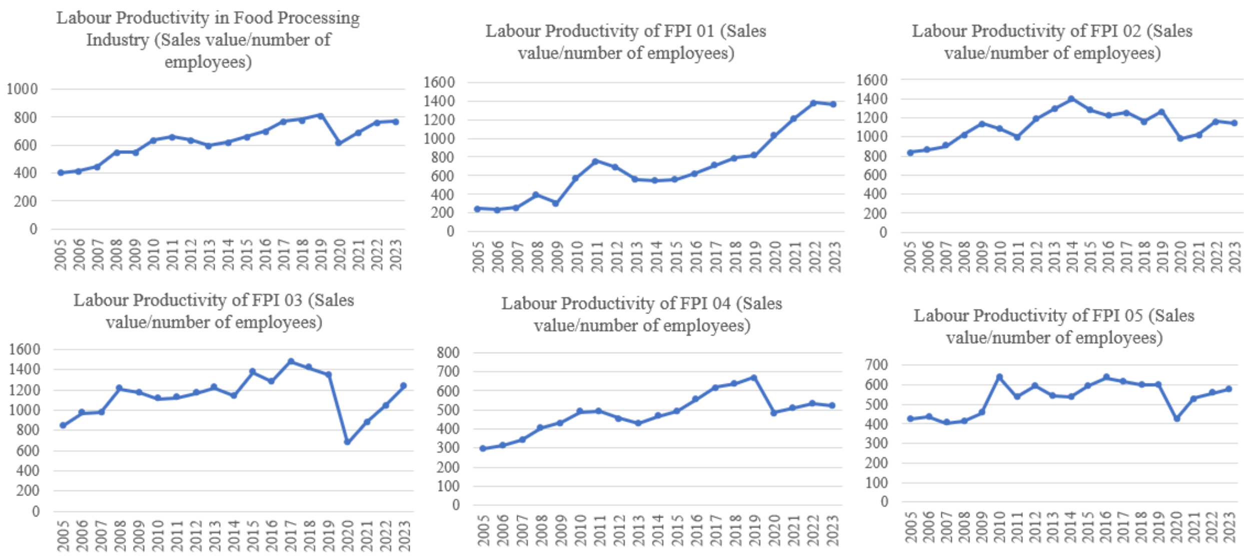

Figure 2: Labour Productivity in the Food Processing Industry
Source: Department of Statistics Malaysia (2024)

Literature Review

Total Factor Productivity

The total factor productivity (TFP) requires the specification of a production framework that remains stable over time, independent of technological change, and is applicable at the selected level of aggregation for computation (Carlaw & Lipsey, 2003). The concept of TFP stems from the Cobb-Douglas production function. In line with Comin (2010), TFP denotes the portion of output not explained by the inputs utilized in production. Therefore, it is shaped by the intensity and efficiency of the inputs used in production. TFP is characterized by the ratio of aggregate outputs (Y) to aggregate inputs (X), expressed as $TFP = Y/X$ (Carlaw & Lipsey, 2003; Kneip & Sickles, 2012). Solow (1957) and Carlaw and Lipsey (2003) stated that TFP is derived from the Cobb-Douglas Production function, $Y = AX_L^{\alpha}X_K^{1-\alpha}$ where Y represents aggregate output, $X_K^{1-\alpha}$, and X_L^{α} are physical capital and labour with their respective weights, and A represents the technological progress or TFP. Consequently, the TFP is measured as a geometric index in level: $TFP = \frac{Y}{X_L^{\alpha}X_K^{1-\alpha}}$ = A (Carlaw & Lipsey, 2003; Felipe & Adams, 2005).

Empirical Review of the Factor Affecting Productivity

An empirical study on productivity is widely discussed in the literature. Regarding Endogenous Growth Theory (Romer, 1986), research and development (R&D) expenses include the efforts and resources allocated to enhancing current products, and management practices, introducing new

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methods and skills, and creating new goods and services, are crucial drivers of productivity. An empirical by Shamsudin, Zainal, Mohamed, Yusop, and Radam (2011) revealed that R&D positively affected the TFP in the Malaysian FPI from 2000 to 2006. This was further supported by the study of Yodfiatfinda Mad Nasir, Zainalabidin, Md Ariff, Zulkornain, and Alias (2012), who demonstrated a positive association between R&D and the productivity of LSEs in the Malaysian FPI during the same period. Briefly, R&D expenditure has not been extensively studied in previous research, but it is important as expenditure on research and development indicates the technological change and innovation. Hence, investment in R&D is expected to boost productivity in Malaysia, leading to a positive impact on TFP.

Additionally, Foreign Direct Investment (FDI) boosts productivity by utilizing capital formation and technology transfer. Romer (1986) asserted that such investment promotes economic growth by enabling technology transfer from developed to developing countries, as well as by enhancing knowledge and human capital skills through labour and managerial training. Previous studies have pointed out that the FDI improves productivity (Shamsudin et al., 2011; Yodfiatfinda et al., 2012). FDI is a crucial factor that impacts the growth of the economy, and it has played a significant role in boosting the acceleration of the Malaysian manufacturing industry since the 1980s. In 2021, the Malaysian manufacturing industry consists of the largest portion which is 61.4% of the FDI (Malaysian Investment Development Authority, 2024). Thus, the FDI possibly improves productivity in Malaysia as the FDI indicates the financing of the growth of the FPI's production and management, this variable is anticipated to have a positive impact on TFP.

Besides that, trade openness provides the FPI with access to raw materials and opportunities for foreign market expansion, hence, it is important to productivity. Shamsudin et al. (2011) indicated that productivity was significantly positively affected by trade openness. Yodfiatfinda et al. (2012) also showed that trade openness determine the productivity in the Malaysian FPI, and the authors indicated that this variable was increasing productivity growth. Although trade openness is not commonly studied, it plays significant role by facilitating the flow of international capital and goods, thereby stimulate the growth of Malaysia's industry and economics. In this study, trade openness is predicted to have a positive relation with TFP.

Nowadays, technology is rapidly advancing and technological innovation deluges the enhancement of productivity as well as expands economic growth. By rapidly progressing innovation and developing the skills and knowledge of the workforce, firms can enhance the efficiency and effectiveness of their production processes, leading to increased productivity. Shamsudin et al. (2011) applied the Tobit regression to evaluate the relationship between the information and technology (IT) expenditure and productivity of the Malaysian FPI from 2000 to 2006 but the research showed that the IT expenditure did not provide an effect on the five components of TFP (technical efficiency change, technological change, scale efficiency change, pure efficiency change, and total factor productivity growth). It was argued by Yodfiatfinda et al. (2012) who defined that the higher the IT expenditure, the higher the productivity. Im and Cho (2021) also disclosed that funding for technology and innovation contributed to enhancing productivity in the South Korean service and manufacturing industries. In the current era of advanced technology, IT is a critical component of modern business operations. It improves communication, efficiency, productivity, data management, customer experience, and overall competitiveness. Therefore, IT is expected to increase the TFP.

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Furthermore, Schultz (1961) introduced the concept that investments in education, training, and other forms of human capital can improve an individual's productivity and earning potential. Goldin (2016) further elucidated that the human capital concept revolves around the idea that investments in individuals, such as education, augment workers' productivity, and skill sets. This theory is relevant to the knowledge economy as it underscores the prevalent notion that individuals with higher education levels are sought after for their specialized knowledge, thereby enhancing their human capital. Companies that consist of a large number of skilled workers are closer to the production possibilities frontier compared to firms with a smaller portion of skilled employees, representing an efficient position for the firms (Andersson & Stone, 2017). Hence, staff training cost is considered one of the key determinants of productivity. It refers to the funds allocated for training activities aimed at improving the skills of workers and staff. Shamsudin et al. (2011) suggested that the expenses related to staff training positively influenced the TFP in the Malaysian FPI. Yodfiatfinda et al. (2012) revealed a positive relationship between staff training cost and productivity by employing panel regression to estimate the 27 sub-industries in the LSEs of the FPI in Malaysia. Briefly, human capital plays a major role in production as highly educated and skilled employees often to be more productive, innovative, effective, and adaptable to change in technology. Also, the staff training cost is promoted by Malaysia such as the Human Resource Development Fund, which has a significant impact on the performance, productivity, and overall success of an industry. Thus, training costs and high education are assumed to positively influence the TFP in the FPI.

Public infrastructure is a key driver of economic growth as improving the public infrastructure will reduce the production cost and transportation costs of goods and services. It is considered government assistance to the industry and also expedites trading activities and indirectly enhances productivity. It was proved by Shamsudin et al. (2011) who analyzed the impact of public infrastructure on the productivity of FPI in Malaysia, the authors deduced that public infrastructure was stimulating the TFP growth. In the LSEs of the Malaysian FPI, the improvement of public infrastructure was benefiting productivity growth. Overall, the public infrastructure is not periodically employed in the existing studies. However, this research might consider public infrastructure as an important factor, as it enhances productivity by reducing transportation and communication costs, as well as minimizing delays caused by congestion and other disruptions. Public infrastructure is a government expense for the public infrastructure, it not only mitigates the production cost but it has the potential to increase productivity in Malaysia.

Few empirical studies concentrated on productivity in Malaysia’s FPI. Several existing research has emphasized productivity growth using DEA and SFA methods rather than the productivity level of specific firm. Besides, while previous studies have examined the productivity of Malaysia’s FPI, they have not specifically focused on the five sub-sectors for both LSEs and SMEs. Although the previous studies are important, they fail to highlight this for the policymakers to implement strategies to support growth in specific sectors. These gaps in the literature have motivated the present study, which aims to fill this gap by measuring TFP across the five sub-sectors of both LSEs and SMEs.

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Methodology

This study concentrates on both SMEs and LSEs within Malaysia's FPI, encompassing two sequential phases of investigation. Firstly, this study uses Microsoft Excel to calculate the total factor productivity (TFP) of the SMEs and LSEs in Malaysia's FPI based on the Cobb-Douglas production function. Subsequently, TFP serves as the dependent variable in the subsequent stage, Stata software is utilized to estimate Panel data analysis to determine the factors influencing TFP.

In this study, the secondary and yearly data on the SMEs and LSEs of Malaysia’s FPI is primarily obtained from the Department of Statistics Malaysia, Malaysian Investment Development Authority (MIDA), World Bank, and International Financial Statistics (IFS) for the period 2000 to 2017. The panel data of the outputs (value added) and inputs (number of labour, fixed capital, and variable cost) from the five sub-sectors of SMEs and LSEs in the FPI are used to determine the TFP as shown in Table 1. Furthermore, Table 2 provides the data sources and definitions of variables utilized for investigating the factors affecting TFP.

Table 1: Data Source and Definition for the Total Factor Productivity Analysis

Variables	Definitions	Data Sources
Output:		Department of Statistics Malaysia
VALUE ADDED	Total value added	
Input:		
LABOUR	Total number of persons engaged	
CAPITAL	Total value of fixed assets	
VARIABLE COST	Total cost of raw materials/ components/ parts used, water purchased, electricity purchased, and fuels used	

Table 2: Data Source and Definition for the Factor Affecting Total Factor Productivity Analysis

Variables	Definitions	Source
Dependent Variable:		
TFP	Total factor productivity	Calculation based on Cobb-Douglas production function
Independent variable:		
TRAIN	Total staff training cost	Department of Statistics Malaysia
RD	Total research and development expenditure	
IT	Payment for data processing and other services related to information technology	
PUB	Government expenses for infrastructure	
TERT	Number of employees with tertiary education	
SPM	Number of employees with high-school education	
FDI	Total foreign direct investment in the food processing industry	Malaysian Investment Development Authority (MIDA)
ENE	World oil prices	World Bank
OPEN	Trade openness index	International Financial Statistics (IFS)

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Total Factor Productivity Approach

According to Carlaw and Lipsey (2003), the TFP in index number is more common. The conventional evaluation of productivity is the ratio of output to input. Total factor productivity (TFP) is adapted to account for the variation in the combination of inputs which is the total output (Y) divided into a weighted average of inputs (αX):

$$TFP = \frac{Y}{\sum \alpha X} \quad (1)$$

Regarding Solow (1957), the weight of this index is the share of input and the TFP index is developed from the basic Cobb-Douglas production function:

$$Y = AL^{\alpha}K^{\beta} \quad (2)$$

Where Y is aggregate output, L is labour input, K is capital input, α and β are the parameter of labour, and capital respectively, and A represents the TFP. The Cobb-Douglas production function from equation 2 brings about the TFP measurement (Kneip & Sickles, 2012):

$$TFP = \frac{Y}{L^{\alpha}K^{\beta}} \quad (3)$$

Generally, the production function assumes that the production process use capital input (K) and labor input (L). However, to measure the entire productivity contribution of all production factors involved in a production process at the level of FPI, the intermediate input or raw material has to be included in the TFP measurement as TFP is the ratio of aggregate output to aggregate inputs utilized in the production (Hulten, Bennathan, & Srinivasan, 2006; Ichihashi & Fujii, 2009; Dai & Wang, 2014; Yasin, 2021; Masitah et al., 2023). Hence the TFP is shown as:

$$TFP = \frac{Y}{L^{\alpha}K^{\beta}M^{1-\beta-\alpha}} \quad (4)$$

Where TFP is the total factor productivity, Y is the value added of the sub-sector, L is the number of workers of the sub-sector, K is the fixed capital expenditure of the sub-sector, M is raw material, and α, β and $1 - \alpha - \beta$ are the parameter of labour, capital and raw material respectively.

Panel Data Analysis

Following the derivation of TFP from the previous estimation (Hamzah, 2020; Ruales Guzmán, Rodríguez Lozano, & Castellanos Domínguez, 2021; Yasin, 2021), Panel data analysis is applied to examine the factor affecting the total factor productivity. Building on prior research (Bhandari & Valiyattoor, 2016; Noor, 2014; Shamsudin et al., 2011; Vijayalalitha et al., 2022; Yodfiatfinda et al., 2012), the dependent variable is total factor productivity (TFP), while independent variables encompass TRAIN = Total staff training cost, RD = Total research and development expenditure, IT = expenses on information technology, TERT = number of employees with tertiary education, SPM = number of employees with SPM education, PUB = government expenses for infrastructure,

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FDI = foreign direct investment in FPI, ENE = Average annual OPEC crude oil price, OPEN = trade openness index, i = cross sectional unit, t = time period, u_{it} = error term that is independent and identically distributed. Besides that, TRAIN, RD, IT, TERT, PUB, FDI, and OPEN are expected to have a positive sign on TFP while SPM and ENE are anticipated to have a negative sign on TFP in this study.

The Panel Data Analysis as below:

$$TFP_{it} = \beta_0 + \beta_1 lnTRAIN_{it} + \beta_2 lnRD_{it} + \beta_3 lnIT_{it} + \beta_4 lnTERT_{it} + \beta_5 lnSPM_{it} + \beta_6 lnFDI_{it} \ \beta_7 lnPUB_{it} + \beta_8 lnENE_{it} + \beta_9 OPEN_{it} + u_{it} \quad (5)$$

Findings and Discussion

Total Factor Productivity

Table 3 presents the outcomes of total factor productivity (TFP) for both Small and Medium Enterprises (SMEs) and Large-Scale Enterprises (LSEs) in Malaysia's FPI. The average TFP for LSEs is 1.161, signifying that LSEs generate 1.161 units of value added by using 1 unit of aggregate inputs. This result also indicates that LSEs have the capacity to increase output by up to 16.1%. Conversely, the average TFP for SMEs is 0.935, which indicates that the SMEs produce an output of 0.935 for a unit of aggregate inputs used in production. Generally, this study shows that the average TFP of LSEs is higher than the finding of Yodfiatfinda et al. (2012) who reported the average TFP of LSEs in Malaysia's FPI from 2000 to 2006 as much as 7.3%. Furthermore, the mean of TFP of SMEs in this study is lower than the result of Shamsudin et al. (2011) which implied the mean of TFP of SMEs in Malaysia's FPI was 0.987 during the period 2000 to 2006. When comparing the TFP of LSEs and SMEs, it is evident that LSEs outperform SMEs in production, given their higher TFP level. As stated above, Figure 2 provides decreasing labour productivity in the whole FPI from 2011 to 2013, coupled with a reduction in TFP levels for SMEs during the same period. The TFP of LSEs has fluctuated more and it has been reducing since 2013, the TFP is in contrast to labour productivity of overall FPI during this period. This implies that the capital investment might not be used efficiently and the technology not be well-integrated into the production process. Also, it shows the existence of decreasing and unstable productivity issues in the FPI. In short, the finding of this study aligns with the problem statement as the TFP based on the Cobb-Douglas production function confirms that Malaysia’s FPI consists of low TFP issues.

Among the five sub-sectors of LSEs, the beverage manufacturing sector (LSE05) demonstrates the highest Total Factor Productivity (TFP) throughout the observed period in Table 4. It is succeeded by the processed meat, fish, fruits, vegetables, oils, and fats industry (LSE01), the dairy processing industry (LSE02), the other processed food sector (LSE04), and the manufacturing of grain mill products and prepared animal feeds (LSE03). Simultaneously, within SMEs, the manufacture of beverages (SME05) also exhibits the highest TFP level among other food processing sub-sectors, following the processing of meat, fish, fruits, vegetables, oils, and fats industry (SME01), the manufacture of other food products (SME04), and the manufacturing of grain mill products and prepared animal feeds (SME03), with the TFP of the manufacture of dairy products (SME02) being the lowest among SMEs' FPI.

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These findings indicate that the beverage manufacturing sector demonstrates superior performance among sub-sectors, frequently showcasing higher TFP compared to other sub-sectors of both LSEs and SMEs in the FPI. LSEs in the beverage processing industry are capable of generating 1.58 billion units of output with 1 billion units of aggregated inputs, while SMEs in this sector produce 1.056 units of output with 1 unit of aggregated inputs. This could be attributed to beverages such as bottled water, soft drinks, and juices having higher value-added compared to basic processed foods. Additionally, it might be due to Malaysia's beverage industry benefiting from export opportunities as they expand their market share and increase sales profit. For instance, a prominent beverage producer in Malaysia, Fraser and Neave Holding Berhad, saw its net profit surge from RM92.95 million in 2022 to RM198.79 million in 2023, driven by increased exports from this industry (The Star, 2023).

Moreover, the manufacture of dairy products is associated with the lowest TFP index, standing at 0.87 in the SME sector, indicating that 1 unit of aggregated inputs can only yield 0.87 units of output. This could be attributed to the heavy reliance on dairy product processing on imported raw materials and ingredients (Beckman, 2023). Malaysia is a net importer of raw materials which Malaysia generally purchases imported dairy ingredients from New Zealand, Netherlands, and Australia (Flanders Investment and Trade Malaysia Office, 2020). Besides that, Faghiri, Yusop, Eric Krauss, Hj Othman, and Mohamed (2019) indicated that Malaysia's dairy sector faces complex challenges, such as poor breed performance and inability to adapt to local environmental conditions, inadequate training and skills, ineffective dairy farm management, inadequate nutritional feed, and consistently high input and feed expenses. A notable observation from Table 4 is that SMEs engaged in the production of grain mill products, starch products, and prepared animal feeds (SME03) achieve a TFP index of 0.8834, which is only marginally higher by 0.0131 units compared to the manufacture of dairy products (0.8703). Meanwhile, the mean TFP value (0.8574) for LSEs involved in producing grain mill products, starches, and prepared animal feeds ranks at the bottom among other sub-sectors (Table 4). This could be attributed to the substantial cost of raw materials and ingredients in this industry, as Malaysia's tropical climate limits large-scale wheat production. Consequently, Malaysia heavily relies on imported wheat from countries such as Australia, Canada, the United States, India, and Ukraine, with Australia being the primary and traditional wheat supplier, accounting for 80% of Malaysia's wheat imports (ISHAK, 2022; Beckman, 2023).

Table 3: Total Factor Productivity of LSEs and SMEs

	Total Factor Productivity	
Year	LSEs	SMEs
2000	2.671	0.594
2001	1.385	0.570
2002	0.429	1.343
2003	0.269	0.488
2004	3.521	0.112
2005	0.821	1.242
2006	1.060	2.955
2007	0.851	0.941

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2008	1.151	0.478
2009	1.651	0.435
2010	0.349	0.914
2011	0.370	0.999
2012	0.510	1.108
2013	1.680	0.852
2014	1.480	0.710
2015	0.823	0.911
2016	0.889	0.950
2017	0.992	1.235
Means	1.161	0.935

Source: Authors

Table 4: TFP Mean of Sub-sectors in LSEs and SMEs

Sector	TFP Mean	Sector	TFP Mean
LSEs	1.1613	SMEs	0.9354
LSE01	1.274	SME01	0.9593
LSE02	1.1985	SME02	0.8703
LSE03	0.8575	SME03	0.8835
LSE04	0.8929	SME04	0.9079
LSE05	1.5835	SME05	1.0561

Source: Authors

Descriptive Statistics

The summary of the descriptive statistics of 11 variables which are 1 response variable and 9 explanatory variables is displayed in Table 5. The dependent variable is total factor productivity (TFP) and the independent variables are training cost (TRAIN), research and development (RD), information and technology (IT), employees with tertiary education (TERT), employees with SPM education (SPM), foreign direct investment (FDI), government expenses on infrastructure (PUB), world oil price (ENE), and trade openness (OPEN).

The mean values of all the variables exceed their relative standard deviations, indicating that the data set is dispersed and relatively concentrated around the mean. Moreover, TFP, INEFF, TRAIN, RD, IT, TERT, and FDI have a long-right-tail (more weight on the left side) while SPM, PUB, ENE, and OPEN have negative skewness values that the distribution is skewed to the left. Additionally, the probability values of Jarque-Bera for all variables, except IT, are higher than a 5% significant level which does not reject the null hypothesis of normality. This reveals that these data (exclude IT) are normal distribution and exhibit constant variance.

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Table 5: Descriptive Statistics

	TFP	TRAIN	RD	IT	TERT	SPM	FDI	PUB	ENE	OPEN
Mean	1.048	9.454	10.679	9.681	9.332	11.228	13.62	18.29	5.279	172.17
Standard Dev.	0.728	0.907	1.386	0.915	0.623	0.419	0.596	0.484	0.451	30.963
Minimum	0.112	8.195	8.421	8.255	8.408	10.355	12.82	17.41	4.476	126.9
Maximum	3.521	11.716	13.527	12.452	10.756	11.877	14.74	18.94	5.823	220.41
Skewness	1.781	0.434	0.793	0.928	0.388	-0.684	0.367	-0.237	-0.49	-0.02
Kurtosis	6.29	2.372	2.715	4.216	2.322	2.669	2.106	1.758	1.974	1.48
Jarque-Bera	35.27	1.72	3.894	7.39	1.593	2.971	2.009	2.651	3.015	3.467
Probability	2.2	0.4231	0.1427	0.0248	0.4508	0.2264	0.3662	0.2657	0.2214	0.1767
Observations	36	36	36	36	36	36	36	36	36	36

Source: Authors

Unit Root Test

Before conducting panel data analysis, the unit root test is conducted to ensure that the variables in the estimations are free from unit roots and that the time series data is stationary. Additionally, panel unit root tests evaluate both the time series and cross-sectional data of the panel, providing a thorough examination of stationarity across entities and over time.

Table 6 illustrates the unit root test results for both the dependent and independent variables in the Panel data analysis. All variables exhibit statistical significance in terms of stationarity in either one or both tests. TFP and PUB, categorized as I(0) variables, do not display a unit root at the level. Conversely, TRAIN, RD, IT, and SPM are stationary at the first difference in both LLC and IPS unit root tests. However, ENE is stationary at a level in LLC and FDI is stationary at level in IPS, while TERT and OPEN are deemed as an I(1) variable in the IPS test only. In line with established panel data econometric practices (Baltagi, 2005), variables of theoretical importance should not be excluded solely based on unit root test results, as these tests may be sensitive to specific sample characteristics or test limitations.

Table 6: Panel Unit Root Test Result

	LLC		IPS	
Variables	At level	1st Difference	At level	1st Difference
TFP	-5.0547***	-5.5178***	-2.7946***	-3.1907***
	(0.000)	(0.000)	(0.0026)	(0.0007)
TRAIN	-0.7591	-3.2577***	0.5636	-3.1181***
	(0.2239)	(0.0006)	(0.5636)	(0.0009)
RD	1.6667	-2.3673***	1.5552	-3.3986***
	(0.9522)	(0.0090)	(0.9400)	(0.0003)
IT	0.0015	-4.0838***	0.7946	-2.6855***
	(0.5006)	(0.0000)	(0.7866)	(0.0036)
TERT	-0.4245	-0.9462	2.6905	-1.9176**
	(0.3356)	(0.1720)	(0.9964)	(0.0276)
SPM	-0.0051	-2.4432***	1.6438	-2.3393***

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	(0.4980)	(0.0073)	(0.9499)	(0.0097)
FDI	-0.2265	-3.6311***	-1.2832*	-3.8740***
	(0.4104)	(0.0001)	(0.0997)	(0.0001)
PUB	-1.8630**	-3.8178***	-1.7157**	-1.5979*
	(0.0312)	(0.0001)	(0.0431)	(0.0550)
ENE	-2.0885**	-1.6161*	-0.1320	-2.1943**
	(0.0184)	(0.0530)	(0.4475)	(0.0141)
OPEN	-0.1411	-0.1760	0.7904	-2.3059**
	(0.4439)	(0.4302)	(0.7853)	(0.0106)

Source: Authors

Panel Data Results

Table 6, Table 7, and Table 8 present the summary of factors affecting the total factor productivity (TFP) of Malaysia's FPI via Pooled OLS, fixed effects, and random effects panel analysis respectively. The p-value of the diagnostic and other test results are displayed in Table 9. This is a semilog (lnX) functional form, hence the change in Y when X changes is interpreted as if X increased by 1 percent, Y will change by $\beta/100$ units (Studenmund, 2020). Firstly, the Breusch Pagan Lagrange Multiplier test (Table 9) is conducted to select an appropriate model between the pooled OLS model and panel analysis it is statistically insignificant at 5% significant levels. Hence, this study does not reject the null hypothesis that no panel effect. This suggests that the pooled OLS model is the preferred estimator. Furthermore, the finding of several diagnostic tests (Table 9) exhibits that the TFP model does not encounter any issues that may affect the empirical testing procedure and outcomes. The TFP model is free from non-normal distribution, autocorrelation, heteroskedasticity, and instability as the probability of these tests is not significant at a 5% significance level. Hence, this model fails to reject the null hypotheses of normality, no autocorrelation, homoskedasticity, and no omitted variables.

This analysis reveals that staff training (TRAIN) has a statistically significant positive impact at a 10 per cent level on TFP which means that staff training is positively affecting the TFP in FPI. The investment in the education and training of the workers leads to improving the productivity and efficiency of the industry growth. This finding aligns with previous studies (Shamsudin et al., 2011; Yodfiatfinda et al., 2012). Government expenditure on infrastructure (PUB) also exhibits a positive and significant effect on TFP. The results indicate that government investment in the public infrastructure benefits the FPI by establishing an industrial park, facilitating manufacturers with a convenient transport network, reducing operational costs, and offering an attractive location. This result is consistent with findings from studies by Bhandari and Valiyattoor (2016) and Shamsudin et al. (2011). Trade openness (OPEN) significantly contributes to TFP at the 5% significant level, suggesting that relaxed trade barriers enhance the TFP of FPI. This could be attributed to food producers expanding market penetration in foreign countries and acquiring raw materials from overseas at a lower cost. This result aligns with prior research (Shamsudin et al., 2011; Yodfiatfinda et al., 2012).

Surprisingly, this study reveals a negative and statistically insignificant association between research and development (RD) and total factor productivity (TFP). This implies that a high level of investment in research and development may impede the TFP of the FPI. This could

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be attributed to food manufacturers channeling investments into operational development rather than traditional production aspects, such as the installation of 4G LTE technology and advancements in the working environment. This divergent result is revealed in existing studies (Gumbau-Albert & Maudos, 2002; Barasa et al., 2015), suggesting that the impact of research and development on productivity may be dynamic. The current research and development investment might yield productivity gains in the future (Gumbau-Albert & Maudos, 2002). Moreover, companies may encourage research and development to boost their productivity within the company, while simultaneously contributing to lower productivity in non-research and development firms, thereby contributing to lower overall industry productivity (Barasa et al., 2015).

This paper suggests the non-significant negative coefficient of information and technology (IT) implies that an increase in information and technology expenses reduces total factor productivity (TFP). This finding is supported by previous studies (Im & Cho, 2021; Shamsudin et al., 2011; Yodfiatfinda et al., 2012), suggesting that Malaysia's FPI might be labor-driven or labor-intensive, as the utilization of information and technology or capital-intensive methods does not enhance the industry. In this study, foreign direct investment (FDI) is found to be insignificantly but positively related to TFP in the FPI. The increase in foreign funding facilitates the operations of food processing enterprises, enabling accelerated management and production. This outcome aligns with findings by Phan (2004) and Charoenrat and Harvie (2017). Furthermore, the world oil price (ENERGY) demonstrates an inverse relationship with TFP but is insignificant. This could be attributed to the rising world oil price increasing transportation costs and reducing enterprise revenue. This result aligns with existing research by Yodfiatfinda et al. (2012).

Table 6: Pooled Ordinary Least Squares (OLS) Analysis

TFP	Coef.	St.Err.	t-value	p-value
TRAIN	0.5243	0.2856	1.84	0.0780*
RD	-0.0773	0.2998	-0.26	0.7990
IT	-0.1670	0.2298	-0.73	0.4740
TERT	-0.3194	0.7536	-0.42	0.6750
SPM	-0.2211	0.4717	-0.47	0.6430
FDI	0.6137	0.4094	1.50	0.1460
PUB	4.1272	2.3628	1.75	0.0920*
ENE	-1.4371	1.0105	-1.42	0.1670
OPEN	0.0600	0.0257	2.33	0.0280**
Constant	-82.586	43.435	-1.90	0.0680*

Source: Authors

Table 7: Panel Data Analysis (Fixed Effects)

TFP	Coef.	St.Err.	t-value	p-value
TRAIN	0.5307	0.2914	1.82	0.0810*
RD	-0.0713	0.3057	-0.23	0.8170
IT	-0.2214	0.2922	-0.76	0.4560
TERT	-0.4557	0.8836	-0.52	0.6110
SPM	0.0741	1.0641	0.07	0.9450
FDI	0.6199	0.4172	1.49	0.1500
PUB	4.4008	2.5607	1.72	0.0980*
ENE	-1.5704	1.1143	-1.41	0.1710
OPEN	0.0624	0.0273	2.29	0.0310**

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Constant	-89.012	48.8023	-1.82	0.0800*

Note: ***, **, * denote statistical significance at 1%, 5% and 10% significant level.
Source: Authors

Table 8: Panel Data Analysis (Random Effects)

TFP	Coef.	St.Err.	t-value	p-value
TRAIN	0.5243	0.2856	1.84	0.0660*
RD	-0.0773	0.2998	-0.26	0.7970
IT	-0.1670	0.2298	-0.73	0.4670
TERT	-0.3194	0.7536	-0.42	0.6720
SPM	-0.2210	0.4717	-0.47	0.6390
FDI	0.6137	0.4094	1.50	0.1340
PUB	4.1272	2.3628	1.75	0.0810*
ENE	-1.4371	1.0105	-1.42	0.1550
OPEN	0.0600	0.0257	2.33	0.020**
Constant	-82.5860	43.4348	-1.90	0.0570*

Note: ***, **, * denote statistical significance at 1%, 5% and 10% significant level.
Source: Authors

Table 9: Diagnostic Test

Test	Probability
Breusch Pagan Lagrange Multiplier	1.0000
Normality	0.2352
Heteroskedasticity	0.4215
Misspecification	0.0729
Autocorrelation	0.0691

Source: Authors

Conclusion

Malaysia's food processing sector may be grappling with the challenge of low and declining total factor productivity (TFP) d decreasing and unstable labor productivity for certain periods and sub-sectors. Consequently, this study aims to assess the TFP levels of both Small and Medium Enterprises (SMEs) and Large-Scale Enterprises (LSEs) in Malaysia's food processing industry (FPI) using the Cobb-Douglas production function. It also aims to analyze the factors influencing the overall TFP of the industry through Panel data analysis during the period of 2000 to 2017.

Firstly, this study obtains the TFP known from the Cobb-Douglas production function. This suggests that LSEs have the potential to increase aggregate outputs by up to 16.1% with a unit of aggregate inputs. Conversely, the average TFP in SMEs is considerably lower, indicating that SMEs produce only 0.935 units of output for every unit of input employed. The discovery of this study corresponds with the issue outlined in the problem statement, as the TFP derived from the Cobb-Douglas production function affirms that Malaysia's FPI faces challenges with low TFP. Additionally, the empirical findings emphasize the need for resource management in the FPI, particularly for SMEs, involving aspects such as labor, capital, raw materials, water, electricity, and fuels, to optimize efficiency and effectiveness in resource utilization for maximum output.

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In the subsequent step, this study employs a Panel model, revealing a positive relation of TFP in the FPI to changes in training costs, public infrastructure, and trade openness. The study recommends increased public and private investment such as investment in training costs by both the government and food manufacturers, highlighting the importance of employee training in enhancing their understanding, knowledge, and skills for more effective role fulfillment, ultimately contributing to organizational performance. Moreover, this study suggests that government support for infrastructure and international trade is crucial for the FPI, emphasizing the need for policies that control global trade while promoting trade openness for the benefit of food manufacturers. However, during crisis periods like the Covid-19 pandemic, the enterprises play an important role, particularly SMEs. It advocates for policies that protect local companies and regulate the openness of foreign enterprises to ensure the resilience and stability of the local FPI.

Limitations and Suggestions

This study consists of several limitations in determining the TFP of Malaysia's food processing industry (FPI) that require further exploration in the future. The first limitation is the difficulty in obtaining the data, as microeconomic level data used to determine productivity is not publicly accessible. Moreover, the period of data observed in this study is 2000-2017 because of the latest annual survey and census of FPI collected by the Department of Statistics Malaysia (DOSM) for the reference year 2017, the FPI data for the year before 2000 is under a different classification. Moreover, the findings derived from the study are incorporated in a small sample and limited period of observation, expanding the dataset might bring about different results.

Future researchers could focus on the extended period of the dataset in future studies, as a prolonged data sample might bring about the disparity in the findings because of the dynamics and technological change in the FPI. Besides that, future researchers should also assess the quality measurement and delve into other countries that have food-related business connections with Malaysia. Also, investigate the outcomes of additional variables (ownership, years of experience, management style, and market share) on TFP.

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