Estimating Productivity and Identifying the Frontier

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Executive Summary

Analysis of productivity at industry and sectoral-level is often too broad to be a practical basis for policy and strategy formulations. To better translate the sectoral productivity into feasible and effective policies and incentives, it is therefore essential to understand how enterprise-level productivity patterns evolve by taking into account the heterogeneity between firms.

On the basis on this backdrop and in an effort to facilitate and support productivity enhancement at the enterprise level, a preliminary exploration had been conducted to measure the productivity performance across enterprises for benchmarking purposes quantitatively. The main aim is to identify the most productive firms (frontier) within the same subsector to be presented as an exemplary and lead model as a channel to spread good practices for other business entities (non-frontier).

The proposed benchmarking mechanism and framework for evaluating and tracking enterprise-level productivity is drawn upon a productivity measurement model called DEA. DEA or Data Envelopment Analysis measures the relative efficiency performance of business entities in terms of resource utilization that can assist in the identification of benchmark peers. Such identification enables possible efficiency and productivity improvements that may help the non-frontier firms or laggards to reach their relative potential.

As this is among the first attempts to assess the micro-level productivity, the scope of this study is only limited to enterprises and firms that are publicly listed in the primary board of Bursa Malaysia, covering 149 companies across eight specific priority subsectors. This is mainly driven by the aim of collecting comparable data across firms while achieving the broadest possible coverage from the available published sources. Data were gathered and compiled from the respective firms' annual reports for the most recent published years covering 2017 to 2019.

The analysis from the study suggests several key findings worth highlighting:

1. Firms generally stay on the frontier for a short time and inherently unstable over the period 2017 to 2019. Majority of the subsectors manifested slight volatility in the number of frontier firms and generally lesser by number as compared to the earlier years.
2. Two from the overall eight subsectors registered high volatility in efficiency and productivity across different years (2017-2019) while one subsector relatively stable. The remaining subsectors recorded moderate fluctuations in firms' efficiency scores and productivity trends.
3. In five subsectors, the average productivity trends for the non-frontier firms were catching-up against the frontier firms. Nevertheless, the productivity gap between the frontier and non-frontier firms were widening between 2017 to 2019 for two of the subsectors studied. One subsector, on the other hand, recorded a relatively stable pattern over time between the frontier and non-frontier firms.
4. The primary sources of productivity growth over the period of 2017 to 2019 were significantly different among subsectors. While most subsectors gained tremendously from the improvement in scale efficiency in more recent years, there were also cases where the technical change decomposition dominantly contributed to productivity growth. Notwithstanding this development, several subsectors, however, recorded a declining trend (negative growth) in pure efficiency from 2017 to 2019.

Contents

Figures

Figures

Figures

Tables

Background

The Malaysia Productivity Blueprint defines five key strategic thrusts that form the basis to address the five key challenges to drive Malaysia towards sustainable economic growth. These strategic initiatives outlined clear directions forward that covers various vital aspects of the economy that deeply rooted on talent and workforce, digital readiness and capabilities, responsible businesses, established regulatory framework and effective governance mechanism.

In successfully delivering these initiatives, a three-stages rollout was proposed that holistically covers the broad national segments of the economy, sectoral level as well as at the enterprise level. The latter recognizes 9 key priority subsectors across various industries, from services to manufacturing, that require extra deep-dive attention to propel the economy forward.

At the enterprise level, with the aim to enhance operations and productivity at the foundational level, several specific strategies were outlined. Among these include the establishment of nexus for each priority subsectors to drive, assist and guide business entities including the SMEs to face the challenges through greater improvement in productivity. These initiatives were partly manifested through the Enterprise Productivity Programme that was introduced by the Malaysia Productivity Corporation as a structured, hands-on and customised approach to uplift the productivity of the enterprises.

In line with these efforts, several other initiatives are also in the pipeline. The ability to quantitatively measure the productivity performance across enterprises for benchmarking purposes are among the agendas put forward. The main aim is to identify the most productive firms (frontier) within the same subsector to be presented as exemplary and lead model as a channel to spread good practices for other business entities (non-frontier).

In pursuing this agenda, the MPC has commissioned a study to explore on the possible quantitative framework to assess and measure enterprises productivity for Malaysia. Specific country level studies that have been conducted to measure firm productivity levels are regarded as the focal references, in addition to the methodological practices presented by the Organization for Economic Co-operation and Development (OECD) through their MultiProd Project.

On the basis of this initiative and in an effort to facilitate and support productivity enhancement at the enterprise level, a preliminary (pilot study) exploration has been conducted by a group of researcher for this purpose. As this is among the first attempts to assess the micro level productivity and given the constraints in data availability, the scope of this study is only limited to enterprises and firms that are publicly listed in the primary board of Bursa Malaysia, covering eight specific priority subsectors.

Objectives

Analysis of productivity at industry and sectoral-level is often too broad to be a practical basis for policy and strategy formulations. To better translate the sectoral productivity into feasible and effective policies and incentives, it is therefore essential to understand how enterprise-level productivity patterns evolve by taking into account the heterogeneity between firms. The analysis of productivity at the firm level also provides fundamental insights on short-term fluctuations of output over time due to unexpected shocks in the economy that may have diverse effects on productivity growth. Moreover, identification of frontier firms and laggard firms, according to industries would provide a better insight for the government and relevant authorities in devising effective policies and incentives so as to boost productivity improvement, particularly during the post-COVID19 economy.

The objectives of the study are:

1. Preliminary evaluation of firm level efficiency and productivity based on 'Productivity Nexus'

2. Identification of frontier firms and laggard firms at the sectoral level

3. Recommendation on benchmarking framework for enterprise level productivity assessment

Context

Productivity is one of the most important factors influencing our economic well-being. Productivity growth is essential to propel higher standard of living and is vital to a sound economic environment. At the enterprise level, the increase in productivity brings upon a variety of positive effects to various stakeholders. Workforce could benefit through improved work conditions and compensation packages, the shareholders benefited from increased profits and dividend distributions while customers may gained through lower prices. Given the broad scope and importance of productivity challenge, it is important to explore ways of improving Malaysia's productivity performance not only at the sectoral level, but through enterprises. To provide better context for the need to explore the enterprise level productivity assessment, the report begins by highlighting the basic concepts and methodology used by several studies.

Frontier Firms: Definitional variants and approaches

Productivity reflects how efficiently a combination of inputs is used to produce output. The applicable algorithm related to this concept is the Multi-Factor Productivity (MFP) or also known as Total Factor Productivity or TFP. It is often thought of as a proxy for broad technological advances that increase outputs from a composite of inputs. These advances can include new technology associated with new types of equipment, improvements in management and production processes as well as increased scale and improved worker skills.

The OECD defines *'frontier firms'* as those in the top 10% of the productivity distribution – either globally (global frontier) or among domestic firms (domestic frontier). The measurement of MFP adopted by MultiProd project is based on the Solow residual model using ORBIS database covering firms under two-digit International Standard Industrial Classification (ISIC).

For country-level studies, there are, however, slight differences in the nature of definition used to reflect the concept of 'frontier firms'. These variances may take the form of top 10th ranked firms or even a top 5 percent quartile ranked firms based on sectoral productivity performance (New Zealand Productivity Commission, 2020). In addition, localize databases were used to conduct country-specific studies that better captured the sectoral identity of firms at the micro-level. Similarly, various approaches have been adopted to measure the firm's productivity level ranging from the index number approach to parametric and nonparametric techniques.

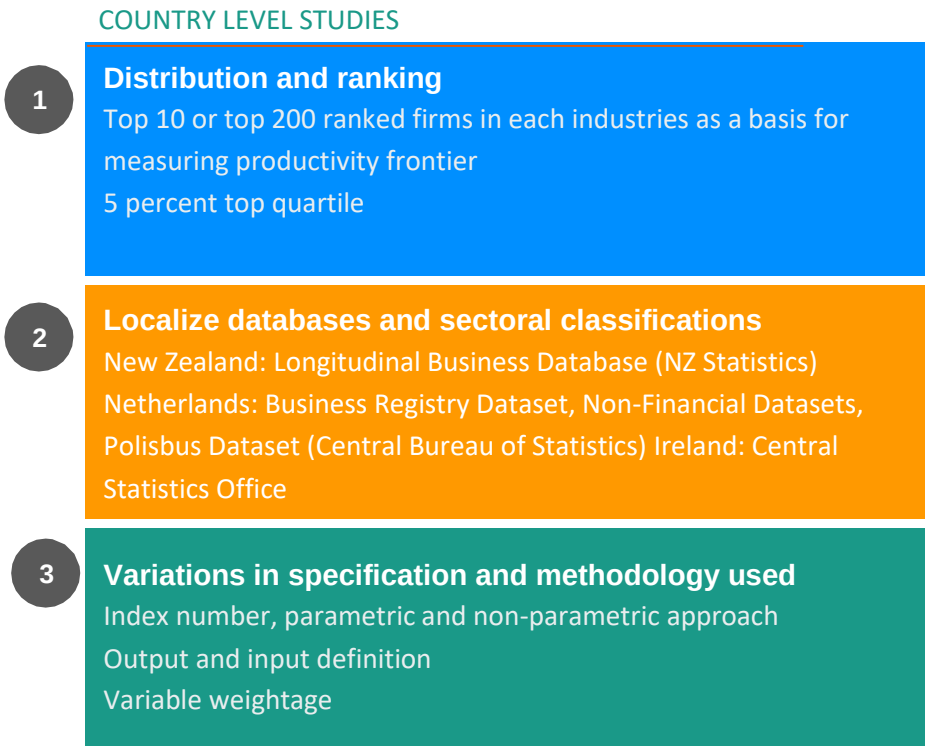


Figure 1: Variation in country level studies

The above figure presents a few instances of crucial variants concerning the country-level studies as compared to the MultiProd project under the OECD. In addition to the conceptual aspect and databases used that varies across studies, independent and official research for country-specific studies also differs in terms of the output and input specifications used that are highly dependent on the availability of firm's microdata at country level.

In our context, the conduct of this particular study is to harmonize the context of MultiProd project by the OECD by means of incorporating flexibility given the existing nature of available micro data. Through this approach, a complementary framework could be developed that will enable firm level productivity assessment for benchmarking and policy formulation.

Methodology

The study uses a non-parametric approach to quantitatively analyze firm level microdata as a technique to measure the firm's performance. Specifically, Data Envelopment Analysis (DEA) is employed to extract firms productivity purely on the basis of reported and published numerical data. The context of the reported statistics need to be understood via qualitative inquiry and thus involve the next complementary measures (Phase 2) in the form of case studies with the main aim to capture the entire aspect of productivity before proceeding to the engagement phase with the respective stakeholders (Phase 3).

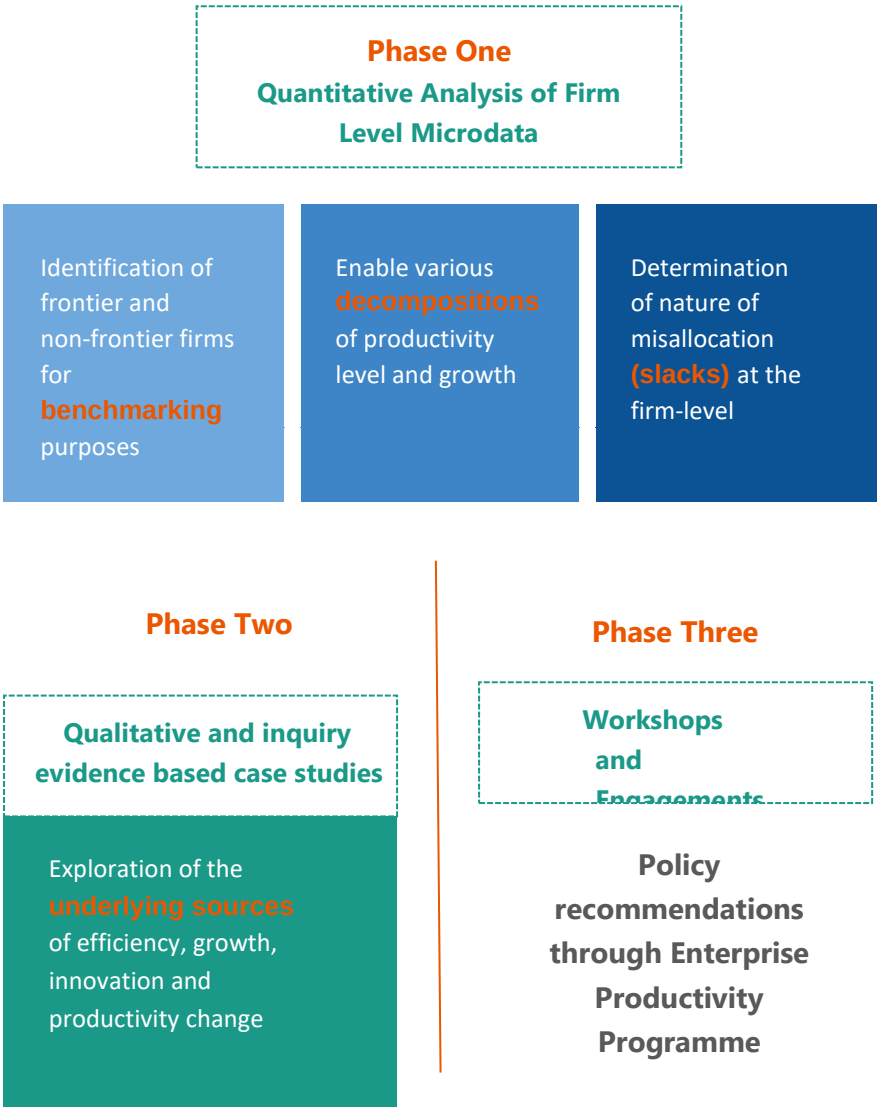


Figure 2: Quantitative phase and the complementary phases

Frontier Analysis

Data Envelopment Analysis (DEA) constructs a frontier as the ratio of the weighted sum of outputs to a weighted sum of inputs to enable relative comparisons of efficiency and productivity performance. The DEA uses a ratio of total factor productivity to measure performance by attributing a virtual optimal weight to each production entity's input and output. The optimal weights are arrived at by means of a Linear Programming (LP) model. The efficient frontier is a function that indicates the maximum attainable level of output corresponding to given composite inputs as demonstrated by the production entities sampled.

Instead of defining frontier firms as those in the top-quartile (percentage) of the ranking, our DEA methodology defines frontier firms as those who consume the least ratio of composite inputs to generate a composite output. The convex line on the graph below called Efficient Frontier (EF), and it represents the prevailing technology for the industry based on what has been demonstrated by the firms. In other words, the technology in practice to be considered as efficient is not assumed but derived from the reported performance of the firms. All firms along the EF are frontier firms, and their technical efficiency score is 100 percent. All firms not on the EF are non-efficient, and their technical efficiency scores are quantified in terms of how far the firms are from the EF.

In other words, DEA will not consider firms that are capable of producing the highest volume of composite outputs as efficient firms if they are utilizing more amount of composite inputs relative to other firms. In Figure 3, *firm E* and *firm F* are equally efficient despite the huge difference in their respective output volume because they both produce the most based on their respective amount of composite inputs compared to others with a similar level of input consumption.

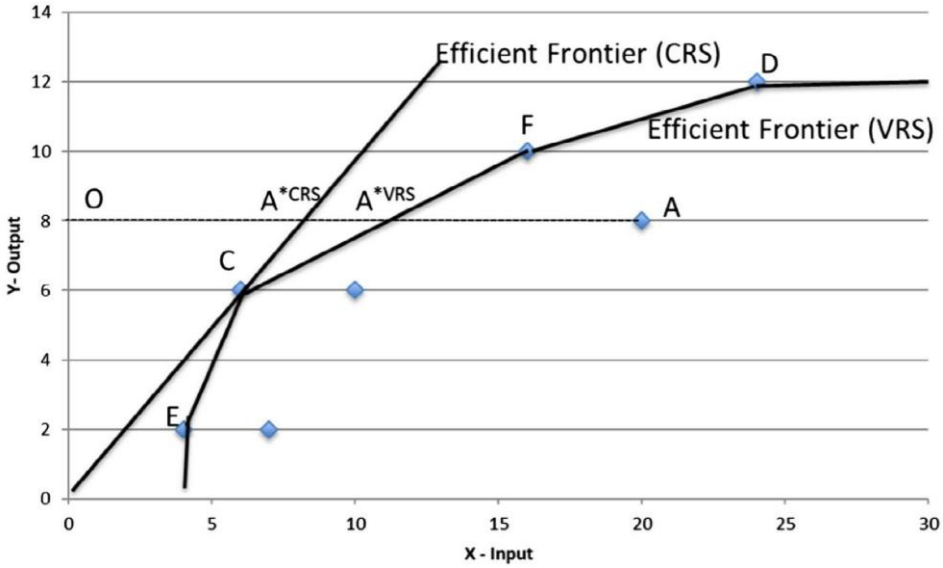


Figure 3: Hypothetical illustration of an efficient frontier (adapted from Thanassoulis and Silva (2018))

For instance, *firm F* is using roughly 15-16 units of input to produce 10 units of output and identified as the benchmark for *firm A*, who is using about 19-20 units of input to produce 8 units of output. However, *firm F* is not identified as the benchmark for *firm X* at the far below because *firm X* is operating with about half of the input level of *firm F*. For *firm X*, the benchmark is *firm E* which has about the same amount of input consumption.

DEA technique also allows the replication of frontier firms' practice based on the relative significance of peers. In this context, the frontier firms act as the benchmark and their relevance as a role model could be computed for the non-frontier firms. The importance of peers to a particular non-frontier firm denoted by lambda values. Lambda could be understood as a description of the chemistry level and/or how well a respective peer among the frontier firms suits to become the benchmark for every non-efficient firm. A greater value of lambda indicates a better benchmark and role model the specific frontier firm is, relative to the other frontier firms after taking into account their respective operating scale.

Similarly, the technical efficiency scores generated by DEA technique could also be used to rank the sampled firms for benchmarking purposes. Firms that obtained technical efficiency values equal to 1 are the efficient firms and thus, identified as the frontier firms. On the other hand, the firms that register technical efficiency score less than 1 implies the inefficient (non-frontier) firms. This study adopts the Super Efficiency model introduced by Anderson and Peterson (1993) to further extend the analysis in determining the ranking among the frontier firms. In particular, this study takes the approach of considering the consistently frontier firms over the range of sample periods to rank the best performers.

Overall, the findings of the analysis will focus on three main aspects that are:

Efficiency score

DEA represents performance by an efficiency score, calculated as the firm's distance to the best practice industry frontier.

Comparative analysis

The general use of DEA is to determine, compare and evaluate efficiency of multiple production entities against the best observed performance.

Slack adjustment & Peers

A firm that is not on the frontier is rated to be inefficient and has the potential to improve its performance by realigning its resources according to its benchmark peers.

Figure 4: Key deliverables of proposed DEA analysis

Malmquist Productivity Index

In addition to giving performance evaluation for a particular period, such as for a year, DEA could also provide performance evaluation across multiple periods. The latter assessment is possible by the computation of MPI. MPI or DEA-based Malmquist productivity index indicates total factor productivity change (TFP) from one period to another. A change or movement in productivity over time can be further decomposed into two parts (Figure 5):

1. Movement (shift) of the frontier due to changes in potential capabilities of the firm (technical change) which encompasses broad improvement aspects including stock of knowledge, new technologies, smart infrastructure and *etc.*;
2. Movement of the firm towards (or away from) the best-practice frontier (efficiency change) due to changes in operational efficiency (also termed as pure efficiency change) that are associated with the change in output production or input usage; and/or changes in the efficiency due to scale effects (scale efficiency change).

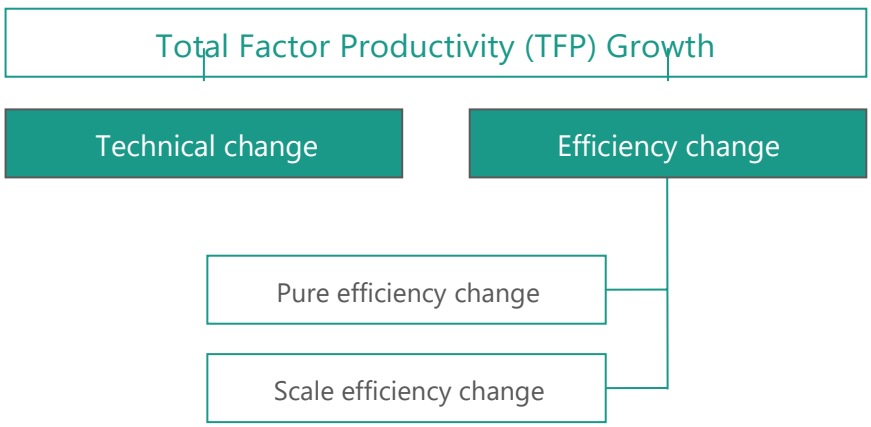


Figure 5: Decomposition of productivity growth

The computed MPI values describe the rate of growth or contraction between two adjacent periods. Index value greater than 1 implies positive growth between years while index value lesser than 1 implies negative growth (declining) productivity. Similarly, the same interpretation applies for the decomposition of TFP growth that relates to the concept of technical change, pure efficiency change and scale efficiency change. The computation of the MPI for this study adopts the model by Ray and Desli (1997).

General Specifications and Parameters

This study replicates the OECD MultiProd project general output and input specifications to measure and examine the efficiency and productivity. In particular, the output parameter corresponds to the value-added (revenue - cost of sales), and the general input parameters are capital and investment as well as labour. In line with the disclosure and reporting standards, three specific inputs have been chosen for this study which are total assets, total equities and labour input (proxied by staff costs). The choice of the input measures has been driven by the aim of collecting comparable statistics across firms while achieving the broadest possible coverage. Figure 6 below presents the specifications for this study which are adapted from the OECD MultiProd project (Berlingieri et al., 2017).

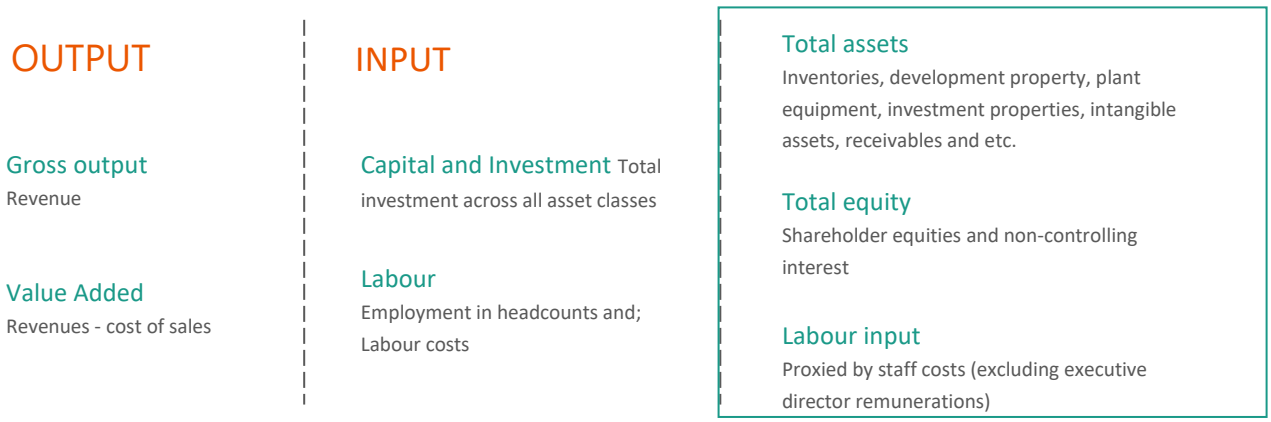


Figure 6: Output and input specifications

Data Source and Compilation

The study relies on annual financial reports of public listed (main market) companies under Bursa Malaysia. The priority subsectors under the Productivity Nexus are the key domains for measuring firms' productivity over the period of 2017 to 2019. As listed companies in the prime board, all sampled firms are in full compliance with relevant rules and guidelines prescribed by Securities Commission and Bursa Malaysia. Besides, the prime market for the listing of public companies is also in compliance with the market benchmark, which is purely market-driven.

The Bursa Malaysia's Main Board comprises of 767 companies covering 13 main sectors based on Industry Classification Benchmark (ICB) and Global Industry Classification Standards (GICS). From the 13 main sectors, 9 main sectors are divided further into 38 subsectors, as presented in Table 1 below:

	Sector	Subsector
1.	Construction	
2.	Consumer products and services	Agricultural product Automotive Food/beverages Household goods Personal goods Retailers Travel, leisure and hospitality
3.	Energy	Energy infrastructure, equipment and services Oil and gas producers Other energy resources
4.	Financial services	Banking Insurance Other financials
5.	Healthcare	Healthcare equipment and services Healthcare providers Pharmaceuticals

	Sector	Subsector
6.	Property	
7.	Industrial products and services	Auto parts Building materials Chemicals Diversified industries Industrial engineering Industrial materials, components and equipment Industrial services Metals Packaging materials Wood and wood products
8.	Real estate investment trusts	
9.	Technology	Digital services Semiconductors Software Technology equipment

	Sector	Subsector
10.	Transportation and logistics	Transportation and logistic services Transportation equipment
11.	Telecommunications and media	Media Telecommunications equipment Telecommunications service providers
12..	Utilities	Electricity Gas, water and multi-utilities
13.	Plantation	

Notes:
Industry Classification Benchmark (ICB)
Global Industry Classification Standards (GICS)

Table 1: Bursa Malaysia sector and subsector classifications

Due to variation in the standard of classifications employed by Bursa Malaysia, mapping is necessary to group the listed companies into the priority subsectors based on the Productivity Nexus. Several notable points worth to be highlighted with regard to this process:

1. There are overlapping subsectors across various sectors between the standards employed by Bursa Malaysia relative to the Malaysia Standard Industrial Classifications (MSIC).
2. The number and the listed firms varied across time due to new addition to the board listings as well as the possible delisting of companies from the Bursa Malaysia.
3. The extracted information from the financial statements are based on standard reporting procedure as required by the disclosure standards based on the listing requirements of Bursa Malaysia.
4. Unavailability of employees headcounts microdata at firm level or number of persons engaged.

The filtering and mapping of the listed companies on the Main Board of Bursa Malaysia brings us to the following samples for the purpose of our analysis:

Figure 7: Mapping of firms based on MPC priority subsectors

Findings

The reporting of the findings is presented based on the key priority subsectors. Each subsection presents the main key deliverables for each priority subsector that are in line with the objectives of the study which can be summarised as below:

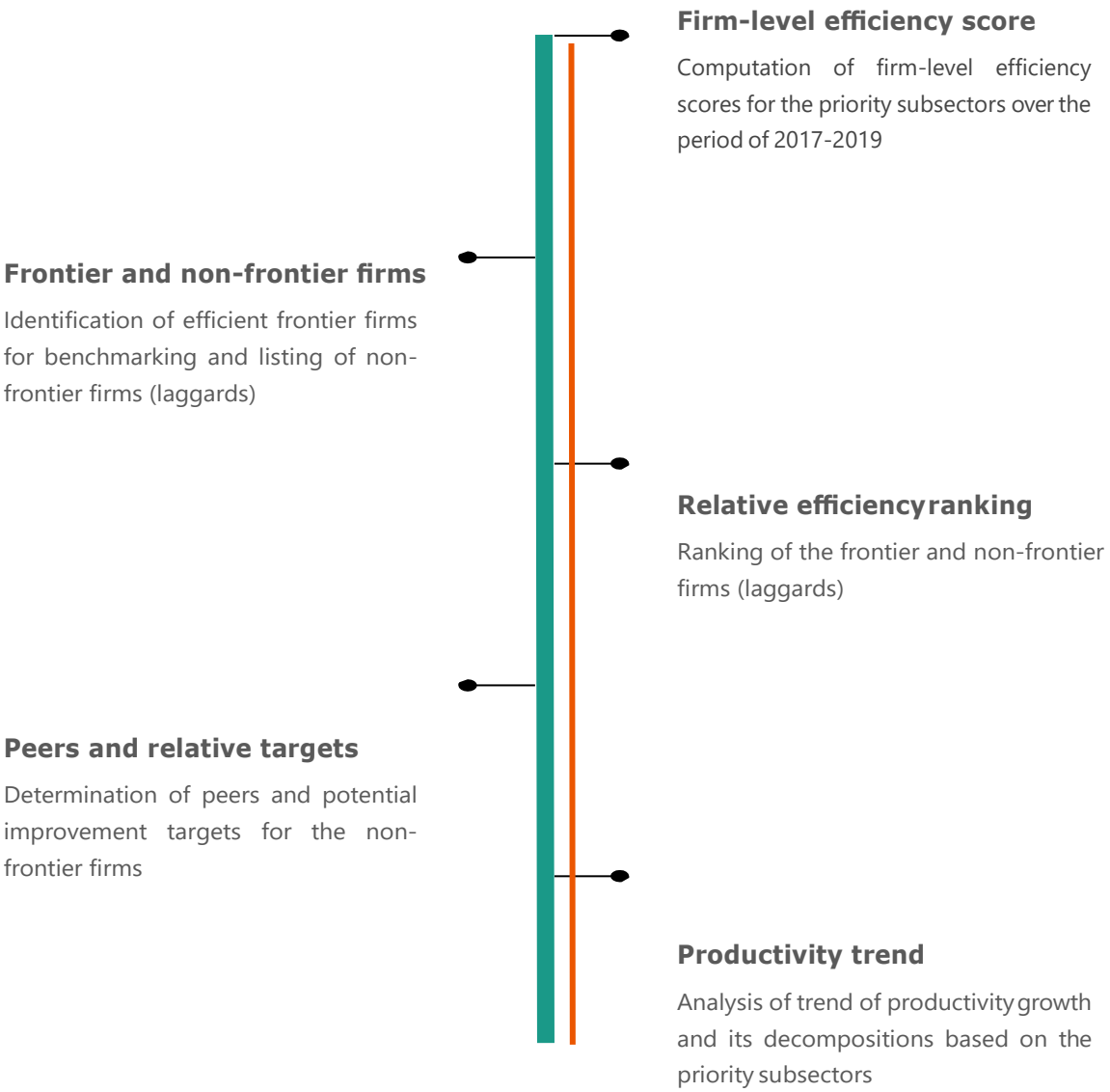


Figure 8: Flow of reporting of key deliverables

Tourism

Analysis of firms within the tourism industry focuses on 14 companies within the Hotels and Resorts' core business. Based on market capitalization (as at July 2020), two firms are listed in the KLCI, and the remaining 12 companies are ranked 100 and above. The two top market valuation under Hotels and Resorts subsector are Genting Bhd and Genting Malaysia Bhd. In addition, two holding companies are incorporated abroad which are Shangri-La Group and Mulpha International Bhd.

Market Capitalization

FTSE Bursa Malaysia KLCI index: 2
FTSE Bursa Malaysia Mid 70 index: 0
FTSE Bursa Malaysia Small Cap Index: 12

Foreign-based

Holding companies incorporated abroad: 2

14 Hotels & Resorts

Avillion
Advance Synergy
Berjaya Land
Eastland
Genting Malaysia
Grand Central
Genting Berhad
Iconic Landmarks
MUIIND
Mulpha Inter. Only
World
Pan Malaysia Holdings
Shangri-La

2017		4 out of 14 firms were on the efficient frontier
2018	4	out of 14 firms were on the efficient frontier
2019	5	out of 14 firms were on the efficient frontier

Figure 9: Number of firms on the frontier for Hotels & Resorts subsector by year

The Frontier Firms

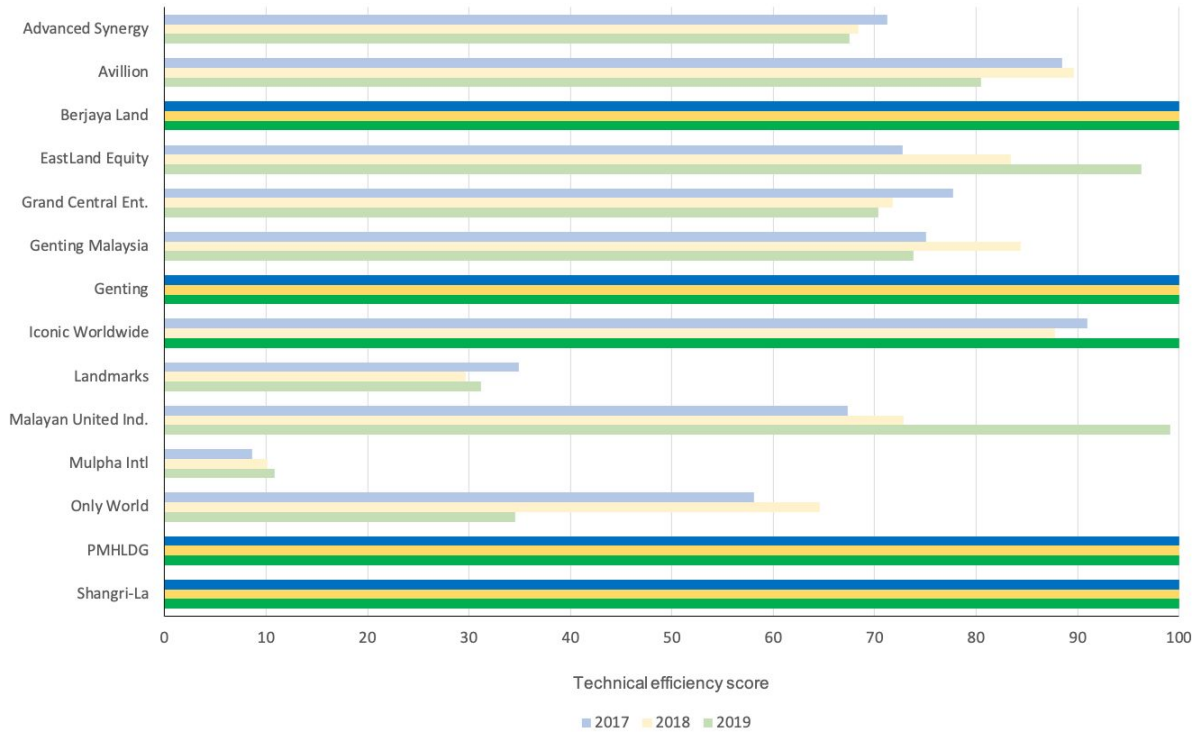


Figure 10: Hotels & Resorts technical efficiency score and frontier firms

Figure 10 presents the technical efficiency score and the frontier firms for the three consecutive years, 2017-2019. Analysis of the annual performance indicates that there were 4 firms that had been identified as the frontier firms for year 2017 and 2018, respectively. On the other hand, year 2019 recorded 5 firms that were identified as the frontier:

Frontier Firms in 2017

Pan Malaysia Holdings Berjaya Land Bhd Genting Bhd
Shangri-La Group

Frontier Firms in 2018

Pan Malaysia Holdings Berjaya Land Bhd Genting Bhd
Shangri-La Group

Frontier Firms in 2019

Pan Malaysia Holdings Berjaya Land Bhd Genting Bhd
Shangri-La Group

Generally, all the frontier firms were able to maintain their efficient performance between 2017 and 2019. However, instead of four companies, Iconic Worldwide Bhd joined the line up of efficient firms in 2019. Over the period of 2017-2019, 4 firms had been consistently rated as frontier firms for the Hotels & Resorts subsector. These were:

1) Pan Malaysia Holdings
2) Berjaya Land Berhad
3) Genting Berhad
4) Shangri-La Group

Between 2017 and 2019, Genting Malaysia Bhd had consistently ranked 1st based on the technical efficiency performance relative to other firms on the frontier for Hotels and Resorts subsector. However, for the remaining frontier firms, although they could maintain their efficiency, their ranking is fluctuating after 2018. In 2019, Pan Malaysia Holdings had increased its ranking while Berjaya Land Bhd and Shangri-La Group had been ranked lower based on their efficiency score (Figure 11).

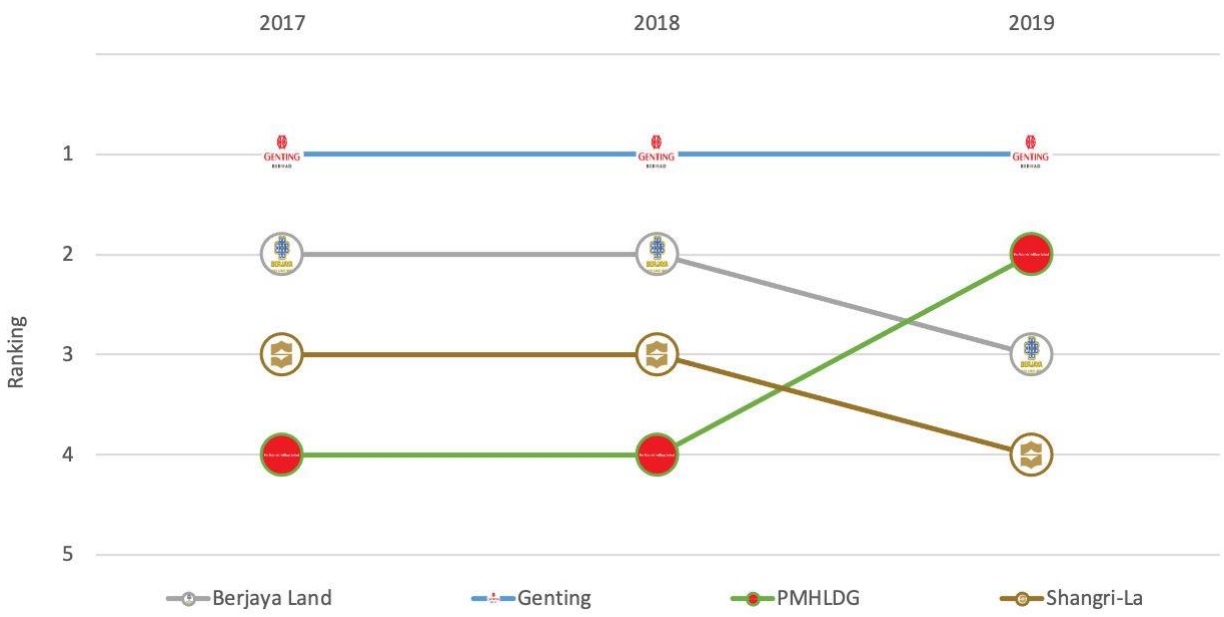


Figure 11: Hotels & Resorts frontier firms' ranking

The Non-Frontier Firms

For firms that have been identified as inefficient, their technical inefficiencies score are presented in Figure 12. The scores suggest a possible reduction in current composite input consumption without compromising the current level of outputs to render them efficient. The calculation of the score is made in comparison to the achievement of their respective benchmark peers (the frontier firms).

The overall technical efficiency score for the non-frontier firms averaged at 64.52, 66.26, and 62.71 percent for the year 2017, 2018 and 2019, respectively. Therefore, on average, non-frontier firms were using more than one-third the required amount of inputs to produce the given output level. For instance, Advance Synergy Bhd could optimise its usage of inputs in 2017 by reducing the consumption by 28.73 percent or operating at 71.27 percent of current practice. Similarly, for 2019, Malaysian United Industry Bhd could optimised performance by running at 99.11 percent of current usage; only an additional 8.9 percent input saving to be rated a frontier firm.

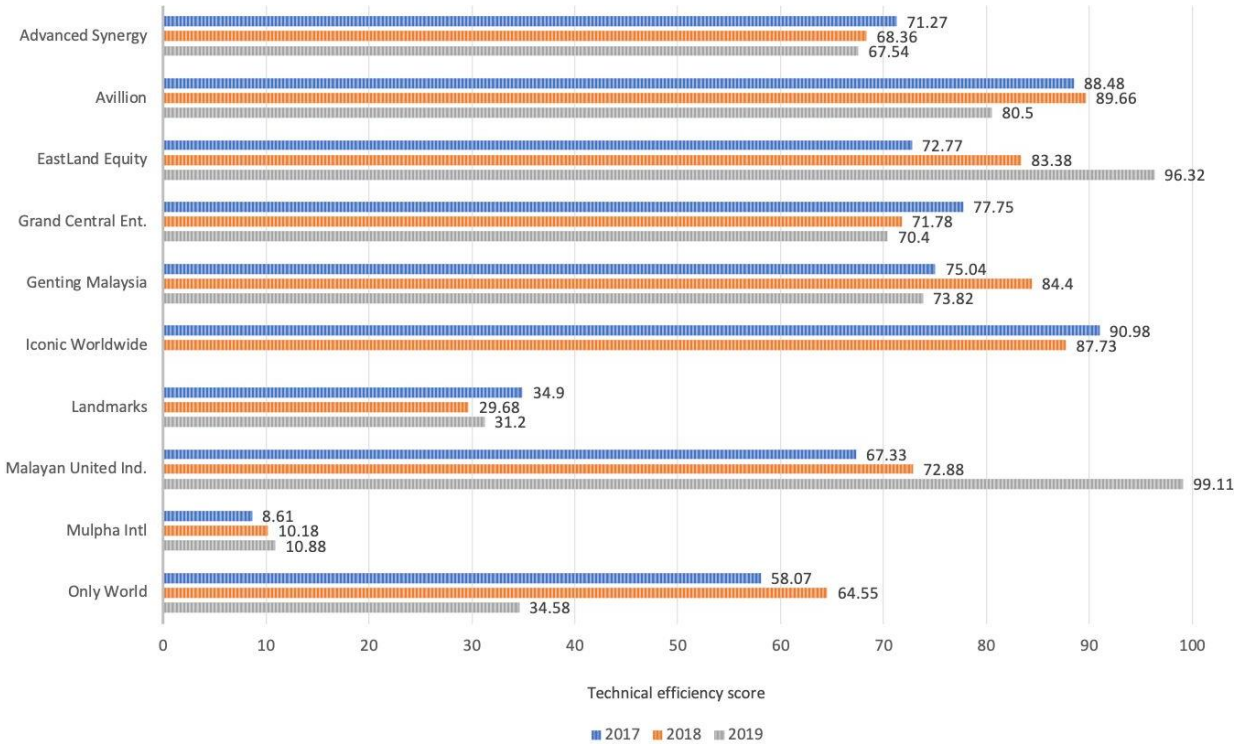


Figure 12: Technical inefficiency of the non-frontier firms

The Benchmark Peers

The importance of peers to a particular non-frontier firm is calculated and presented as the lambda values (Table 2). The most frequently quoted as benchmark peers among the three frontier firms in 2019 is Pan Malaysia Holdings. Hence, Pan Malaysia Holdings would be considered as the best role model for Hotels and Resorts subsector. It is true because not only that Pan Malaysia Holdings is identified as the benchmark for all the non-efficient firms (with the exception of, Genting Malaysia Bhd), but also because of the significant values of its lambdas as the benchmarking peer relative to others. In contrast to Shangri-La Group, although frequently cited as the benchmark for several non-frontier firms, each lambda value, however, is relatively small. Therefore, Shangri-La Group would not be an ideal role model for the overall subsector. Berjaya Land Bhd, on the other hand, is recommended as the significant benchmark only for Genting Malaysia Bhd.

	Non-frontier firms			
1.	Advanced Synergy	(0.02)	(0.15)	(0.83)
2.	Avillion	(0.02)	(0.02)	(0.96)
3.	EastLand	(0.01)	(0.00)	(0.99)
4.	Grand Central	(0.01)	(0.00)	(0.99)
5.	Genting Malaysia	(0.87)	(0.00)	(0.00)
6.	Landmarks	(0.04)	(0.00)	(0.96)
7.	MUIIND	(0.09)	(0.00)	(0.91)
8.	Mulpha	(0.04)	(0.02)	(0.94)
9.	OWG	(0.00)	(0.03)	(0.97)

Notes:
Figures in parentheses are Lambda values

Table 2: Hotels & Resorts non-frontier firms' peers for 2019

The Laggards

On the basis of the efficiency score of firms rated as inefficient, three firms were consistently identified as the most laggard firms. These were Only World Group (OWG), Landmarks Bhd and Mulpha International Bhd as presented in Figure 13. Furthermore, their ranking had been the same throughout the period. On the other hand, Advanced Synergy Bhd was identified as the bottom forth for the year 2018 and 2019, a decline from bottom 5th ranking in 2017.

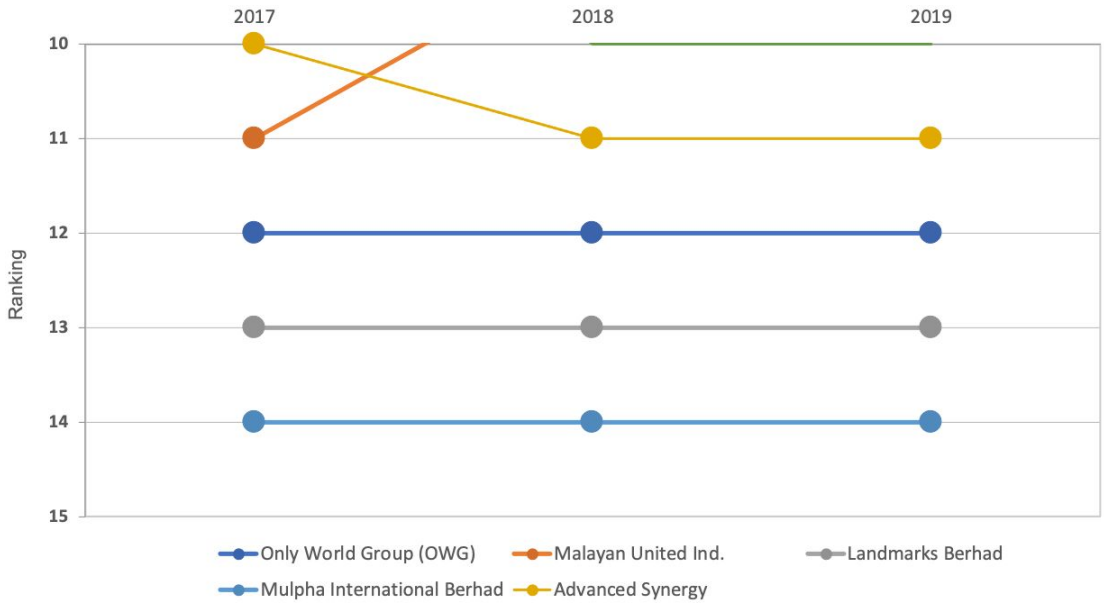


Figure 13: Hotels & Resorts subsector laggards

For every inefficient firm, improvement targets to become efficient are recommended whilst maintaining the current input-output ratio and output level of the firm. Figure 14 illustrates, the proposed reduction in inputs of the respective laggard firms for the year 2019 in order to hypothetically replicate the frontier firms. For instance, reduction by 73.28 percent of total assets, 65.42 percent of total equity and 65.42 percent of wages & salaries by OWG would render it efficient thus become comparable to its peer Pan Malaysia Holdings. The proposed improvement plan is considered feasible as it has been customised for OWG based on the achieved performance of its benchmark peer, Pan Malaysia Holdings.

Figure 14 : Targets for Hotels & Resorts subsector laggards (2019)

The Productivity Trends

Productivity trends describe the efficiency performance between two adjacent periods. Figure 15(a) and 15(b) illustrate the general productivity trends for the overall Hotels and Resorts subsector and its decompositions. In general, the Hotels & Resorts subsector saw a significant increase in TFP growth between 2018 - 2019. TFP growth was recorded at a rate of 20.3 percent for 2018-2019 albeit the recorded decline in the preceding year by 3.5 percent.

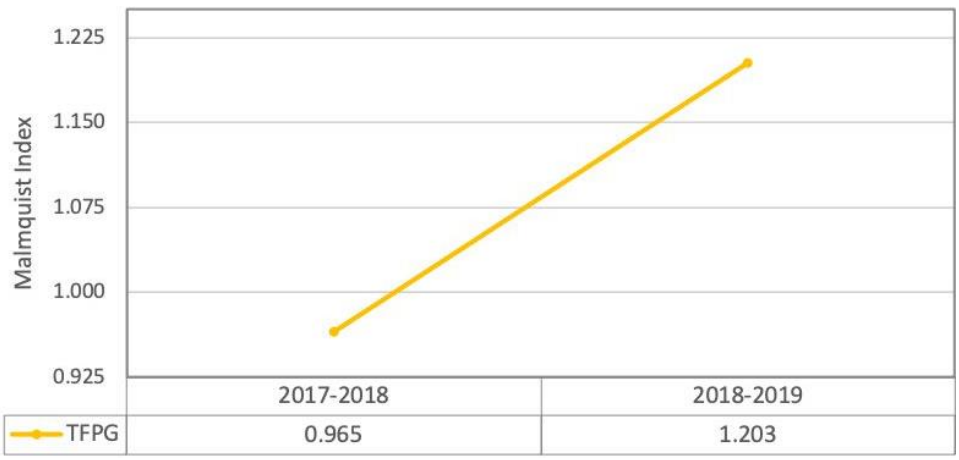
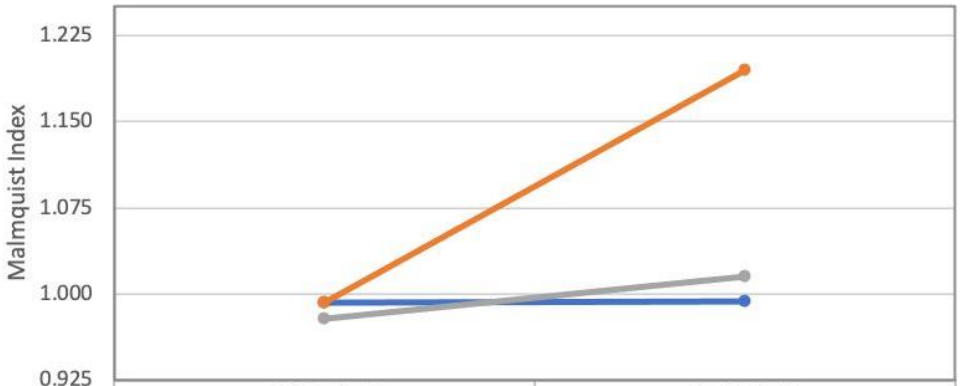


Figure 15(a): Hotels & Resorts productivity trends

The growth in TFP presented in Figure 15(a) was mainly contributed by the increase in scale efficiency and improvement in pure efficiency trend in 2018-2019; illustrated in Figure 15(b). Despite the growth, technological change however recorded a decrease between the same period.



	2017-2018	2018-2019
TC	0.993	0.994
SEC	0.993	1.195
PEC	0.979	1.015

Figure 15(b): Hotels & Resorts productivity decomposition

Further breakdowns of the productivity trends for the Hotels and Resorts subsector are provided in the subsequent figures. Figure 16(a) illustrates the average productivity trends for the frontier firms while Figure 16(b) depicts the trends for the non-frontier firms.

In particular, Figure 16(a) implies greater growth in TFP for the frontier firms in 2018-2019 with an average of 2.1 percent relative to 2017-2018 which was almost stagnant. The sources of TFP growth for the frontier firms were mainly contributed by the scale efficiency change while the other sources of growth remain constant over time.

With respect to the non-frontier firms (Figure 16(b)), the improvement in TFP growth was significantly much larger as compared to the frontier firms' average in 2018-2019. The recorded productivity growth was by 28.4 percent albeit the declining TFP growth in the preceding year by 4.9 percent.

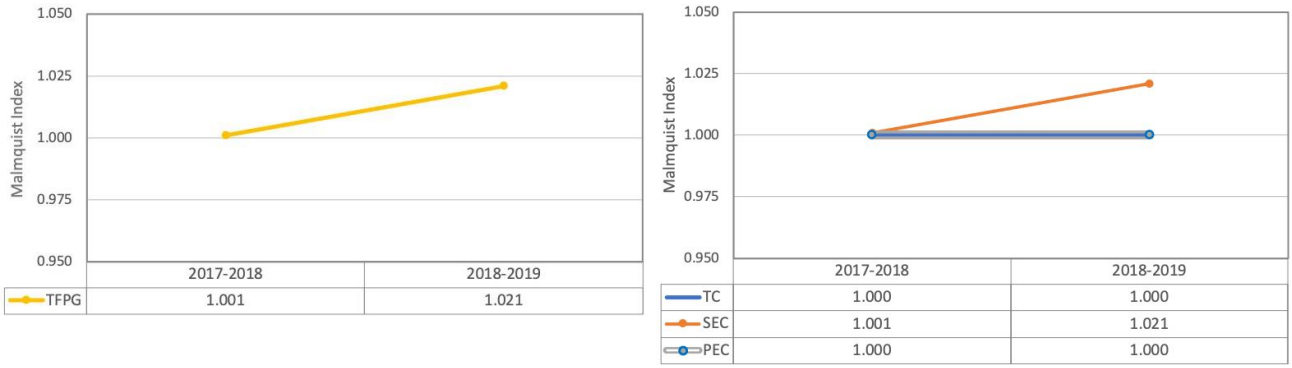


Figure 16(a): Hotels & Resorts Frontier firms productivity trends and decompositions

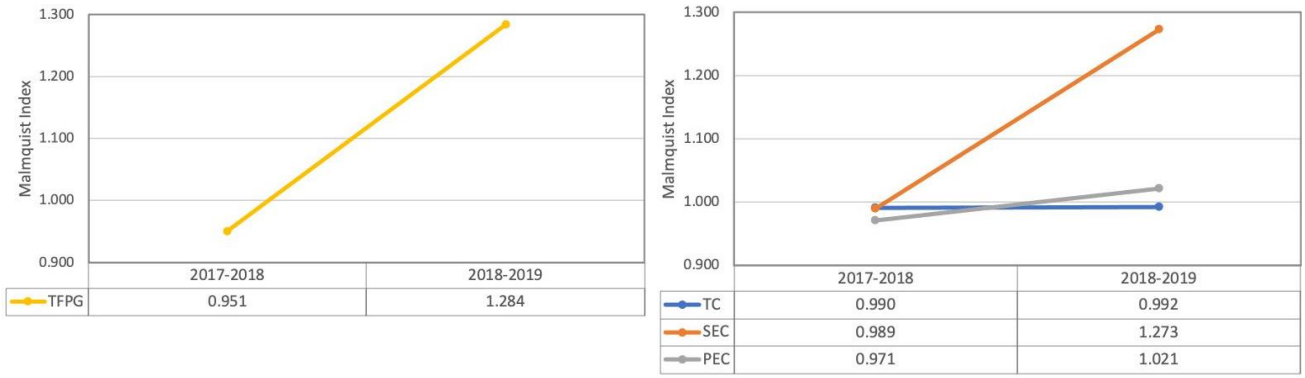


Figure 16(b): Hotels & Resorts Non-Frontier firms productivity trends and decompositions

Comparison between Figure 16 (a) and (b) implies that on average, the non-frontier firms' productivity trends were catching up relative to the frontier firms. The scale efficiency for the non-frontier firms recorded significant improvement relative to the firms identified on the frontier with the growth rate of 27.3 percent in 2018-2019. Although on average the technical change for the non-frontier firms declined in recent years, the pure efficiency change is more promising with the recorded growth of 2.1 percent.

At the firm level, Iconic Worldwide Bhd recorded the largest TFP improvement in 2018-2019, contributed mainly by the scale change decomposition that grew by more than 900 percent which made the company joining the top rank frontier firm. This was followed by

the Only World Group Bhd (ranked 2nd in terms of TFP growth) that saw a 87 percent improvement in the pure efficiency change component.

Electrical & Electronics

The 21 short listed Electrical & Electronics firms consist of 10 semiconductors and 11 technology equipment firms. Based on market capitalization, six firms are listed in the Mid 70 index, and the remaining 13 companies are ranked 100 and above. The six top market valuation under Electrical & Electronics subsector are Frontken Corporation, Inari Amerton Bhd, Malaysian Resources Corporation, Mi Technovation Bhd, Pentamaster Corporation and Vitrox Corporation. In addition, Turiya Bhd, Unisem Bhd, JCY International Bhd and Pentamaster Bhd are companies that have holding companies incorporated abroad.

Market Capitalization

FTSE Bursa Malaysia KLCI index: 0
FTSE Bursa Malaysia Mid 70 index: 6
FTSE Bursa Malaysia Small Cap Index: 13

Foreign-based

Holding companies incorporated abroad: 4

21 Electrical & Electronics

VITROX
UNISEM
TURIYA
M'SIA PACIFIC IND.
KEYASIC

KESM
INARI
GLOBETRONICS
FRONTKEN
D&O GREENTECH

VSTECS
TRIVE
PENTAMASTER
NOTION
MMS VENTURES

MI
JCY
ITRONIC
FSBM
EDARAN
ELSOFT

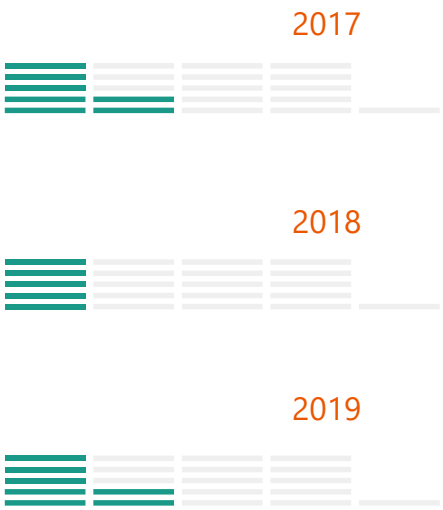


Figure 17: Number of firms on the frontier for Electrical & Electronics subsector by year

The Frontier Firms

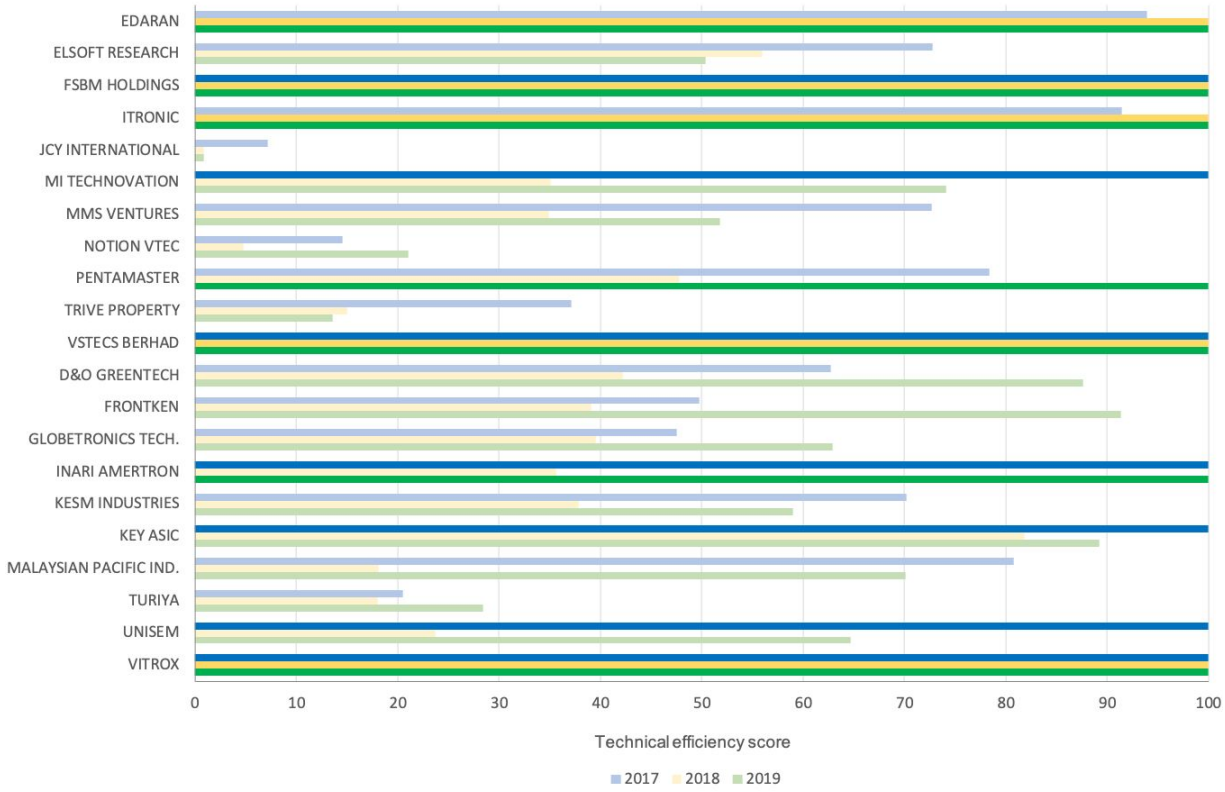


Figure 18 : Electrical & Electronics technical efficiency score and frontier firms

Figure 18 presents the technical efficiency scores and the frontier firms for the three consecutive years, 2017-2019. Analysis of the annual performance indicates that there were 7 firms that had been identified as the frontier firms for year 2017 and 2019, respectively. On the other hand, year 2018 recorded 5 firms that were identified as the frontier:

Frontier Firms in 2017

FSBM HOLDINGS
VSTECS
VITROX
MI TECHNOVATION
INARI AMERTRON
KEY ASIC
UNISEM

Frontier Firms in 2018

FSBM HOLDINGS
VSTECS
VITROX
EDARAN
INDUSTRONICS

Frontier Firms in 2019

FSBM HOLDINGS
VSTECS
VITROX
EDARAN
INDUSTRONICS
PENTAMASTER
INARI AMERTRON

In general, frontier firms could not consistently maintain their efficient performance over time. The count of efficient firms is fluctuating at 5 and 7 in between 2017 and 2019. With regard to the ranking of the firms that have been identified as consistently efficient over the period of 2017 to 2019, there are 3 companies:

1. FSBM Holdings Berhad
2. VSTECS Berhad
3. VITROX Berhad

FSBM Holdings and VSTECS Bhd had consistently ranked 1st and 2nd based on the technical efficiency score performance for Electrical & Electronics subsector in 2018 and 2019, a switch in their 2017 ranking. VITROX Bhd, on the other hand, maintained its 3rd position in the ranking since 2017 until 2019 (Figure 19).

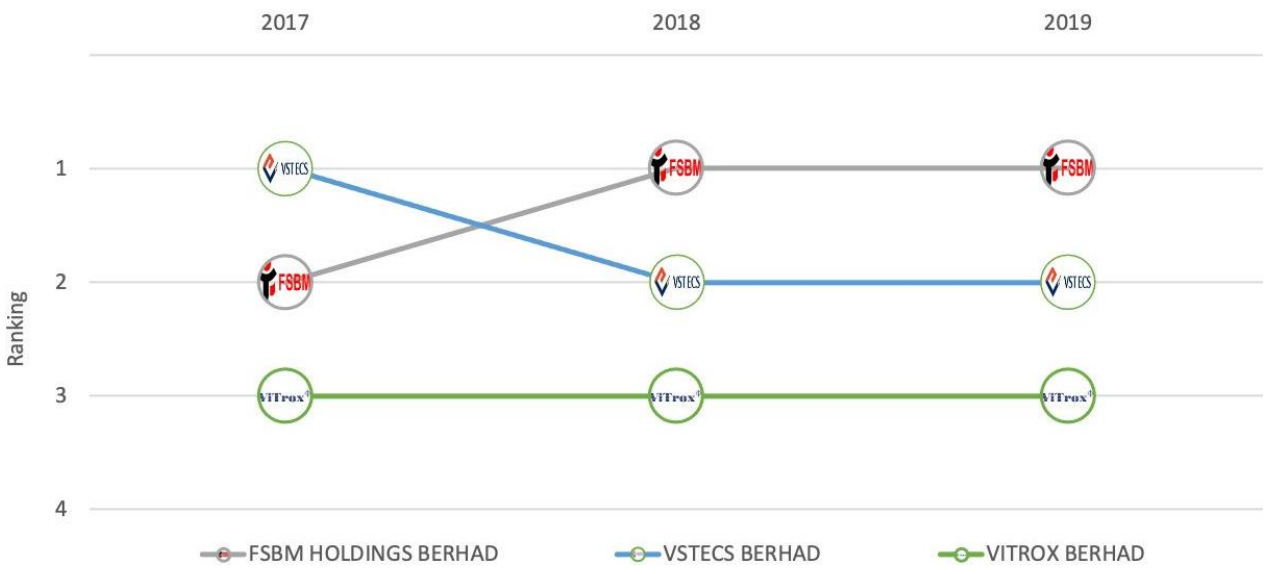


Figure 19 : Electrical & Electronics frontier firms' ranking

The Non-Frontier Firms

As summarised in Figure 20, the overall technical efficiency score for non-frontier firms averaged at 57.10 in 2017, 33.13 in 2018, and 54.64 in 2019. The score indicates on average, the non-frontier firms were using more than doubled the required amount of inputs to produce the given output level.

To substantiate, the reported efficiency score for Pentamaster International Limited Bhd (PENTA) in 2018 is 78.32 percent. The score indicates, in comparison to its benchmark peers that have similar composite inputs consumption, PENTA could optimise input usage by reducing its consumption by 21.68 percent or operating at 78.32 percent of the current level. Impressively, although there was a sharp drop in its 2018 performance, from 78.32 fell to 47.77 percent, PENTA leap to become a frontier firm in 2019.

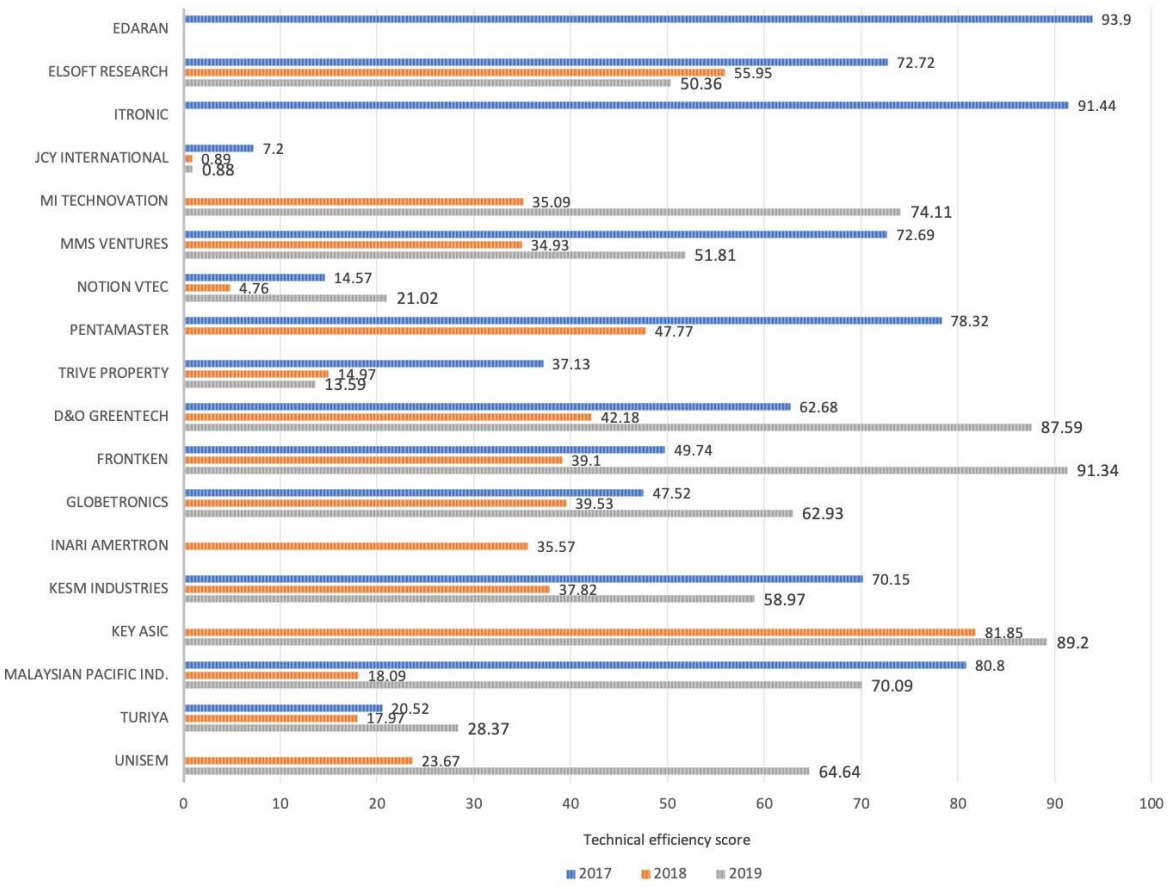


Figure 20: Electrical & Electronics technical inefficiency of the non-frontier firms

The Benchmark Peers

The relative importance of peers as a benchmark and role model for the non-frontier firms are based on the generated lambda values presented in Table 8. For example, for JCY International Bhd, its ideal role model is solely FSBM Holdings as reflected by its lambda of 1 or 100 percent. Nevertheless, for Key Asic Bhd, although three role models have been recommended, the ideal benchmark for the firm is FSBM Holdings as reflected by the substantial lambda of 0.78 or 78 percent as opposed to 0.01 or 1 percent and 0.03 or 3 percent for the remaining benchmarks.

	Non-frontier firms	FSBM	VSTECS	ViTrox
1.	Elsoft Research	(0.80)	(0.04)	(0.07)
2.	JCY International	(1.00)	(0.00)	(0.00)
3.	MI Technovation	(0.00)	(0.27)	(0.34)
4.	MMS Ventures	(0.64)	(0.00)	(0.04)
5.	Notion VTEC	(0.00)	(0.02)	(0.09)
6.	Trive Property	(0.99)	(0.00)	(0.00)
7.	D&O Greentech	(0.00)	(0.00)	(0.00)
8.	FRONTKEN	(0.00)	(0.00)	(0.04)
9.	Globetronics	(0.00)	(0.00)	(0.16)
10.	KESM Industries	(0.00)	(0.00)	(0.08)
11.	Key Asic	(0.78)	(0.01)	(0.03)
12.	Malaysia Pacific Industries	(0.00)	(0.00)	(0.00)
13.	Turiya	(0.92)	(0.06)	(0.02)
14.	UNISEM	(0.00)	(0.00)	(0.00)

Table 3 : Electrical & Electronics non-frontier firms' peers for 2019

The Laggards

Figure 21 graphs non-frontier firms which continually rated the bottom four in terms of the efficiency scores among firms in Electrical and Electronic subsector. After 2017, Turiya Bhd and Notion Vtec Bhd experienced an increase in ranking, but Trive Property Bhd experienced otherwise. Likewise, JCY Bhd was consistently rated laggard and was considered the least efficient among all.

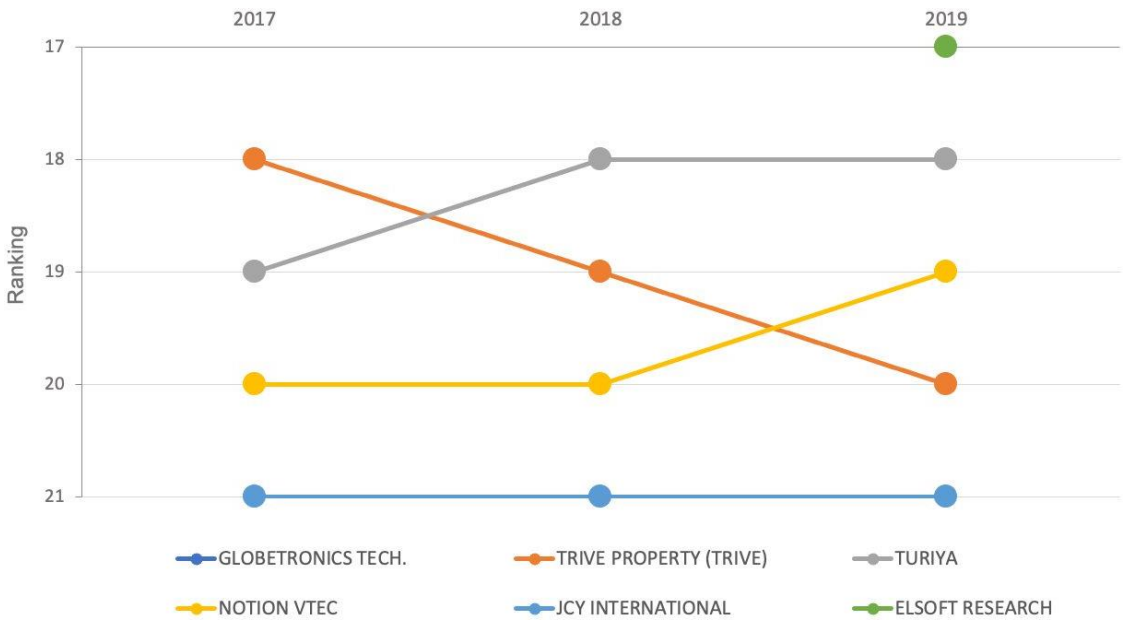


Figure 21 : Electrical & Electronics subsector laggards

The improvement targets for the inefficient Electrical and Electronic firms to duplicate the practice of the frontier firms is presented in Figure 22. Considering Elsoft Bhd as an example, the firm is recommended to slash its overall input usage by half to be fully efficient based on the practice of its benchmark, FSBM Bhd as well as Vitrox Bhd and Vstec Bhd. Specifically, reduction by 49.64 percent of total assets, of total equity, and of wages & salaries are needed and considered feasible as they were calculated specifically for Elsoft Bhd based on the performance of its benchmark peers.

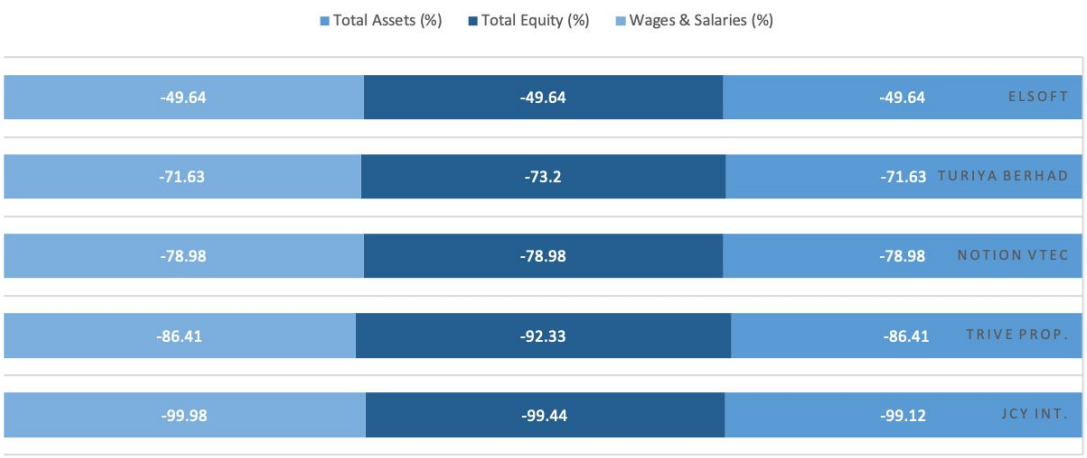


Figure 22 : Targets for Electrical & Electronics subsector laggards (2019)

The Productivity Trends

The changes in firm-level productivity patterns is measured by Malmquist productivity index. It indicates total factor productivity change from one period to another. Figure 23(a) depicts the overall TFP trend for the Electric and Electronics subsector. Since the index values for both periods (2017-2018 and 2018-2019) are greater than 1, these imply that the sector on average recorded a positive productivity growth throughout 2017 to 2019. The TFP improved at a rate of 11.8 percent in 2017-2018 and increased at a slower rate in 2018-2019 with 7.7 percent.

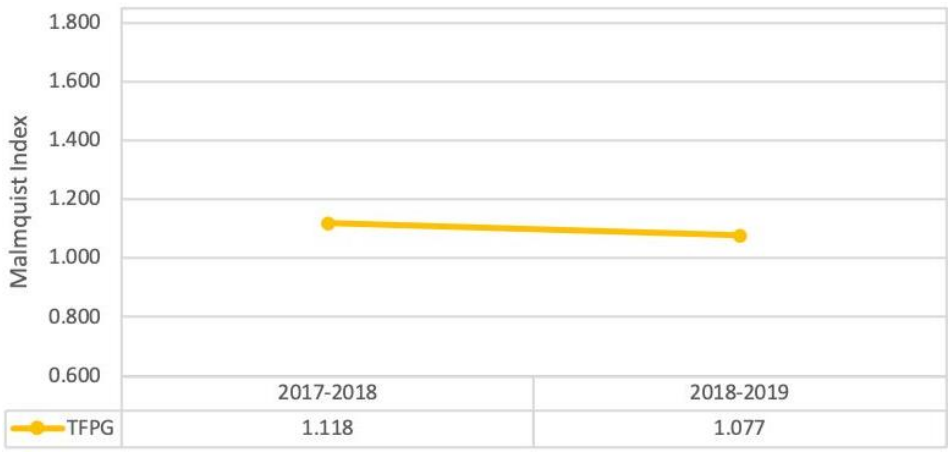
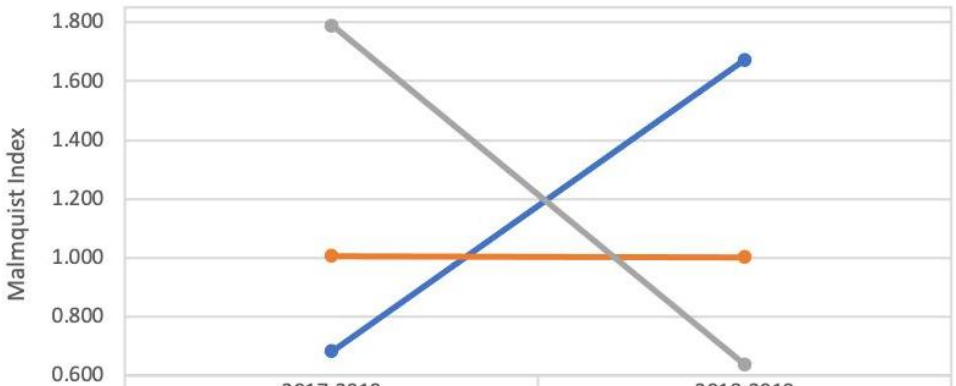


Figure 23(a): Electrical & Electronics productivity trends

The sources of TFP growth for the Electrical and Electronics subsector can be explained by Figure 23(b). The figure illustrates that the dominant source of growth for the sector was mainly contributed by the significant growth of the technological change. In essence, the technological change grew at a rate of 67.3 percent in year 2018-2019 despite a drop by 31.9 percent in year 2017-2018. Notwithstanding, these tremendous progress, the pure efficiency pattern however recorded the opposite trend. In year 2018-2019, the pure efficiency change registered a sharp declining trend with a negative growth rate of 36.5 percent.



	2017-2018	2018-2019
TC	0.681	1.673
SEC	1.006	1.004
PEC	1.791	0.635

Figure 23(b): Electrical & Electronics productivity decomposition

Figure 24(a) and (b) provide the breakdown of the productivity trends by the frontier and the non-frontier firms. On average, the TFP trends for the frontier firms and the non-frontier firms recorded a positive growth between 2017-2018. The non-frontier firms registered slightly higher productivity growth relative to the frontier firms in 2017-2018 by 1.4 percent. The productivity growth among the frontier firms group however did not sustain in the period 2018-2019. On average, the frontier firms had recorded a decline in TFP trend by 1.4 percent. For the non-frontier firms on the other hand, the average TFP growth rate remained positive but with a much smaller positive growth as compared to 2017-2018.

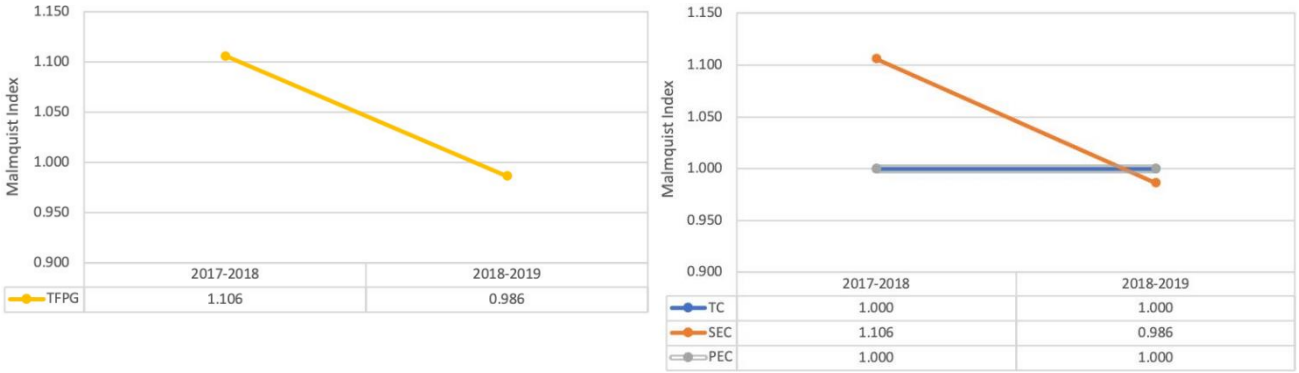


Figure 24(a): Electrical & Electronics frontier firms productivity trends and decompositions

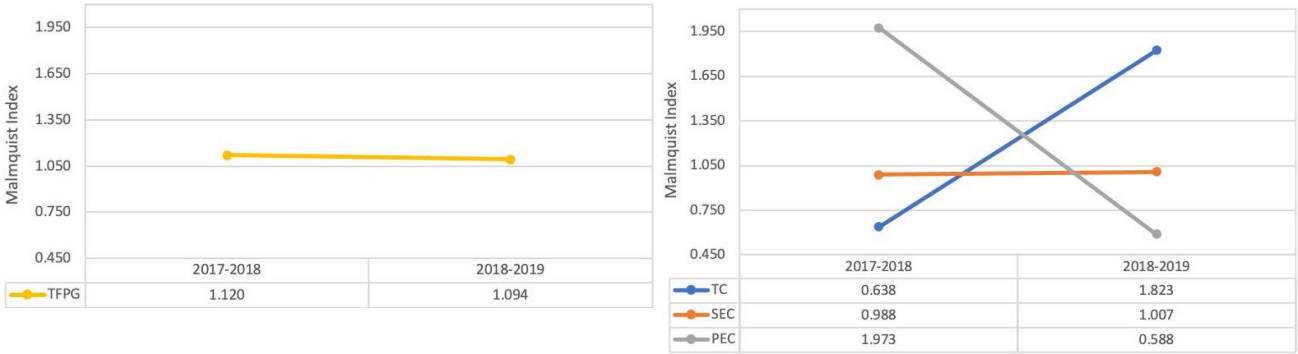


Figure 24(b): Electrical & Electronics non-frontier firms productivity trends and decompositions

For the frontier firms, the dominant source of negative growth in the more recent period was mainly contributed by the average declining trend in scale efficiency. This is different with respect to the non-frontier firms where the average decline in TFP in 2018-2019 was predominantly contributed by the fall in pure efficiency trend that had recorded a negative growth of 41.2 percent.

Among the non-frontier firms, 69 percent of the firms recorded improvement in the overall productivity in 2018-2019 while the remaining registered otherwise. Among these, Elsoft Research Bhd had recorded the most significant improvement relative to the others while Notion Vtech Bhd was among the least performers.

Chemicals & Chemical Products

There are 14 firms that have been identified and grouped under the Chemicals and Chemical Products subsector. Based on market capitalization, one firm is listed in the top 30 KLCI index and Mid 70 index, respectively. These are Petronas Chemicals Group and Lotte Chemical Titan Holdings. The remaining 12 companies are ranked 100 and above. The Lotte Chemical Titan Holdings is the only company within the list that is under a holding company incorporated abroad.

Market Capitalization

FTSE Bursa Malaysia KLCI index: 1
FTSE Bursa Malaysia Mid 70 index: 1
FTSE Bursa Malaysia Small Cap Index: 12

Foreign-based

Holding companies incorporated abroad: 1

14 Chemicals & Chemical Products

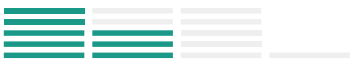
ANCOM
CHEMICAL
COMPANY OF
MALAYSIA
HEXTAR GLOBAL
HEXZA CORP.

HIL INDUSTRIES
IMASPRO CORP.
KARYON
INDUSTRIES
LOTTE CHEMICAL
TITAN

LUXCHEM CORP.
NYLEX MALAYSIA
PETRONAS
CHEMICALS
GROUP
RALCO CORP.

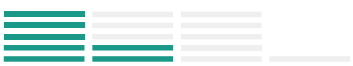
RGT/ASIA KNIGHT
SOUTHERN ACIDS
SAMCHEM
HOLDINGS
TOYO INK GROUP

2017



8 out of 16 firms were on the efficient frontier

2018



7 out of 16 firms were on the efficient frontier

2019

7 out of 16 firms were on the efficient frontier

Figure 25: Number of firms on the frontier for Chemicals & Chemical Products subsector by year

The Frontier Firms

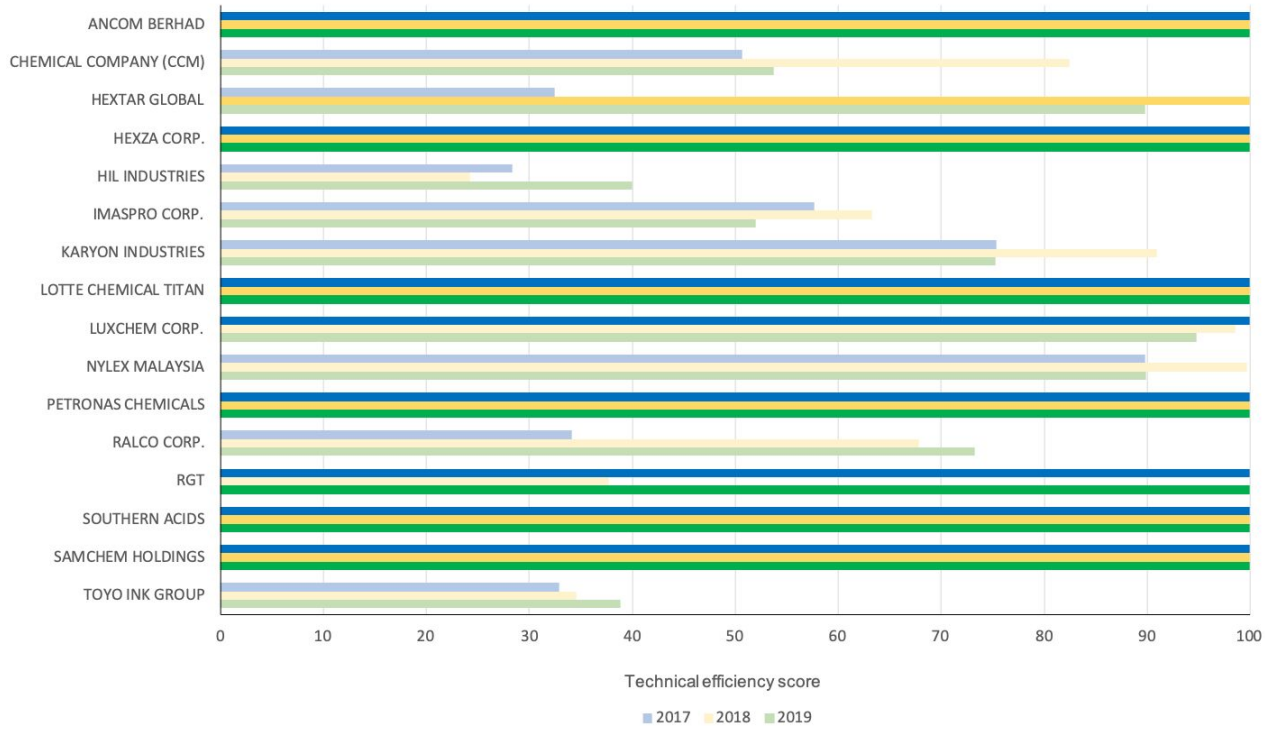


Figure 26 : Chemicals & Chemical Products technical efficiency score and frontier firms

Figure 26 presents the technical efficiency score and the frontier firms for the three consecutive years, 2017-2019. Analysis of the annual performance indicates that there were 8 firms that had been identified as the frontier firms for year 2017. On the other hand, year 2018 and 2019 recorded 7 firms that were identified as the frontier:

Frontier Firms in 2017

ANCOM
HEXZA CORPORATION
LOTTE CHEMICAL TITAN
PETRONAS CHEMICALS
SOUTHERN ACIDS
SAMCHEM HOLDINGS
LUXCHEM
RGT/ASIA KNIGHT

Frontier Firms in 2018

ANCOM
HEXZA CORPORATION
LOTTE CHEMICAL TITAN
PETRONAS CHEMICALS
SOUTHERN ACIDS
SAMCHEM HOLDINGS
HEXTAR GLOBAL

Frontier Firms in 2019

ANCOM
HEXZA CORPORATION
LOTTE CHEMICAL TITAN
PETRONAS CHEMICALS
SOUTHERN ACIDS
SAMCHEM HOLDINGS
RGT/ASIA KNIGHT

Overall, only 6 firms could consistently maintained their performance on the frontier between 2017 and 2019. The count of efficient firms reduces from 8 firms in 2017 to 7 firms in both 2018 and 2019. The 6 firms that have been identified as consistently efficient firms and on the frontier over the period of 2017 to 2019 were:

1. Ancom Berhad
2. Hexza Corporation Berhad
3. Lotte Chemical Titan Berhad
4. Petronas Chemicals Group Berhad
5. Southern Acids Berhad
6. Samchem Holdings Berhad

Over the period of 2017-2019, Lotte Chemical Titan Bhd and Southern Acids Bhd had consistently ranked 1st and 2nd for the Chemicals & Chemical Products subsector based on their technical efficiency score performance as compared to other frontier firms (Figure 27). While Hexza Corporation and Ancom Bhd were alternately ranked 3rd and 4th place throughout the years, Petronas Chemicals Group and Samchem Holdings were consistently ranked 5th and 6th among the frontier firms, respectively.

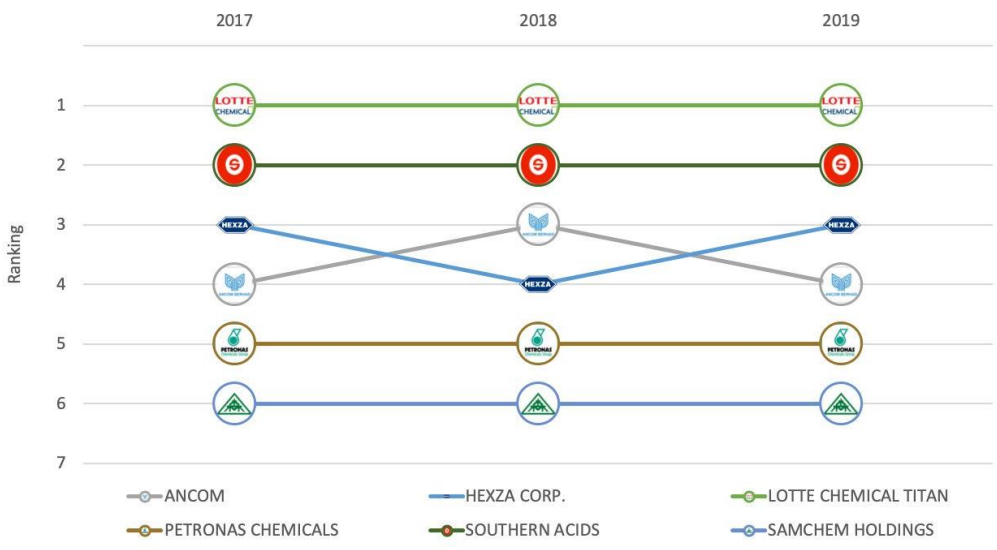


Figure 27: Chemicals & Chemical Products frontier firms' ranking

The Non-Frontier Firms

The overall technical efficiency score for the non-frontier firms averaged at 50.16, 66.57, and 67.50 for the year 2017, 2018 and 2019, respectively. Therefore, on average, it is found that non-frontier firms were using more than 40 percent more of the required amount of inputs to produce the given output level.

From Figure 28, for example, Chemical Company Bhd (CCM) is only rated as 53.72 percent as efficient in 2019. This indicates the fact CCM had over utilised its resources by 46.28 percent in comparison to its benchmark peers that have a similar ratio of inputs to the output. In other words, reducing the input utilisation to 53.72 percent from its current usage would make CCM an efficient firm in the Chemicals & Chemical Products subsector. Disturbingly, although CCM managed to improve its performance from 50.71 percent in 2017 to 82.41 percent in 2018, CCM stumbled back to its weaker 2017 performance in 2019.

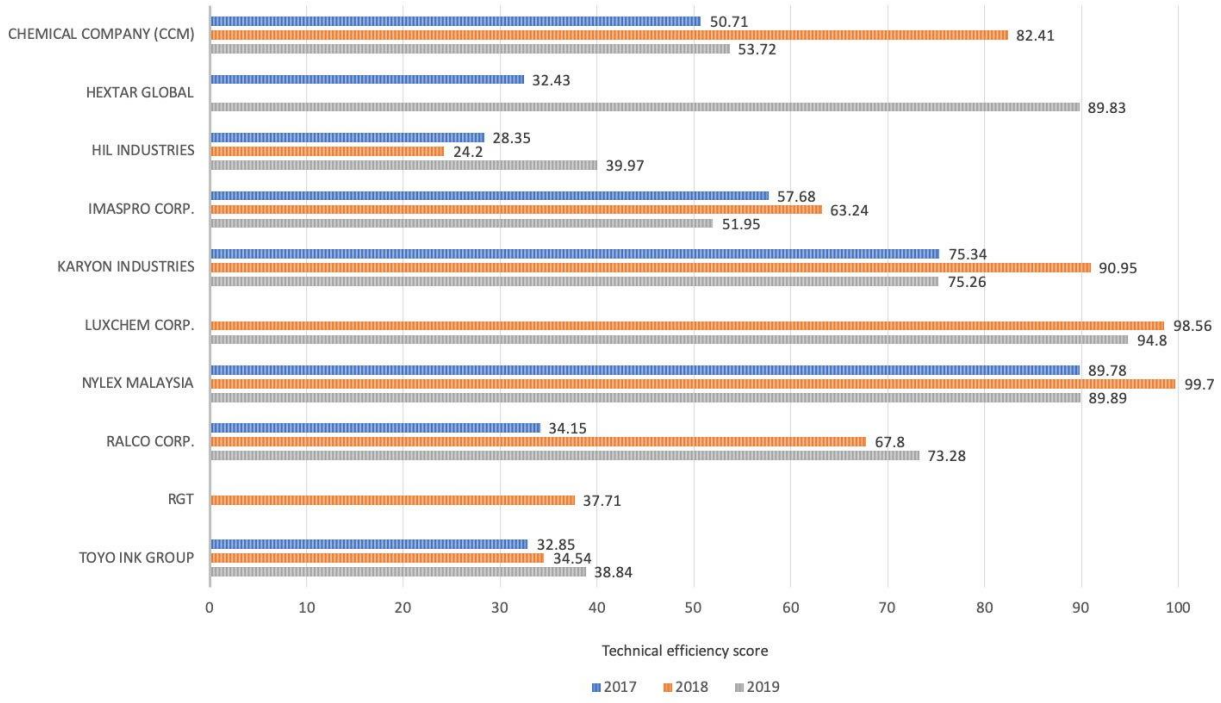


Figure 28 : Chemicals & Chemical Products technical inefficiency of the non-frontier firms

The Benchmark Peers

The relative importance of peers as a benchmark and role model for the non-frontier firms are based on the generated lambda values presented in Table 4. Based on the frequency quoted as benchmark peer and values of lambdas, Petronas Chemicals Group and Samchem Holdings would make ideal role models for Chemical and Chemical Products subsector. They both identified as benchmark peers for 4 different non-frontier firms with significant lambda values each.

For Hextar Global Bhd, in particular, its improvement target to become frontier firm should replicate the practice of Samchem Holdings by 59 percent, of Hexza Corporation by 25 percent as well as of Petronas Chemicals Group by 17 percent.

	Non-frontier firms	HEXZA	PETRONAS	
1.	Chemical Company of Malaysia	(0.00)	(0.27)	(0.71)
2.	Hextar Global	(0.25)	(0.17)	(0.59)
3.	HIL Industries	(0.17)	(0.53)	(0.29)
4.	Imaspro Corp.	(0.00)	(0.86)	(0.07)
5.	Karyon Industries	(0.00)	(0.37)	(0.03)
6.	Luxchem Corp.	(0.26)	(0.00)	(0.74)
7.	Nylex Malaysia	(0.00)	(0.00)	(0.90)
8.	Ralco Corp.	(0.00)	(0.97)	(0.00)
9.	Toyo Ink Group	(0.00)	(0.86)	(0.12)

Notes:
Figures in parentheses are Lambda values

Table 4: Chemicals & Chemical Products non-frontier firms' peers for 2019

The Laggards

The overall movement in the ranking of the most laggard firms in Chemicals and Chemical Products subsector is relatively unstable. There were a total of 6 firms rated as the bottom 5 based on their annual efficiency scores between 2017 and 2019. Over the stated years, Ralco Corporation and HIL Industries Bhd were at their highest rank whereas Chemical Company Bhd, Imaspro Corporation and Toyo Ink Group were at their worst rank in 2019.

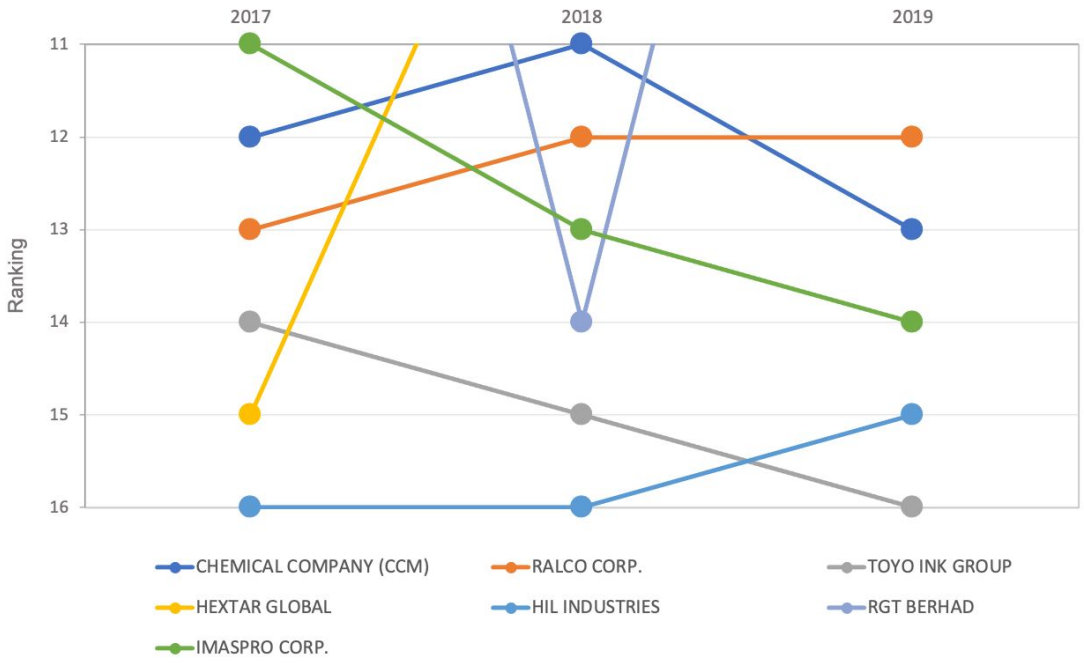


Figure 29: Chemicals & Chemical Products subsector laggards

The subsequent chart, Figure 30 depicts the proposed reduction in inputs for the top five laggard firms in 2019 relative to the best practice frontier firms in the subsector. The improvement targets for CCM to become efficient, for example, require reduction by 46.28 percent of total assets and of wages & salaries as well as reduction by 59.99 percent of total equity. The improvement targets replicate the practice of the benchmark peers for CCM that are Samchem Holdings, Hexza Corporation and Petronas Chemicals Group, therefore, argued to be feasible. Despite the proposed reductions, the targets would still enable CCM to maintain its current input-output ratio and output level.

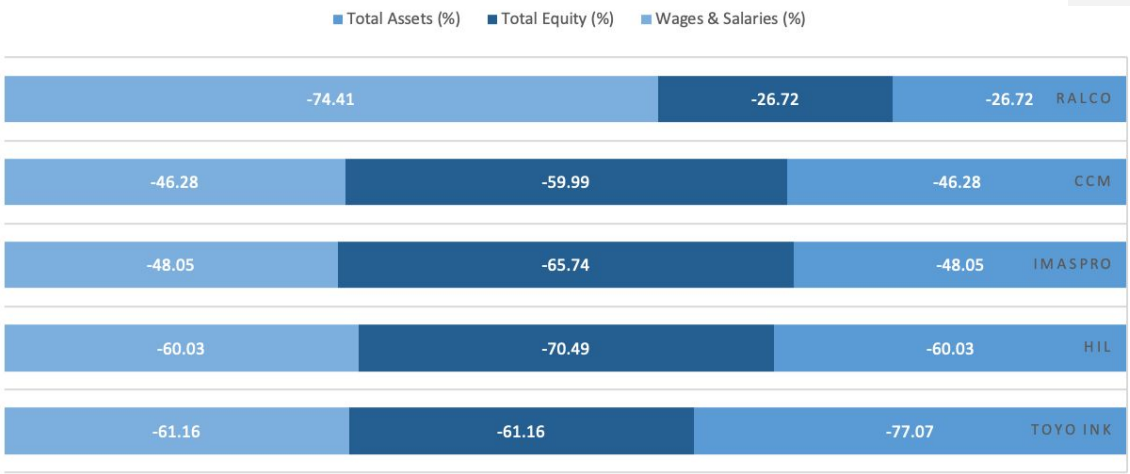


Figure 30: Targets for Chemicals & Chemical Products subsector laggards (2019)

The Productivity Trends

The trends in productivity are presented based on the Malmquist Productivity index. Figure 31(a) depicts the overall productivity trends for the Chemicals and Chemical Products subsector. In general, despite having a negative growth in TFP in 2017-2018, the Chemicals and the Chemical Products subsector registered a positive growth between 2018-2019 by

2.5 percent.

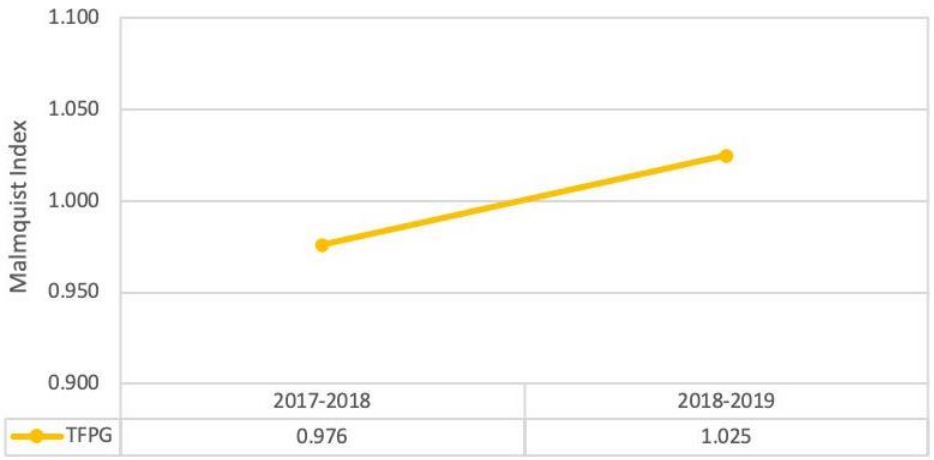
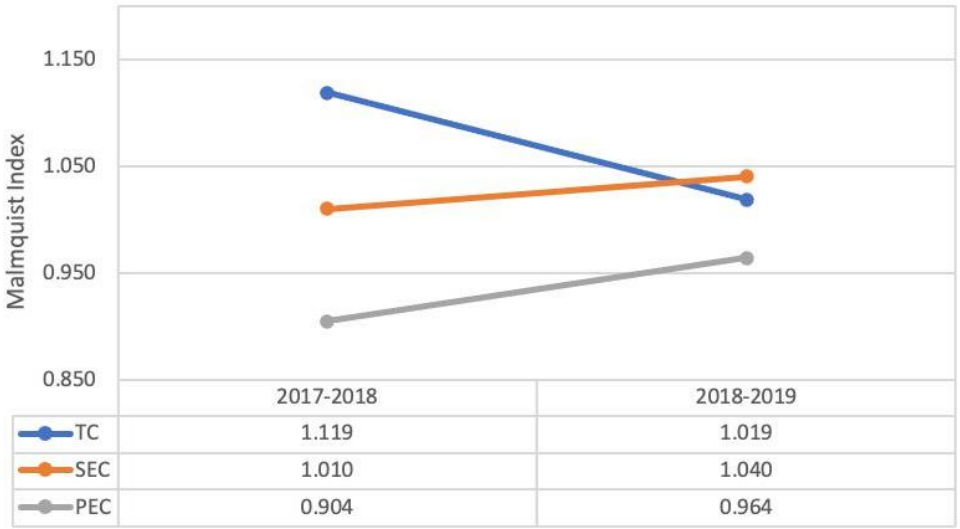


Figure 31(a): Chemicals & Chemical Products productivity trends

As illustrated in Figure 31(b), the improvement in the TFP growth for the period of 2018-2019 was contributed by the positive growth of the technical change and the scale efficiency change. Despite the slower growth in the technical change relative to 2017-2018, the scale efficiency change however registered 3 percentage point increment in the recent years (2018-2019). The pure efficiency change on the other hand, recorded negative growth for both periods, 2017-2018 and 2018-2019. Nevertheless, the decline in the pure efficiency trend in 2018-2019 was by a smaller margin of 6 percent.



	2017-2018	2018-2019
TC	1.119	1.019
SEC	1.010	1.040
PEC	0.904	0.964

Figure 31(b): Chemicals & Chemical Products productivity decomposition

Figure 32(a) and 32(b) illustrate the average TFP trends and its decompositions for the frontier and the non-frontier firms. In general, the productivity growth disparity between the frontier firms and the non-frontier firms continued to widen in 2018-2019. For the frontier firms, on average, the TFP trend had increased by 20.4 percent while the non-frontier firms successively maintained the negative growth rate, albeit with a much smaller margin. The same opposite trend is partially true for the sources of TFP growth. While the scale efficiency change for the frontier firms, on average, improved significantly (from 7.6 percent to 20.4 percent), the non-frontier firms on the other hand, registered a much greater

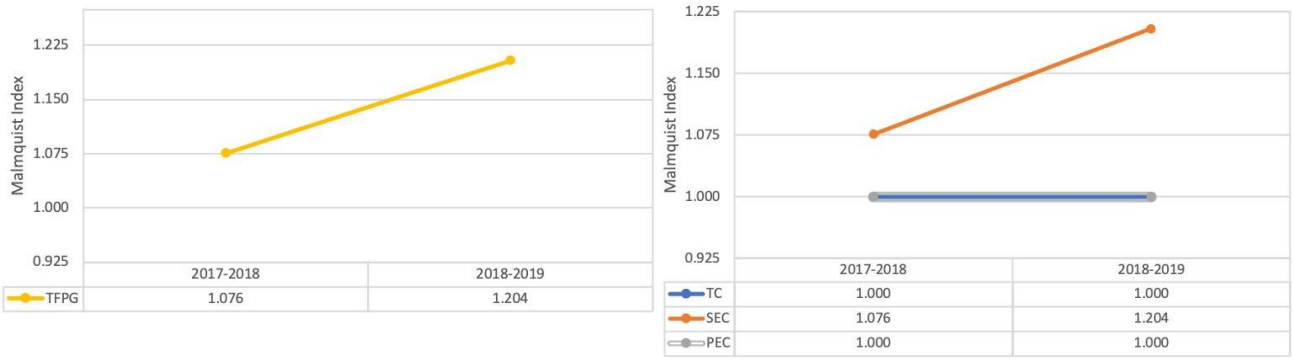


Figure 32(a) : Chemicals & Chemical Products Frontier firms productivity trends and decompositions

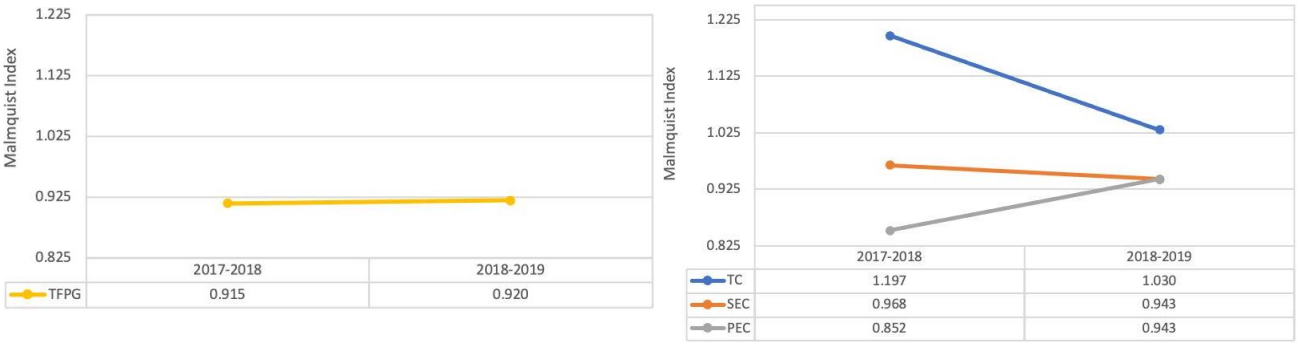


Figure 32(b): Chemical & Chemical Products Non-Frontier firms productivity trends and decompositions

negative growth from -3.2 percent to 5.7 percent, for the periods 2017-2018 and 2018-2019, respectively. Unlike the scale efficiency, the pure efficiency change however recorded a much smaller negative rate from the preceding period.

Among the non-frontier firms, RGT Bhd registered the highest improvement in the TFP for 2017-2018, together with few other companies that recorded positive rate of TFP growth (i.e. HIL Industries Bhd, Luxchem Corporation and Toyo Ink Group). Hextar Global Bhd on the other hand, was the least performing company in terms of productivity trend between 2017-2018. Luxchem Corporation sustained the positive TFP growth in the subsequent period and joined by few other companies such as the Chemical Company of Malaysia Bhd, Imaspro Corporation, Karyon Industries Bhd and Nylex Malaysia Bhd.

ICT

The 15 short listed firms from the ICT subsector consist of 11 digital services and 4 software companies. Based on market capitalization, 2 firms are listed in the Mid 70 index, and the remaining 13 companies are ranked 100 and above. The two top market valuation under the ICT subsector are Datasonic Group Bhd and MYEG Services Bhd. All the 15 holding companies under the ICT subsector are incorporated in Malaysia.

Market Capitalization

FTSE Bursa Malaysia KLCI index: 0
FTSE Bursa Malaysia Mid 70 index: 2
FTSE Bursa Malaysia Small Cap Index: 13

Foreign-based

Holding companies incorporated abroad: 0

15 ICT

ATURMAJU RESOURCES
CENSOF HOLDINGS
EXCEL FORCE MSC
MALAYSIA WILLOWGLEN
DATAPREP HOLDINGS
DIGISTAR CORPORATION
DAGANG NEXCHANGE
DATASONIC GROUP
GHL SYSTEMS
GRAN-FLO
HEITECH PADU MESINIAGA
MY E.G SERVICES
OMESTI
THETA EDGE

2017

7 out of 15
firms were on the efficient frontier

2018

4 out of 15
firms were on the efficient frontier

2019

5 out of 15
firms were on the efficient frontier

Figure 33: Number of firms on the frontier for ICT subsector by year

The Frontier Firms

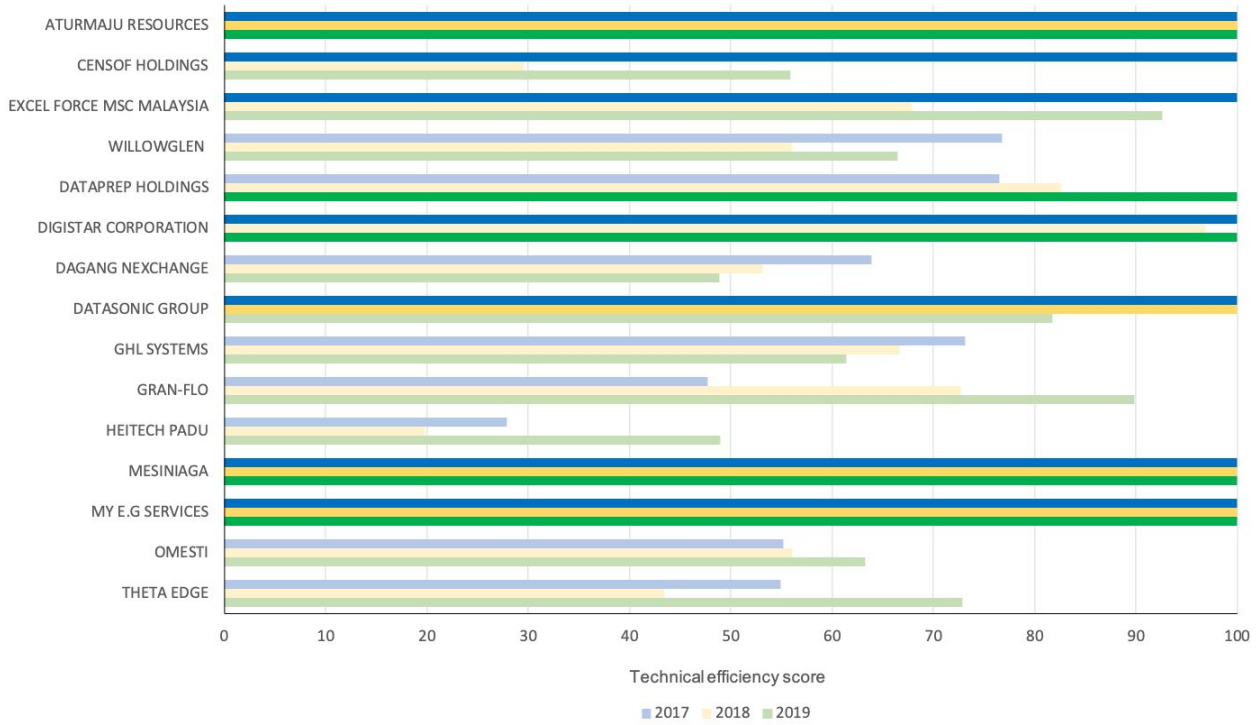


Figure 34: ICT technical efficiency score and frontier firms

Figure 34 presents the technical efficiency scores and the frontier firms for the three consecutive years, 2017-2019. Analysis of the annual performance indicates that there were 7 firms that had been identified as the frontier firms for year 2017. On the other hand, year 2018 and 2019, recorded a smaller number, with 4 and 5 frontier firms respectively:

Frontier Firms in 2017

ATURMAJU RESOURCES
MESINIAGA
MY E.G SERVICES
CENSOF HOLDINGS
EXCEL FORCE MSC
DIGISTAR CORP.
DATASONIC GROUP

Frontier Firms in 2018

ATURMAJU RESOURCES
MESINIAGA
MY E.G SERVICES
DATASONIC GROUP

Frontier Firms in 2019

ATURMAJU RESOURCES
MESINIAGA
MY E.G SERVICES DIGISTAR CORP. DATASONIC GROUP

From 2017 through 2019, the count of frontier firms is unfavourably fluctuating from 7, decreased to 4, then increased to 5 firms. Over these periods, there are 3 firms that are consistently ranked as the frontier firms:

1. Aturmaju Resources Berhad
2. Mesiniaga Berhad
3. MY E.G Services Berhad

Despite the decreasing count of frontier firms in ICT subsector over the years, those firms which had been consistently on the frontier showed stable performance over time as reflected by their respective rankings in Figure 35. In particular, MY E.G Services Bhd, Mesiniaga Bhd and Aturmaju Resources Bhd sustained their respective 1st, 2nd and 3rd rankings for 2017, 2018 and 2019.

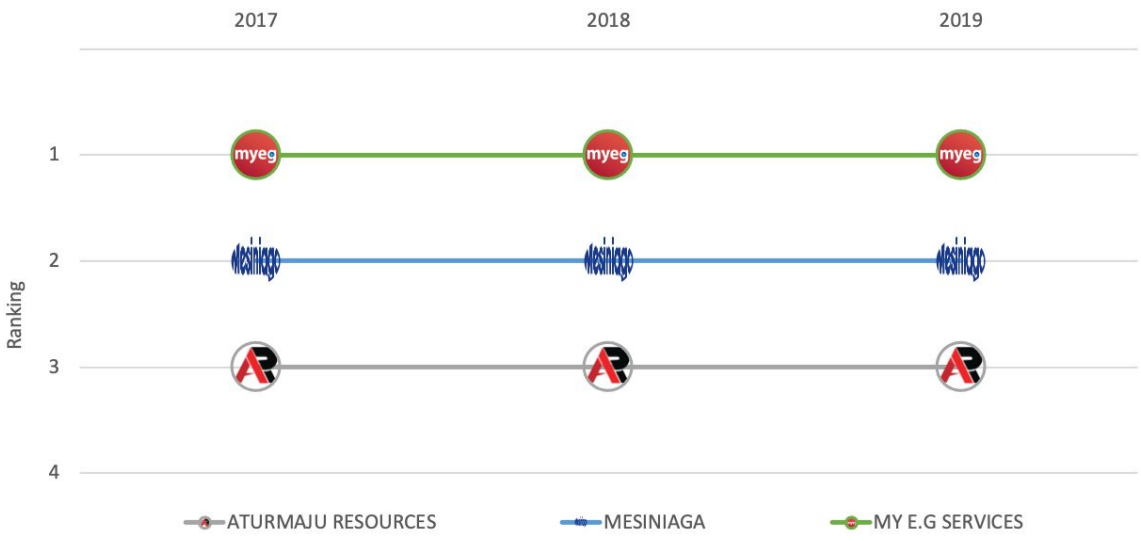


Figure 35: ICT frontier firms' ranking

The Non-Frontier Firms

The reported overall technical efficiency scores for the non-frontier firms belonging to ICT subsector averaged at 59.51, 58.63 and 68.21 for the year 2017, 2018 and 2019, respectively. The average scores indicate the non-frontier ICT firms should be saving more than doubled the amount of inputs to produce the reported output level compared to the amounts demonstrated by their relevant benchmark frontier firms.

As depicted by Figure 36, for instance, Excel Force MSC Malaysia Bhd had visibly improved its efficiency score of 67.93 percent in 2018 to an efficiency score of 92.61 percent in 2019. The firm only needs additional 7.39 percent reduction in the current input utilisation to regain its fully efficient performance demonstrated in 2017.

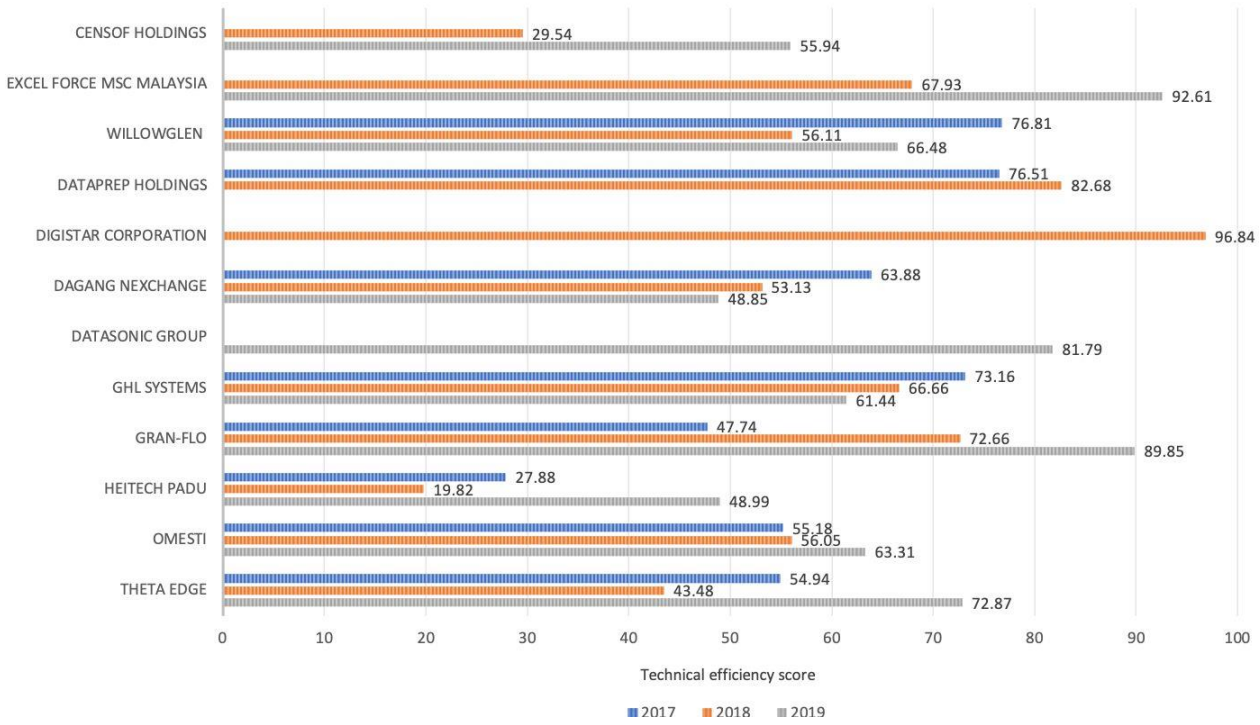


Figure 36: ICT technical inefficiency of the non-frontier firms

The Benchmark Peers

Among the five ICT frontier firms in 2019, Aturmaju Resources Bhd, followed by Dataprep Holdings, are the most frequently cited as the benchmark in setting the improvement targets for ICT non-frontier firms towards becoming frontier firms. Although with relatively smaller values of lambda, MY E.G. Bhd is another frequently recommended benchmark for ICT subsector.

As denoted by the lambda values in Table 5, for Censof Holdings for instance, its targeted inputs consumption level should be about 57 percent identical to that of Aturmaju Resources Bhd and 43 percent identical to that of Dataprep Holdings.

.

	Non-frontier firms	AR	DATAPREP	myeg
1.	CENSOF HOLDINGS	(0.57)	(0.36)	(0.00)
2.	EXCEL FORCE MSC	(0.65)	(0.35)	(0.00)
3.	WILLOWGLEN	(0.00)	(0.90)	(0.10)
4.	DAGANG NEXCHANGE	(0.42)	(0.34)	(0.24)
5.	DATASONIC GROUP	(0.53)	(0.00)	(0.20)
6.	GHL SYSTEMS	(0.60)	(0.00)	(0.28)
7.	GRAN-FLO	(0.70)	(0.20)	(0.00)
8.	HEITECH PADU	(0.08)	(0.60)	(0.05)
9.	OMESTI	(0.57)	(0.00)	(0.03)
10.	THETA EDGE	(0.24)	(0.76)	(0.00)

Notes:
Figures in parentheses are Lambda values

Table 5: ICT non-frontier firms' peers for 2019

The Laggards

The following Figure 37 graphs the ranking of the non-frontier firms based upon their annual efficiency scores. A total of 7 non-frontier firms were inconsistently identified as the bottom five for the ICT subsector. Of these, only three were repetitively ranked as the bottom five laggards every year. These were Dagang Nexchange, Omesti and Heitech Padu. While Gran Flo and Theta Edge leaving the bottom five cluster in 2018 and 2019, respectively, Censof Holdings entering the cluster in 2018.

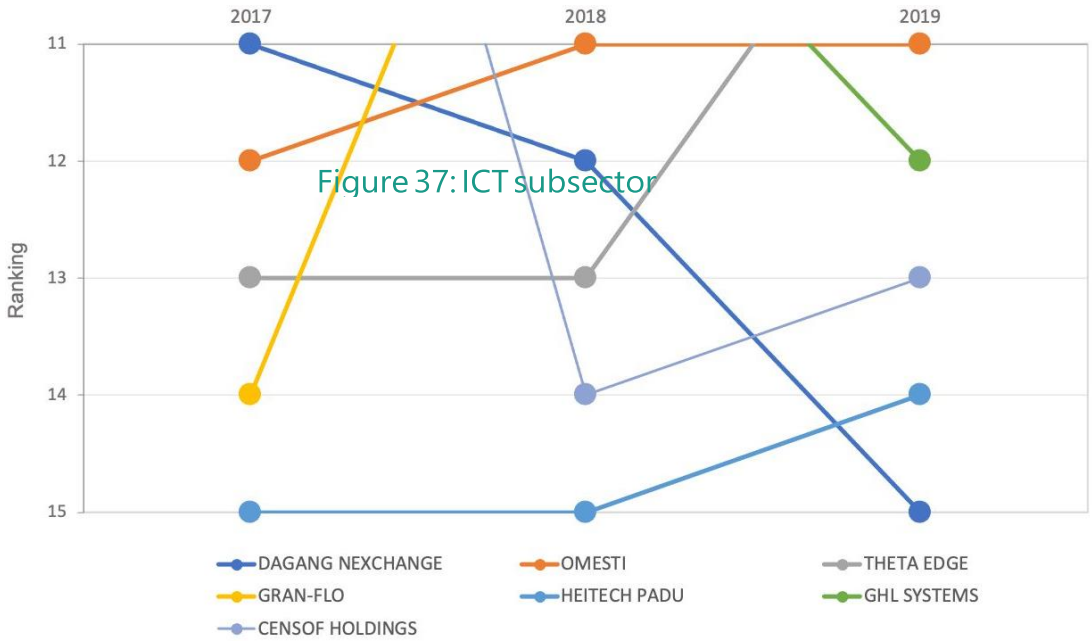


Figure 37: ICT subsector

Figure 37: ICT subsector laggards

For every inefficient firm, improvement targets to become efficient are illustrated without changing the current input-output ratio or the present output volume. Figure 38 depicts the proposed reduction in inputs for the top five laggard ICT firms in the year 2019 to theoretically replicate their respective benchmark peers. Based on Figure 38, every firm requires the same percentage of input saving in the total assets, total equity and wages & salaries, each. In particular, an overall input saving for Omesti Bhd is 39.69 percent, for GHL Systems Bhd is 38.56 percent, for Censof Holdings is 44.06 percent, for Heitech Padu Bhd is percent but for Dagang Nexchange Bhd are 51.15 and 52.27 percent.

Figure 38: Targets for ICT subsector laggards (2019)

The Productivity Trends

Based on the technical efficiency scores in various years, Malmquist Productivity index can be computed to assess the TFP trends and its decomposition. Figure 39(a) illustrates the overall productivity trends for the ICT subsector. In essence, the ICT subsector registered a positive productivity growth throughout 2017 to 2019. Notwithstanding this trend, the rate of TFP growth for the ICT subsector between 2017-2019 however was diminishing.

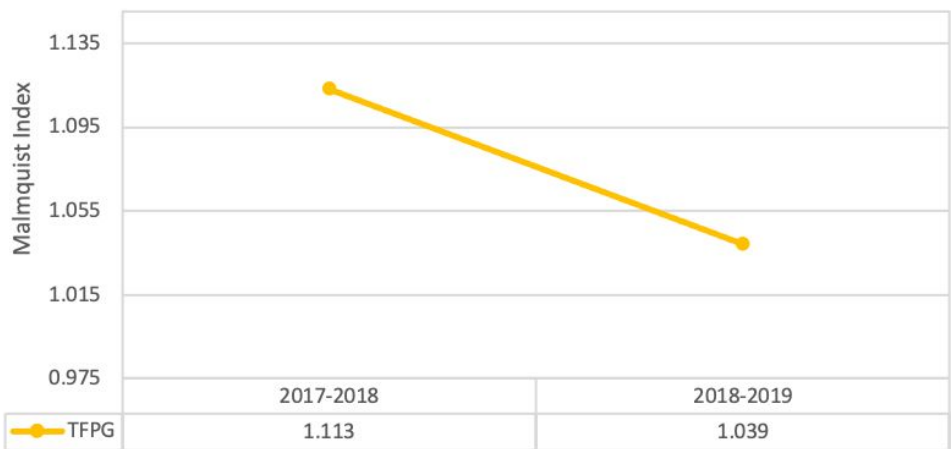
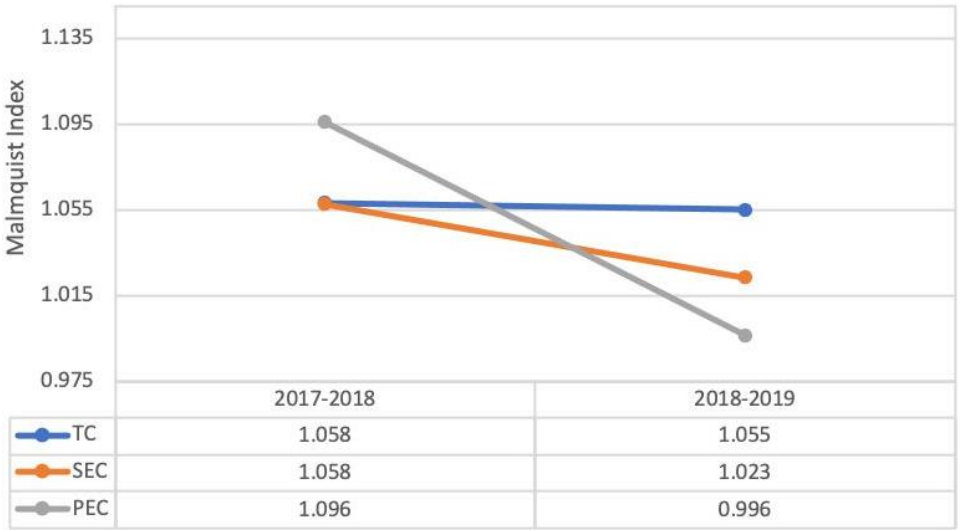


Figure 39(a): ICT productivity trends

The diminishing TFP trends could be explained based on the decomposition as illustrated in Figure 39(b). In general, the declining rate of TFP growth in 2018-2019 was mainly contributed by the negative growth of pure efficiency and the much slower (positive) growth in terms of the scale efficiency.



	2017-2018	2018-2019
TC	1.058	1.055
SEC	1.058	1.023
PEC	1.096	0.996

Figure 39(b): ICT productivity decomposition

Figure 40(a) and 40(b) illustrate the average TFP trends and its decompositions for the frontier and the non-frontier firms. In particular, Figure 40(a) implies that on average, the TFP was stagnant throughout 2017-2019 for the case of frontier firms. This is indicated by the Malmquist values of 1 for both periods, 2017-2018 and 2018-2019. On the other hand, on average, the non-frontier firms recorded 18.6 percent growth in TFP in the first period under consideration (2017-2018). Nevertheless, in the second period (2018-2019), the average trend recorded was negative and declining by -2.6 percent. It is also worth noting that although technical change recorded a positive growth in 2018-2019, the scale and pure efficiency however registered a negative trend at the rate of 0.2 percent and 20.4 percent, respectively in the same period.

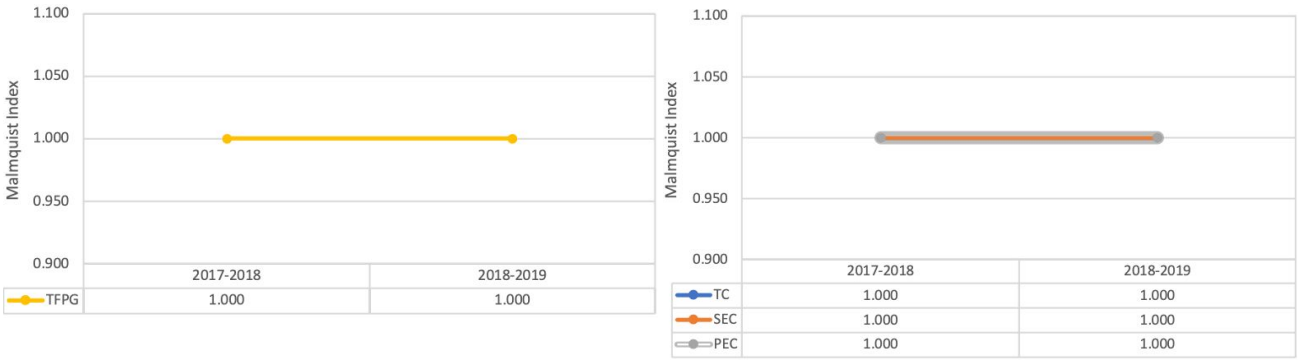


Figure 40(a): ICT Frontier firms productivity trends and decompositions

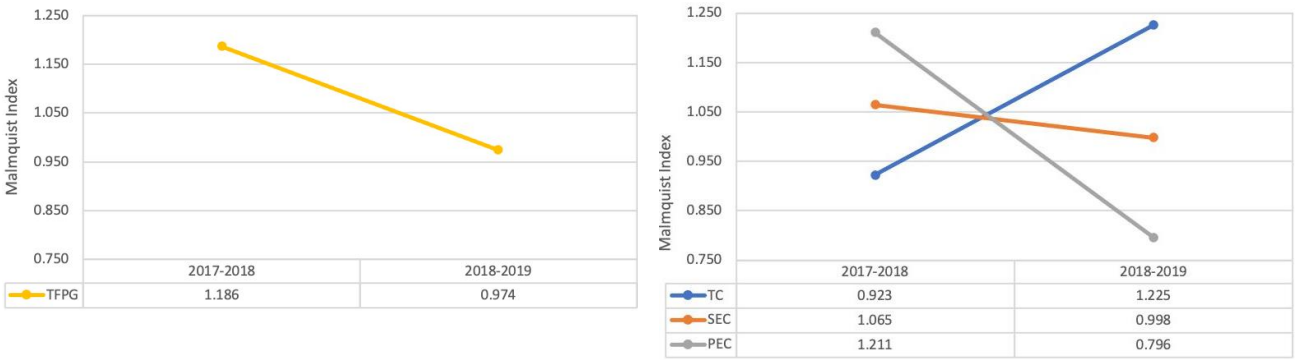


Figure 40(b): ICT Non-Frontier firms productivity trends and decompositions

Among the non-frontier firms, eight firms registered positive growth in TFP for the period of 2017-2018, while four firms recorded a decline. In essence, the Censof Holdings obtained the biggest jump in TFP growth while the four firms that registered declining TFP were Dataprep Holdings, Datasonic Group, Gran-Flo Bhd and Omesti Bhd. For the period 2018-2019, on the other hand, seven firms recorded TFP improvement while five firms registered otherwise. Specifically, not all firms that were able to record positive TFP growth in the preceding year were able to sustain or improve their productivity growth. Among these were Censof Holdings, Digistart Corporation, Heitech-Padu Bhd and Theta Edge Bhd.

Agro Food

Analysis of firms within the Agro Food subsector focuses on 11 firms involved in agricultural food. Based on market capitalization, one firm (QL Resources Bhd) is listed in the Mid 70 index and the remaining 10 companies are ranked 100 and above. All the 11 holding companies under the Agro Food subsector are incorporated in Malaysia.

Market Capitalization

FTSE Bursa Malaysia KLCI index: 0
FTSE Bursa Malaysia Mid 70 index: 1
FTSE Bursa Malaysia Small Cap Index: 10

Foreign-based

Holding companies incorporated abroad: 0

11

Agro Food

CAB CAKARAN CORP
GREENYIELD
LAY HONG LTKM
PWF CORP
QL RESOURCES RHONE MA
HOLDINGS SINMAH
CAPITAL
TECK GUAN PERDANA
TEO SENG CAPITAL TPC
PLUS

2017

5 out of 11
firms were on the efficient frontier

2018

5 out of 11
firms were on the efficient frontier

2019

5 out of 11
firms were on the efficient frontier

Figure 41: Number of firms on the frontier for Agro Food subsector by year

The Frontier Firms

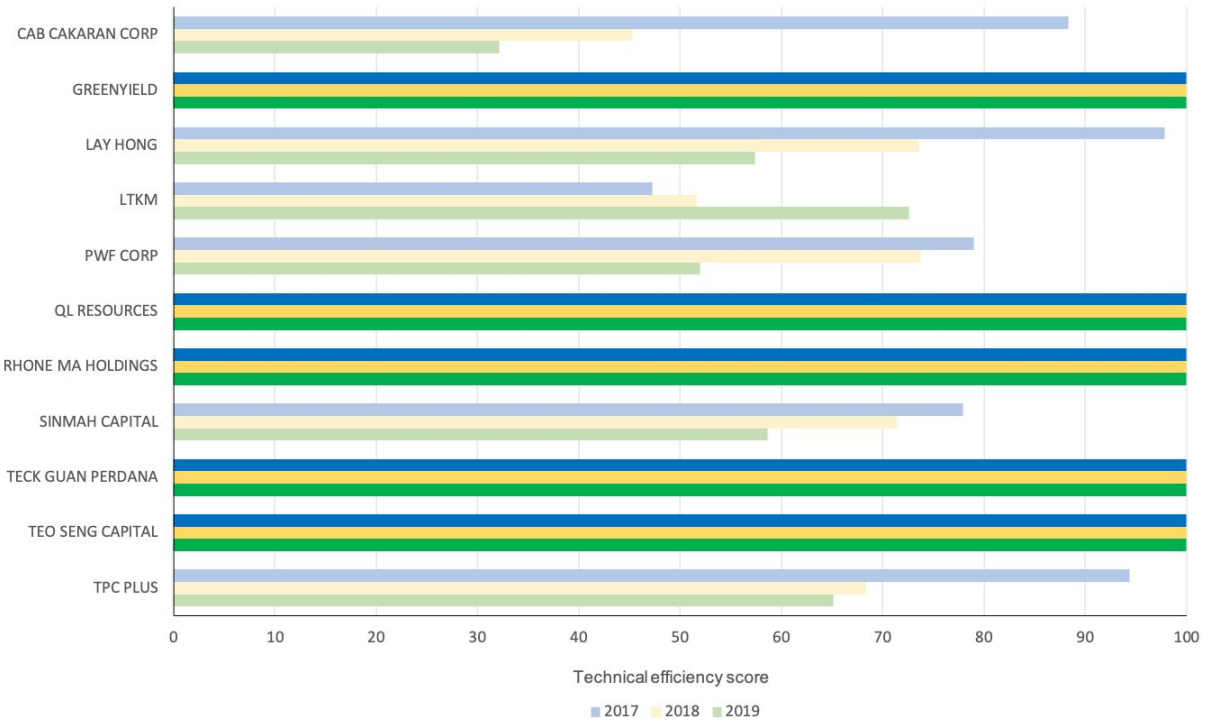


Figure 42: Agro Food technical efficiency score and frontier firms

Figure 42 presents the technical efficiency scores and the frontier firms for the three consecutive years, 2017-2019. Analysis of the annual performance indicates that there were 5 firms that had been identified as the frontier firms for year 2017, 2018 and 2019. The listing of the frontier firms is presented below:

Frontier Firms in 2017

GREENYIELD
QL RESOURCES
RHONE MA HOLDINGS
TECK GUAN PERDANA
TEO SENG CAPITAL

Frontier Firms in 2018

GREENYIELD
QL RESOURCES
RHONE MA HOLDINGS
TECK GUAN PERDANA
TEO SENG CAPITAL

Frontier Firms in 2019

GREENYIELD
QL RESOURCES
RHONE MA HOLDINGS
TECK GUAN PERDANA
TEO SENG CAPITAL

Throughout the period 2017 until 2019, 5 firms were consistently rated as the efficient firms or on the frontier for the Agro Food subsector.

1. Greenyield Berhad
2. QL Resources Berhad
3. Rhone Ma Holdings
4. Teck Guan Perdana Berhad
5. Teo Seng Capital Berhad

The ranking among the frontier firms under the Agro Food subsector is presented in Figure 43. Only QL Resources Bhd had consistently ranked 1st in the technical efficiency performance among the frontier firms. However, for the remaining frontier firms, their ranking is fluctuating. In year 2019, Teo Seng Capital Bhd and Teck Guan Perdana Bhd managed to improve their rankings. On the other hand, for Rhone Ma Holdings and Greenyield Bhd, the rankings deteriorated in more recent years relative to other frontier firms.

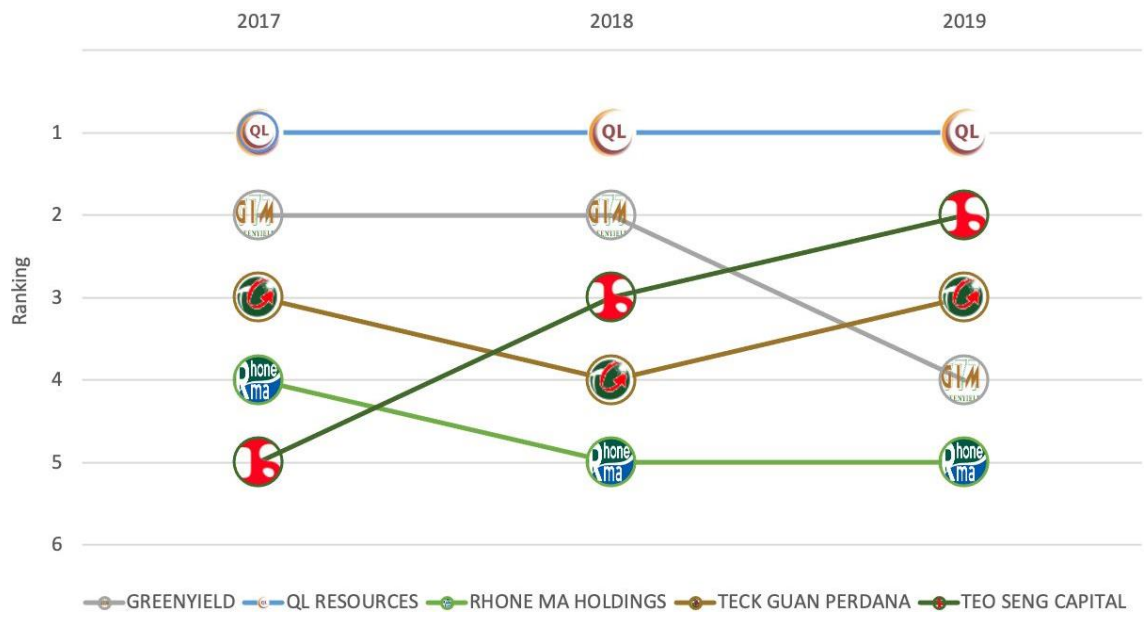


Figure 43: Agro Food frontier firms' ranking

The Non-Frontier Firms

All Agro Food subsector non-frontier firms, except LTKM Bhd, experienced a weakening performance between 2017 and 2019. On average, the overall technical efficiency scores were 80.79 in 2017, reduced to 63.99 in 2018 then further reduced to 56.30 in 2019. Observation of the practice of the Agro Food frontier firms suggests improvement potential for each of the non-frontier firms.

Figure 44 presents the technical efficiency scores for all the non-frontier firms covering the period from 2017 to 2019. For illustration, 32.14 percent score indicates CAB Cakaran Corporation could optimise its current usage of inputs by 67.86 percent to be as efficient as its benchmark peers. It also indicates that the firm had used more than two-third as required to generate its output in 2019. CAB Cakaran had performed much better in the earlier years. Specifically, the technical efficiency score for the firm was 88.3 percent in 2017 before dropped by almost half to 45.26 percent in 2018.

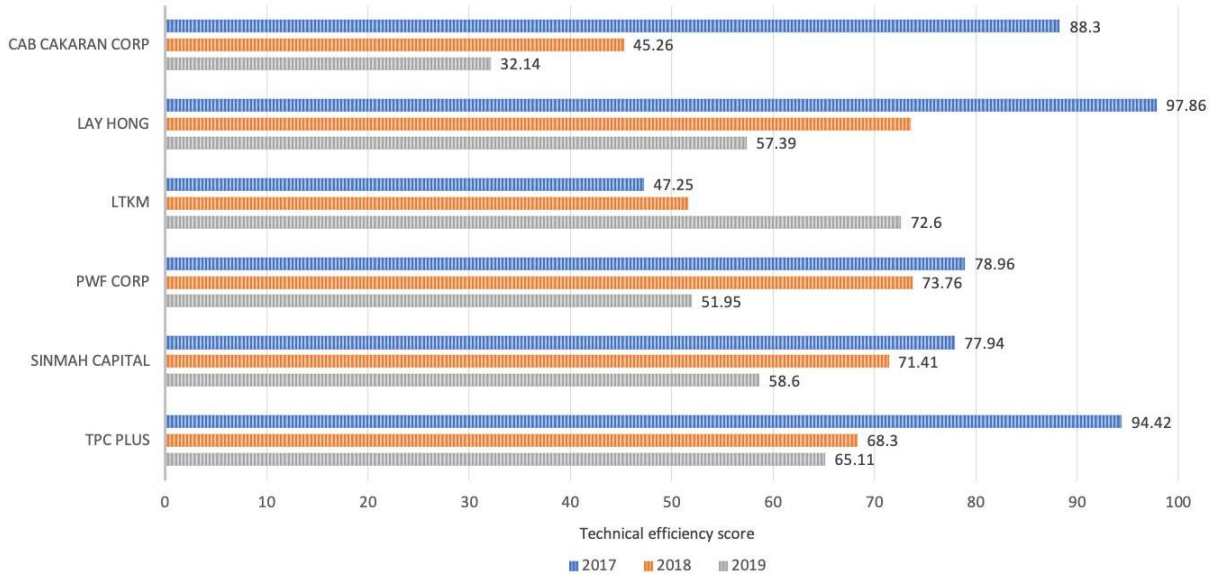


Figure 44: Agro Food technical inefficiency of the non-frontier firms

The Benchmark Peers

Among the five consecutively frontier firms, Teck Guan Perdana Bhd, followed by Teo Seng Capital Bhd and Rhone Ma Holdings, are the most frequently cited in 2019 as the benchmark to set the improvement targets for non-frontier firms in Agro Food subsector.

As denoted by the lambda values in Table 6, Lay Hong Bhd for instance, its targeted inputs consumption level should be about 64 percent identical to that of Teo Seng Capital Bhd and 36 percent identical to that of Teck Guan Perdana Bhd.

	Non-frontier firms	Rhone Ma		
1.	CAB CAKARAN CORP	(0.00)	(0.45)	(0.55)
2.	LAY HONG	(0.00)	(0.36)	(0.64)
3.	LTKM	(0.96)	(0.00)	(0.04)
4.	PWF CORP	(0.88)	(0.00)	(0.12)
5.	SINMAH CAPITAL	(0.00)	(1.00)	(0.00)
6.	TPC PLUS	(0.00)	(0.97)	(0.03)

Notes:
Figures in parentheses are Lambda values

Table 6: Agro Food non-frontier firms' peers for 2019

The Laggards

Based on the efficiency scores of the non-frontier firms in Agro Food subsector, altogether six firms ranked as the five most laggard firms between 2017 and 2019. Nevertheless, the overall annual movement of their rankings had been very volatile (Figure 45). Between 2018 and 2019 particularly, some firms were leaving while some firms were entering the bottom five laggard firms cluster, indicating the inconsistent performance of firms in the industry.

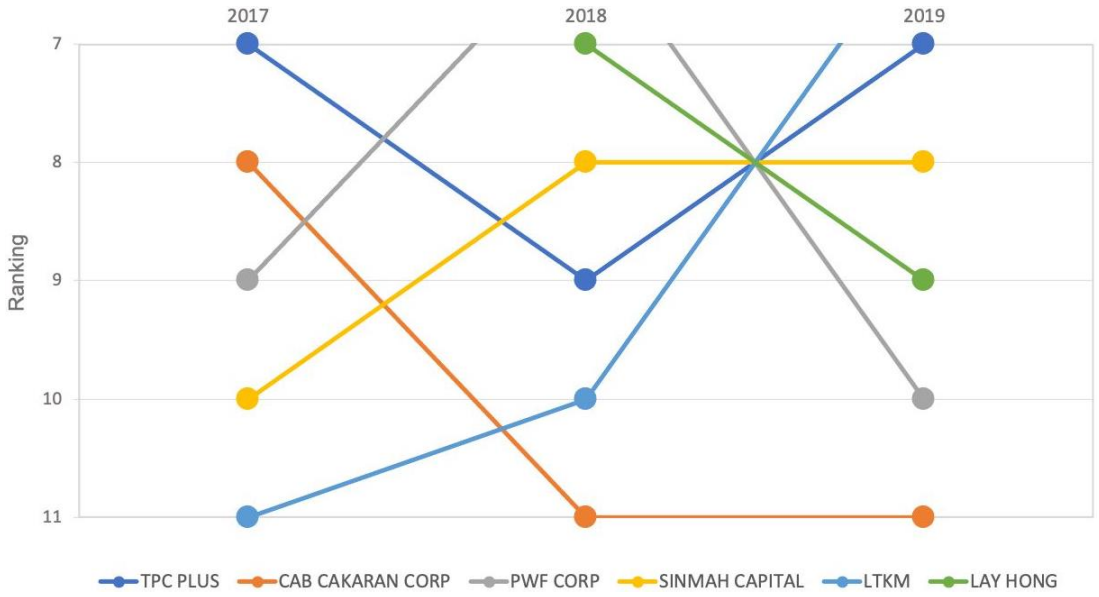


Figure 45: Agro Food subsector laggards

The improvement targets for the inefficient Agro Food firms to become efficient relative to the practice of frontier firms, is summarised in Figure 46. Considering the top among the five most laggards, TPC Plus Bhd for example needed an overall cut in input usage by 40 percent. This would render TPC Plus Bhd as efficient and thus becomes comparable to its primary benchmark peer, Teck Guan Perdana Bhd. In particular, reduction by 36.17 percent of total assets, 34.89 percent of total equity, and 43.01 percent of wages & salaries are needed. The proposed improvement plan is considered feasible as it has been derived and customised for TPC Plus Bhd based on the achieved performance of its dominant benchmark, Teck Guan Perdana Bhd and its weak benchmark, Teo Seng Capital Bhd.

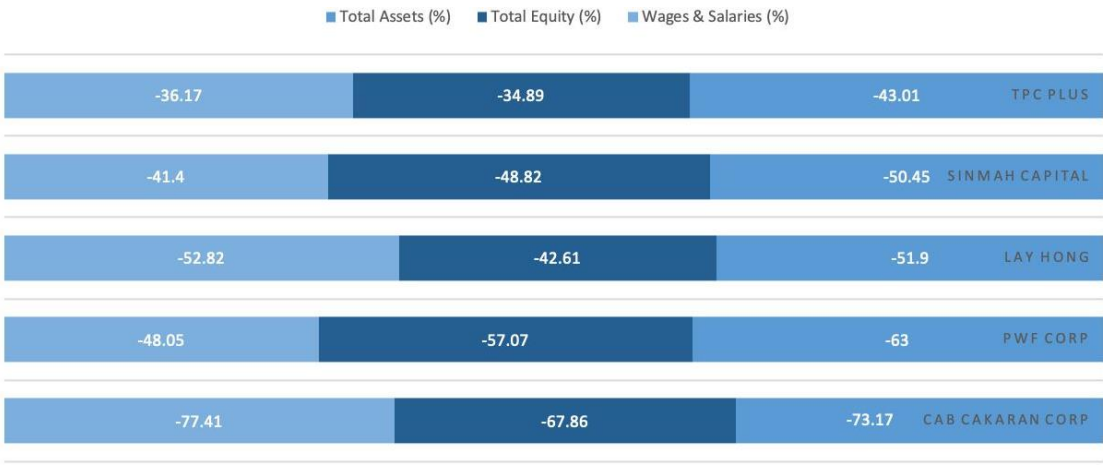


Figure 46: Targets for Agro Food subsector laggards (2019)

The Productivity Trends

Malmquist Productivity index in Figure 47(a) illustrates the overall productivity trends for the Agro Food subsector and its decomposition. In general, the Agro Food subsector registered a positive productivity growth throughout 2017 to 2019. These are denoted by the Malmquist index values that are larger than one. Despite the positive growth over the past years, the productivity growth trends however was slowing down between the period 2017-2018 and 2018-2019.

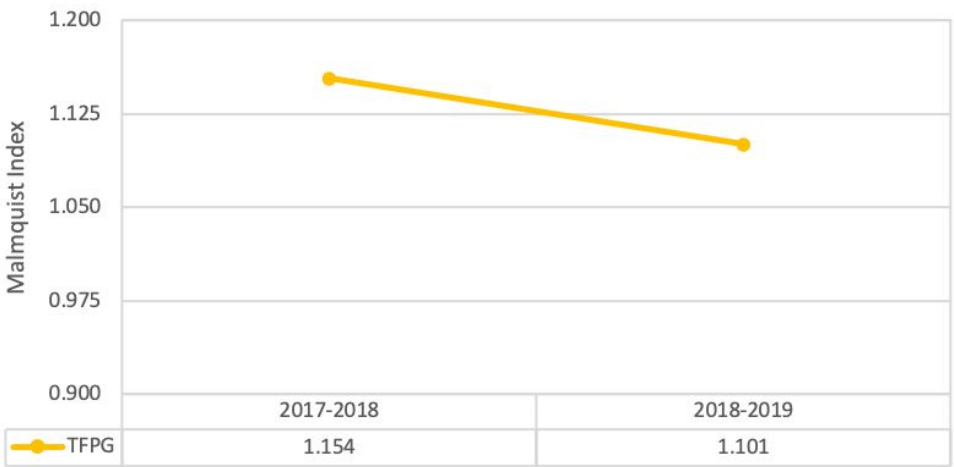
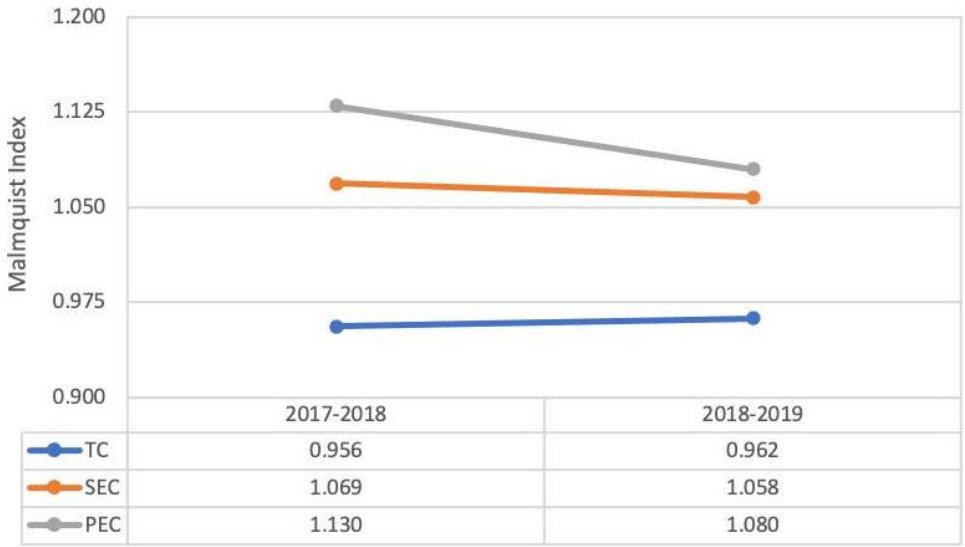


Figure 47(a): Agro Food productivity trends

The slower growth in TFP in the Agro Food subsector was mainly contributed by the sustained decline in the technical change and the slower growth in the scale and pure efficiency effects. These are illustrated in Figure 47(b), where the technical changes recorded negative growths at a rate of 4.4 percent and 3.8 percent, for the period 2017-2018 and 2018-2019, respectively.



	2017-2018	2018-2019
TC	0.956	0.962
SEC	1.069	1.058
PEC	1.130	1.080

Figure 47(b): Agro Food productivity decomposition

Figure 48(a) and 48(b) illustrate the average TFP trends and its decompositions for the frontier and the non-frontier firms under the Agro Food subsector. In particular, Figure 48(a) implies that on average, the TFP growth for the frontier firm was growing, but the growth rate was diminishing at the later stage. The sources of growth for the frontier group was mainly dominated by the improvement in the scale efficiency that was growing at a rate of percent and 7.7 percent, for the period of 2017-2018 and 2018-2019, respectively. Unlike the frontier firms that recorded a stagnation in the pure efficiency change, the average non-frontier firms, on the other hand, registered a promising improvement in the pure efficiency effects that recorded a growth rate of 25.1 percent and 21.5 percent for the period of 2017-2018 and 2018-2019, respectively.

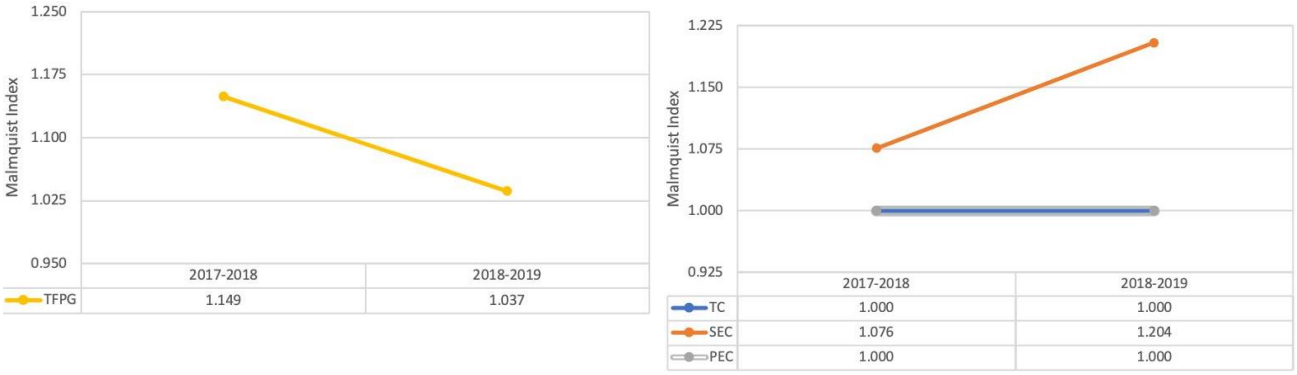


Figure 48(a): Agro Food Frontier firms productivity trends and decompositions

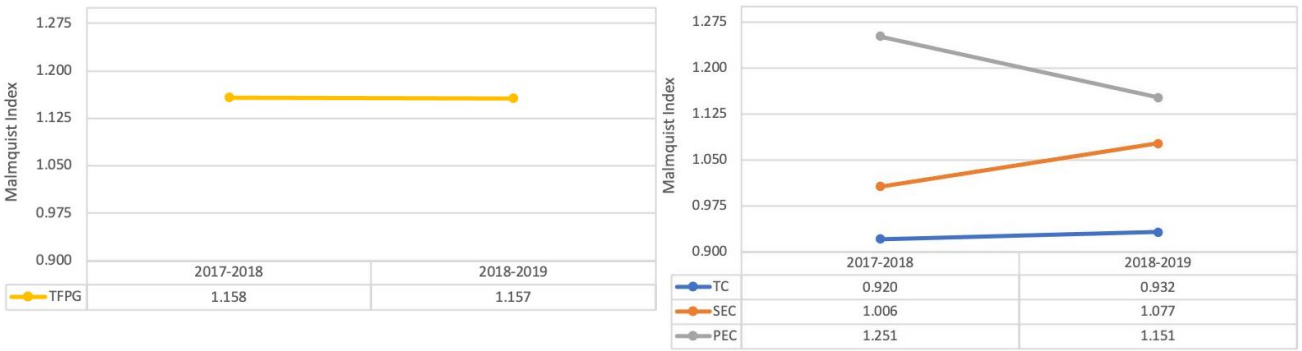


Figure 48(b): Agro Food Non-Frontier firms productivity trends and decompositions

Further exploration on the TFP growth at the firm level indicates that the Teck Guan Perdana Bhd was the main performer that pushed the TFP growth in both periods (2017-2018 and 2018-2019). On the other hand, among the non-frontier group firms, Sinmah Capital Bhd performed significantly better relative to others in terms of improvement in TFP covering the periods of 2017-2018 and 2018-2019. The Lay Hong Bhd managed to turn around the negative TFP growth in 2017-2018 into a positive TFP growth in 2018-2019 while the LKTM Bhd was not able to sustain the positive growth in the second period (2018-2019).

Retail and Food & Beverage

Analysis of firms within the Retail and F&B core businesses focuses on 12 firms that are highly relevant in the context of this study. Based on market capitalization, one firm (Petronas Dagangan Bhd) is listed in the Mid 70 index and the remaining 11 companies are ranked 100 and above. From the 12 companies, two are under holding companies that are incorporated abroad which are AEON Co. Berhad and Amway Holdings Berhad.

Market Capitalization

FTSE Bursa Malaysia KLCI index: 0
FTSE Bursa Malaysia Mid 70 index: 1
FTSE Bursa Malaysia Small Cap Index: 10

Foreign-based

Holding companies incorporated abroad: 2

12 Retail and Food & Beverage

AEON CO
AMWAY HOLDINGS
ATLAN HOLDINGS
HAI-O ENTERPRISE

MYNEWS HOLDINGS PADINI
HOLDINGS PARKSON
HOLDINGS PETRONAS
DAGANGAN

POHKONG HOLDINGS
SEVEN ELEVEN M'SIA
TOMEI CONSOLIDATED
BERJAYA FOOD

2017

8 out of 12
firms were on the efficient frontier

2018

8 out of 12
firms were on the efficient frontier

2019

7 out of 12
firms were on the efficient frontier

Figure 49: Number of firms on the frontier for Retail and F&B subsector by year

The Frontier Firms

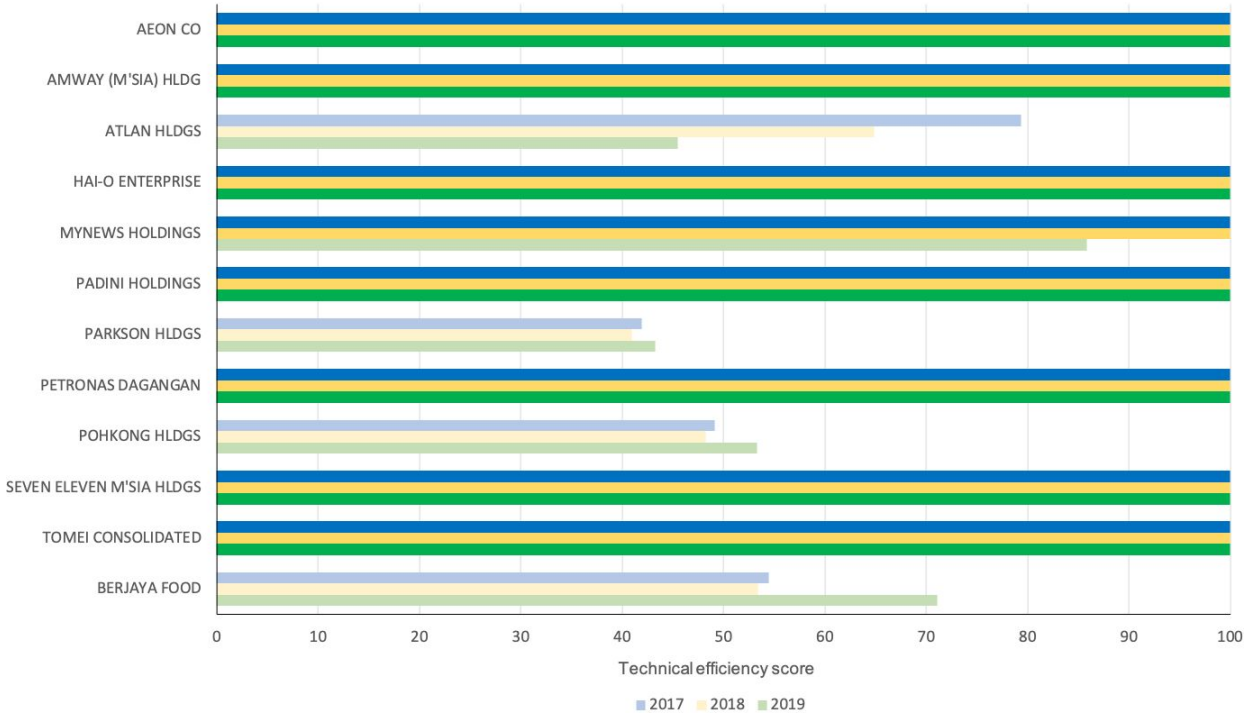


Figure 50: Retail and F&B technical efficiency score and frontier firms

Figure 50 presents the technical efficiency scores and the frontier firms for the three consecutive years, 2017-2019. Analysis of the annual performance indicates that there were 8 firms that had been identified as the frontier firms for year 2017 and 2018. On the other hand, year 2019 saw the number of frontier firms declined to 7. The listing of the frontier firms is presented below:

Frontier Firms in 2017

AEON CO
AMWAY HOLDINGS
HAI-O ENTERPRISE
PADINI HOLDINGS
PETRONAS DAGANGAN
SEVEN ELEVEN M'SIA
TOMEI CONSOLIDATED
MYNEWS HOLDINGS

Frontier Firms in 2018

AEON CO
AMWAY HOLDINGS
HAI-O ENTERPRISE
PADINI HOLDINGS
PETRONAS DAGANGAN
SEVEN ELEVEN M'SIA
TOMEI CONSOLIDATED
MYNEWS HOLDINGS

Frontier Firms in 2019

AEON CO
AMWAY HOLDINGS
HAI-O ENTERPRISE
PADINI HOLDINGS
PETRONAS DAGANGAN
SEVEN ELEVEN M'SIA
TOMEI CONSOLIDATED

MyNews Holdings had been rated as efficient firm in 2017 and 2018 consecutively, but its performance declined in 2019. Over the period of 2017-2019, seven firms had been consistently rated as frontier firms for the Retail and Food & Beverages subsector:

1. AEON Co Berhad
2. Amway (Malaysia) Holdings
3. HAI-O Enterprise
4. Padini Holdings
5. Petronas Dagangan Berhad
6. Seven Eleven (Malaysia) Holdings
7. Tomei Consolidated Berhad

Between 2017 and 2019, Petronas Dagangan Bhd and Seven-Eleven (Malaysia) Holdings consistently ranked 1st and 2nd (Figure 51). In contrast, Padini Holdings, HAI-O Enterprise and Tomei Consolidated Bhd consistently ranked 5th, 6th and 7th, respectively, during the same period. Whereas, Amway (Malaysia) Holdings and AEON Co Bhd switched then maintained their 3rd and 4th rankings after 2017.

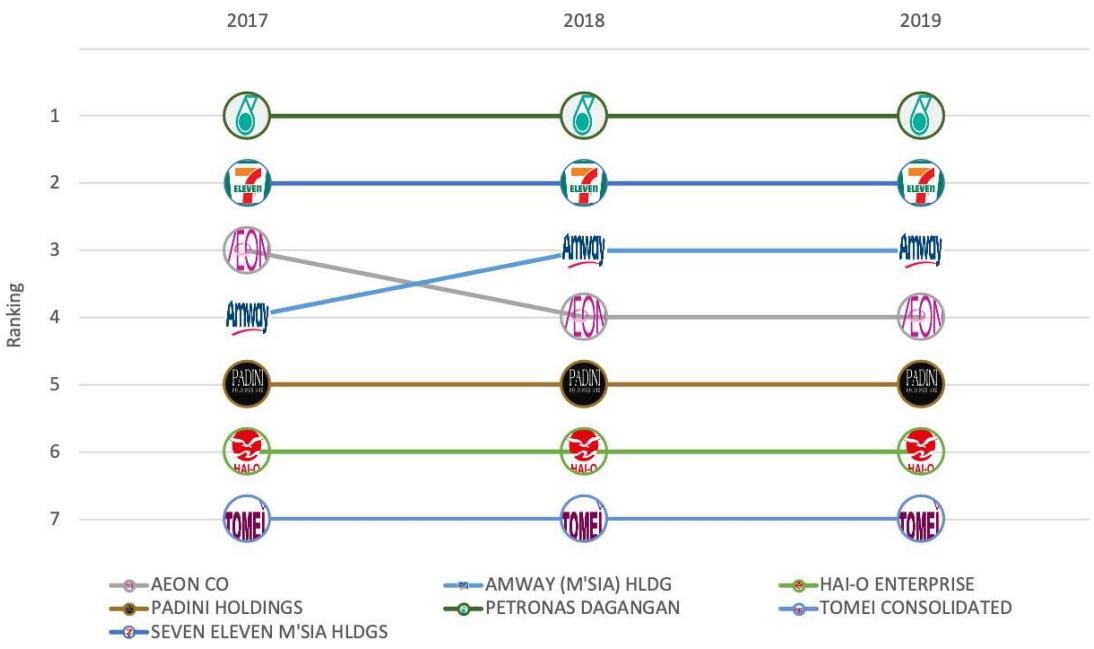


Figure 51: Retail and F&B frontier firms' ranking

The Non-Frontier Firms

The overall technical efficiency score for the non-frontier firms averaged at 56.22, 51.86 and 59.81 for the year 2017, 2018 and 2019, respectively. Therefore, on average, it is found that non-frontier firms were using at least 40 percent more of the required amount of inputs to produce their current output level in comparison to frontier firms for Retail and Food & Beverages subsector.

Figure 52 depicts the technical efficiency scores for all the non-frontier firms. On the basis of the score for example, MyNews Holdings which had been efficient in 2017 and 2018 was rated as only 85.87 percent as efficient in 2019. It indicates the fact MyNews Holdings had over utilised its resources by 14.13 percent in comparison to its benchmark peers in 2019. By reducing the input utilisation to 85.87 percent of year 2019 input usage to produce the same output level, this would make the MyNews Holdings to return as the frontier firm.

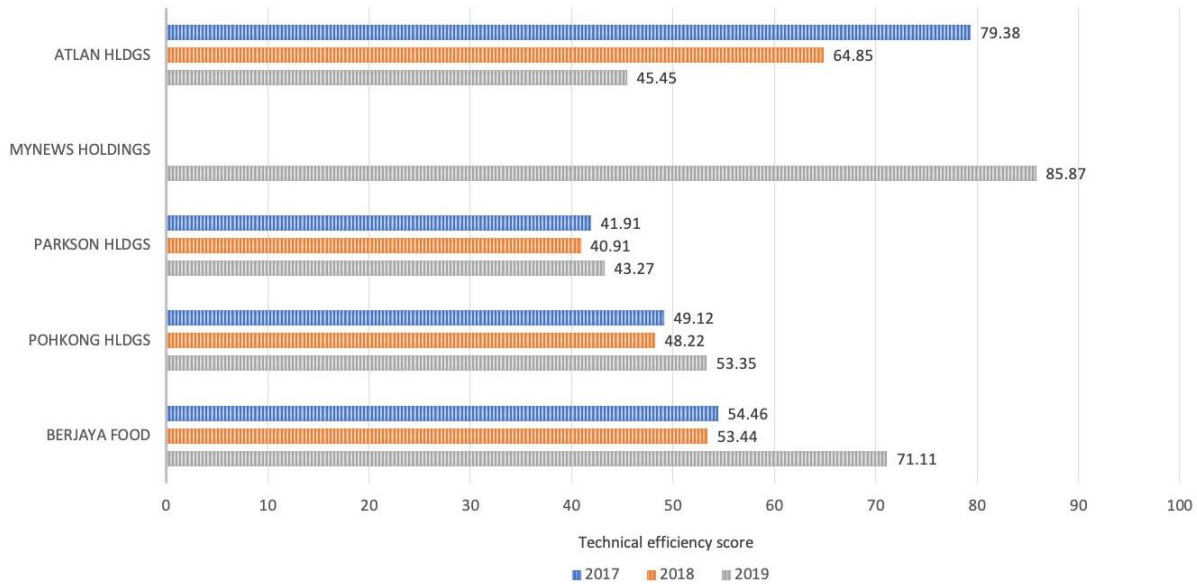


Figure 52: Retail and F&B technical inefficiency of the non-frontier firms

The Benchmark Peers

Between the seven frontier retailers in 2019, Amway (Malaysia) Holding makes the most favourable benchmark because the firm is cited as the benchmark for every non-frontier retailer (Table 7). Moreover, almost every one lambda value assigned is significant. The lambdas could also be implied as indicative of the similar pro-rated operating scale Amway (Malaysia) Bhd has relative to the majority firms in the Retail subsector hence useful in setting the improvement target for non-frontier retailers.

	Non-frontier firms	Amway	HAI-O	PADINI HOLDINGS BHD
1.	ATLAN HOLDINGS	(0.95)	(0.05)	(0.00)
2.	MYNEWS HOLDINGS	(0.50)	(0.38)	(0.00)
3.	PARKSON HOLDINGS	(0.19)	(0.00)	(0.35)
4.	POH KONG HOLDINGS	(0.70)	(0.30)	(0.00)
5.	BERJAYA FOOD	(0.78)	(0.00)	(0.10)

Notes:
Figures in parentheses are Lambda values

Table 7: Retail and F&B non-frontier firms' peers for 2019

The Laggards

Figure 53 graphs the non-frontier firms which continually rated the bottom five in terms of the efficiency scores among firms in Retail and Food & Beverages subsector. Every firm maintained their respective ranking in 2017 and 2018. In 2019 however, Berjaya Food Bhd and Poh Kong Holdings positively improved their positions whereas Atlan Holdings deteriorated further. Besides, MyNews Holdings and Parkson Holdings still maintained their earlier rankings as the best and as the worst among the five most laggards, respectively.

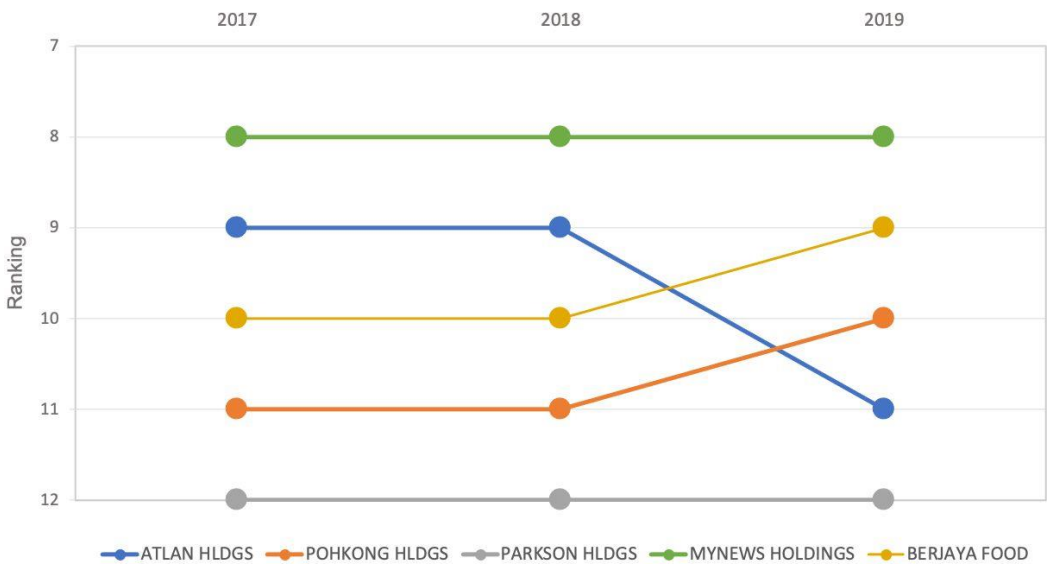


Figure 53: Retail and F&B subsector laggards

Figure 54 portrays the proposed reduction in inputs for the five most laggard firms in 2019 so that they could replicate the best practice of the relevant frontier firms in Retails and Food & Beverages subsector. The improvement targets for MyNews Holdings to become efficient, for example, require reduction by 47.54 percent of total assets as well as reduction by the same 14.13 percent of wages & salaries and of total equity. The improvement targets replicate the practice of the peers for MyNews Holdings, namely Amway (Malaysia) Holdings and Hai-O Enterprise, therefore, argued to be feasible. The targets would also enable MyNews Holdings to maintain its current input-output ratio and output level.

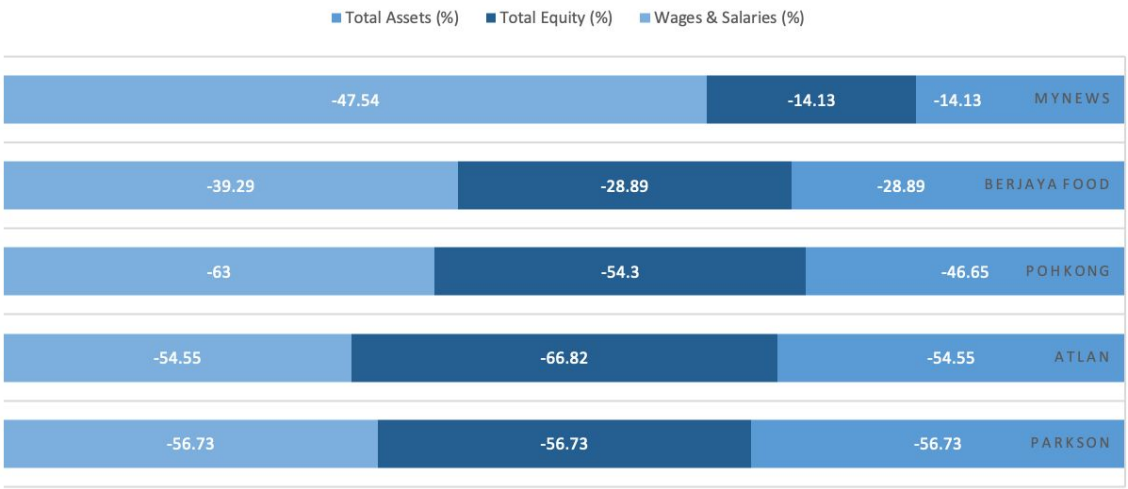


Figure 54: Targets for Retail and F&B subsector laggards (2019)

The Productivity Trends

Figure 55(a) illustrates the Malmquist Productivity index for the Retail and Food & Beverage subsector. The Malmquist Productivity index values are useful to describe the productivity trends as well as the sources of productivity growth. On average, the sectoral TFP growth registered a continuous positive trends from 2017 to 2019 with an annual growth rate of 1.5 percent in 2017-2018 and 4.1 percent in 2018-2019.

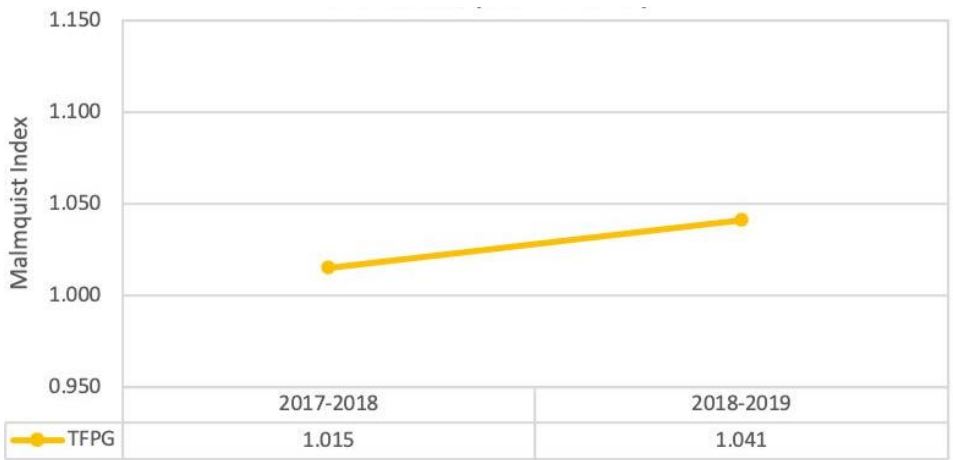
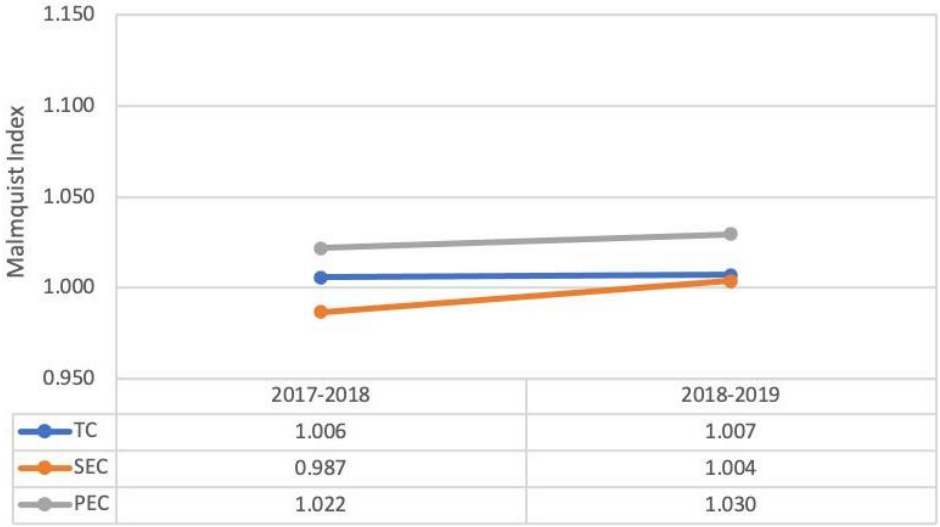


Figure 55(a): Retail and F&B productivity trends



	2017-2018	2018-2019
TC	1.006	1.007
SEC	0.987	1.004
PEC	1.022	1.030

Figure 55(b): Retail and F&B productivity decomposition

The positive growth in TFP in the Retail and Food & Beverage subsector was dominantly contributed by the positive growth of the technical change and the pure efficiency change. This is indicated by Figure 55(b) which illustrates the increase in technical change by 0.6 percent and 0.7 percent for the period 2017-2018 and 2018-2019, respectively. Likewise, the pure efficiency effects also grew positively by 2.2 percent and 3 percent over the same periods.

Further breakdowns of the productivity trends for the Retail and Food & Beverage subsector are provided in the subsequent figures. Figure 56(a) illustrates the average productivity trends for the frontier firms while Figure 56(b) depicts the trends for the non-frontier firms. In general, the non-frontier firms recorded positive productivity growth for both periods (2017-2018 and 2018-2019). This implies that on average, the non-frontier firms are catching up with the frontier counterpart. Moreover, this is also supported by the greater growth rates relative to the average frontier firms over the same periods. Figure 56(b) also shows that the sources of the TFP growth for the non-frontier group were mainly originated from the positive growth in the technical change and the pure efficiency effects. Unlike the case of frontier firms, the average non-frontier firms however registered a declining trend in the scale efficiency effects, particularly in the 2018-2019.

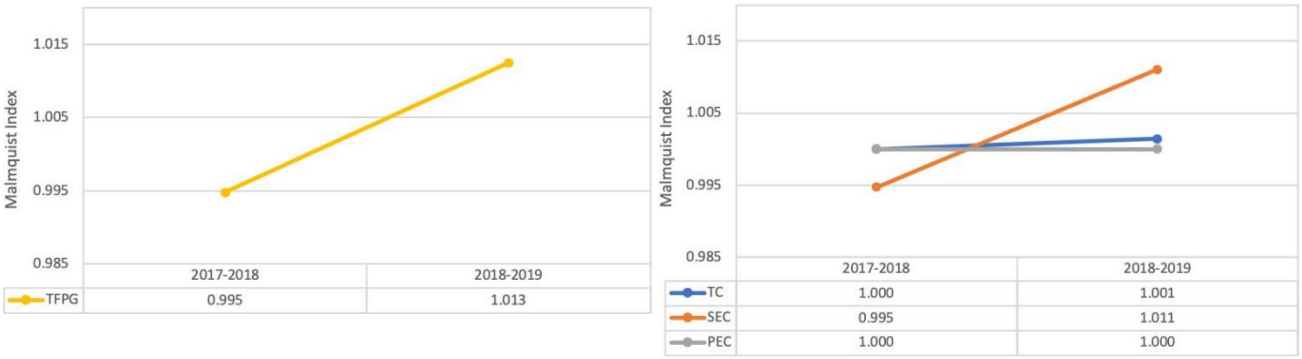


Figure 56(a): Retail and F&B Frontier firms productivity trends and decompositions

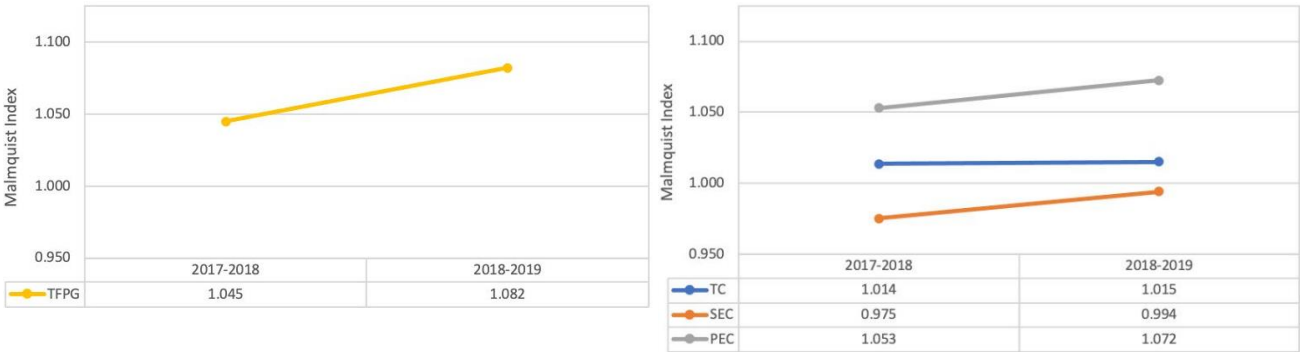


Figure 56(b): Retail and F&B Non-Frontier firms productivity trends and decompositions

Among the non-frontier firms, 60 percent of the firms recorded improvement in the overall productivity in 2017-2018 while the remaining registered negative growth. Among these, Atlan Holdings Bhd had recorded the most significant improvement relative to the others while Berjaya Food Bhd was among the least performers. Atlan Holdings Bhd continued registering a much greater TFP growth in 2018-2019 while Berjaya Food Bhd remained stagnant in terms of the productivity level.

Machinery &Equipment

A total of 39 firms are shortlisted from machinery and equipment subsector. Among these companies, two are under holding companies that are incorporated abroad. These are P.I.E. Industrial Bhd and Sam Engineering & Equipment Bhd. In addition, two companies are listed in the Mid 70 and the remaining are ranked 100 and above; based on market capitalization.

Market Capitalization

FTSE Bursa Malaysia KLCI index: 0
FTSE Bursa Malaysia Mid 70 index: 2
FTSE Bursa Malaysia Small Cap Index: 37

Foreign-based

Holding companies incorporated abroad: 2

39 Machinery & Equipment

AE MULTI HOLDINGS ATA IMS
BOILER MECH HOLDINGS CB INDUSTRIAL PRODUCT HLDG
CHIN WELL HOLDINGS CN ASIA CORP COMINTEL CORP
COMFORT GLOVES
DANCOMECH HOLDINGS
DUFU TECHNOLOGY CORP
EG INDUSTRIES EITA RESOURCES FIBON

FITTERS DIVERSIFIED
FOUND PAC GROUP GE-SHEN CORP
GLOBALTEC FORMATION GUH HOLDINGS
HO WAH GENTING JASA KITA
KOBAY TECHNOLOGY
K. SENG SENG CORP LUSTER INDUSTRIES MUAR BAN LEE GROUP
P.I.E INDUSTRIAL
RUBBEREX CORP SAM ENGIN & EQUIP

SARAWAK CABLE SKP RESOURCES SUCCESS TRANSFORMER CORP
TURBO MECH
UCHI TECHNOLOGIES
UNITED U-LI CORP UMS HOLDINGS
UMS -NEIKEN GROUP
UNIMECH GROUP V..S.
INDUSTRY WELLCAL HOLDINGS WONG ENGINEERING CORP

The Frontier Firms

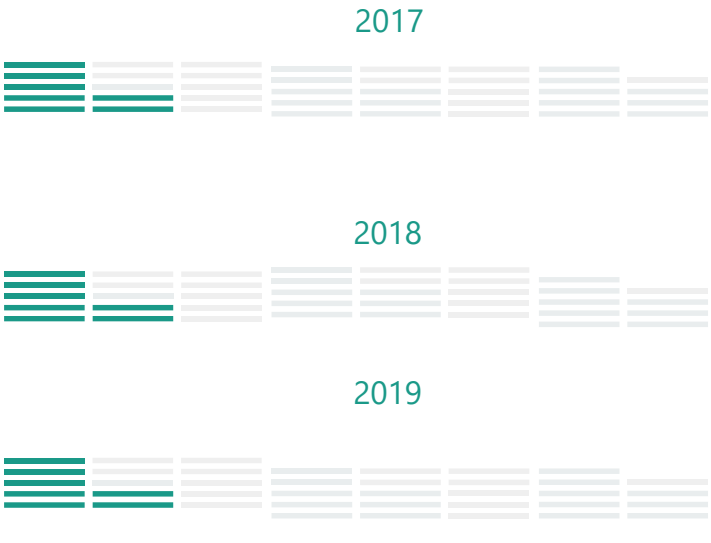


Figure 57: Number of firms on the frontier for Machinery & Equipment subsector by year

Analysis of the annual performance indicates that there were 7 firms that had been identified as the frontier firms for year 2017 and 2019, respectively. On the other hand, year 2018 saw a total of 9 firms identified as the frontier. The listing of the frontier firms is presented below:

Frontier Firms in 2017

CN ASIA CORPORATION
EITA RESOURCES
FIBON
V.S. INDUSTRY
DANCOMECH HLDGS
FOUND PAC GRP
HO WAH GENTING

Frontier Firms in 2018

CN ASIA CORPORATION
EITA RESOURCES
FIBON
V.S. INDUSTRY
DANCOMECH HLDGS
FOUND PAC GROUP
HO WAH GENTING DUFU TECHNOLOGY SKP RESOURCES

Frontier Firms in 2019

CN ASIA CORPORATION
EITA RESOURCES
FIBON
V.S. INDUSTRY
DANCOMECH HLDGS
FOUND PAC GRP
HO WAH GENTING BHD

The overview of technical efficiency scores and the frontier firms for 2017, 2018 and 2019 are illustrated in Figure 58. Overall, only 4 frontier firms were able to maintain their position

on the frontier between 2017 and 2019. The 4 firms that are consistently efficient are:

1. CN Asia Corporation Berhad
2. Eita Resources Berhad
3. Fibon Berhad
4. V.S. Industry Berhad

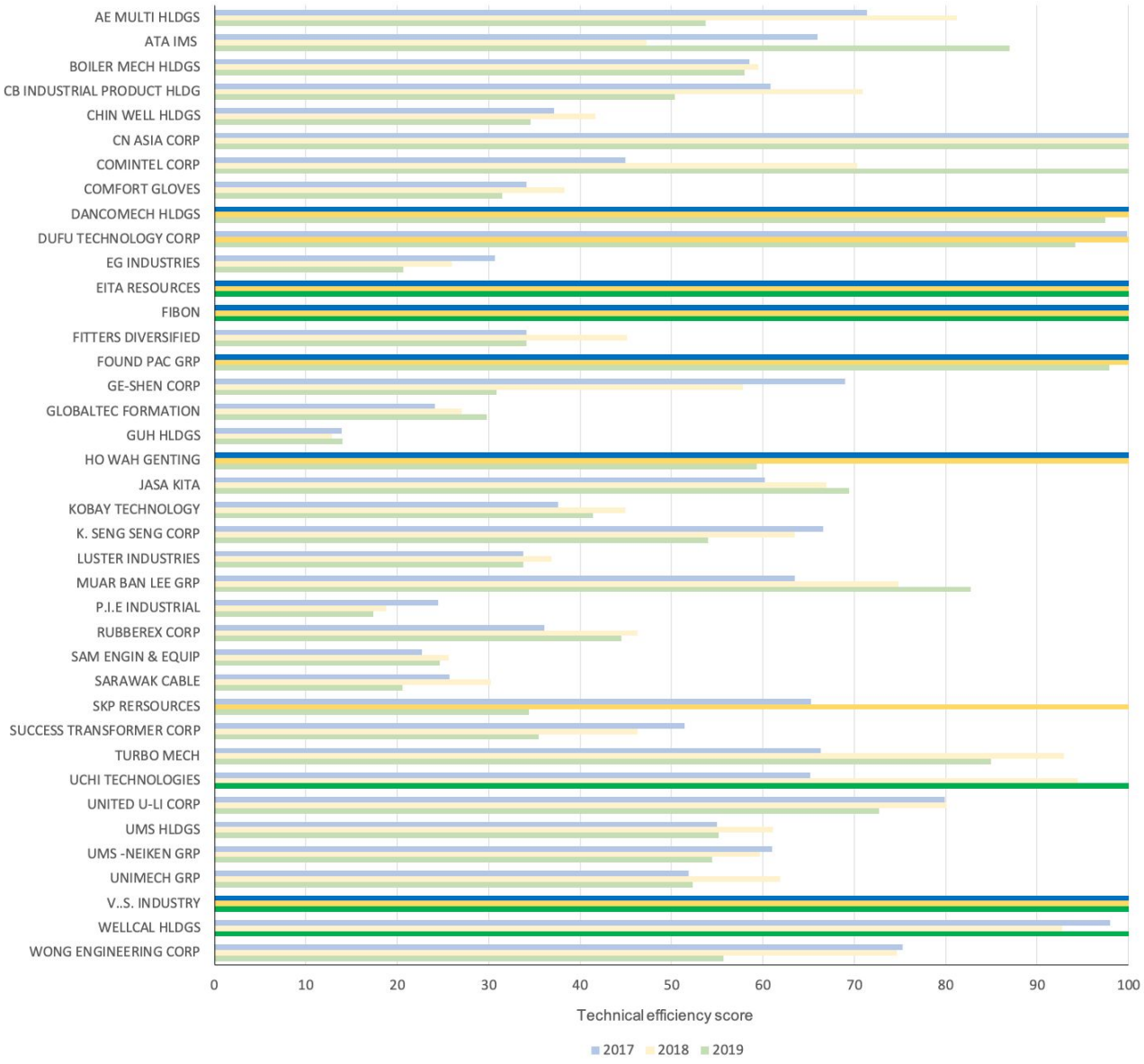


Figure 58: Machinery & Equipment technical efficiency score and frontier firms

Based on Figure 59, both V.S. Industry Bhd and Fibon Bhd had consistently ranked the top (1st ranking) and the bottom (4th ranking) among the 4 efficient firms from 2017 to 2019. Eita Resources Bhd and CN Asia Corporation, on the other hand, switched positions between the 2nd and 3rd ranking, alternately, between 2017 and 2019.

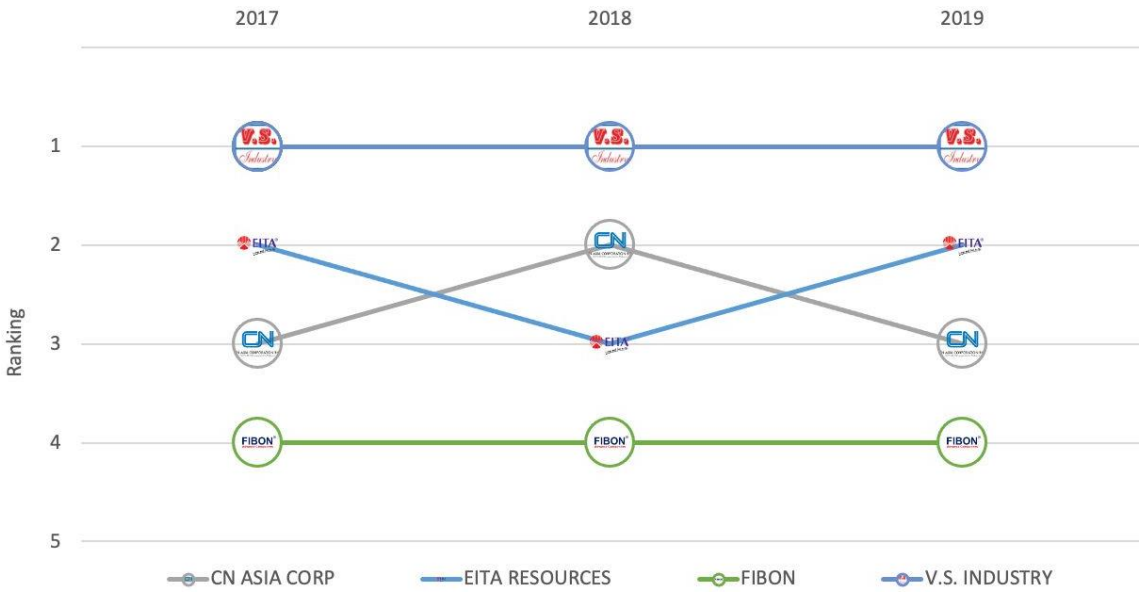


Figure 59: Machinery & Equipment frontier firms' ranking

The Non-Frontier Firms

The scores plotted in Figure 60 indicates the annual efficiency scores for every non-frontier firm from 2017 to 2019. The annually reported scores averaged at about the same percentage over time, specifically, 52.64 in 2017, 55.0 in 2018 and 50.85 in 2019. This implies an unhealthy practice because the firms in Machinery and Equipment subsector on average were utilising almost twice the amount of inputs required to produce the same level of outputs.

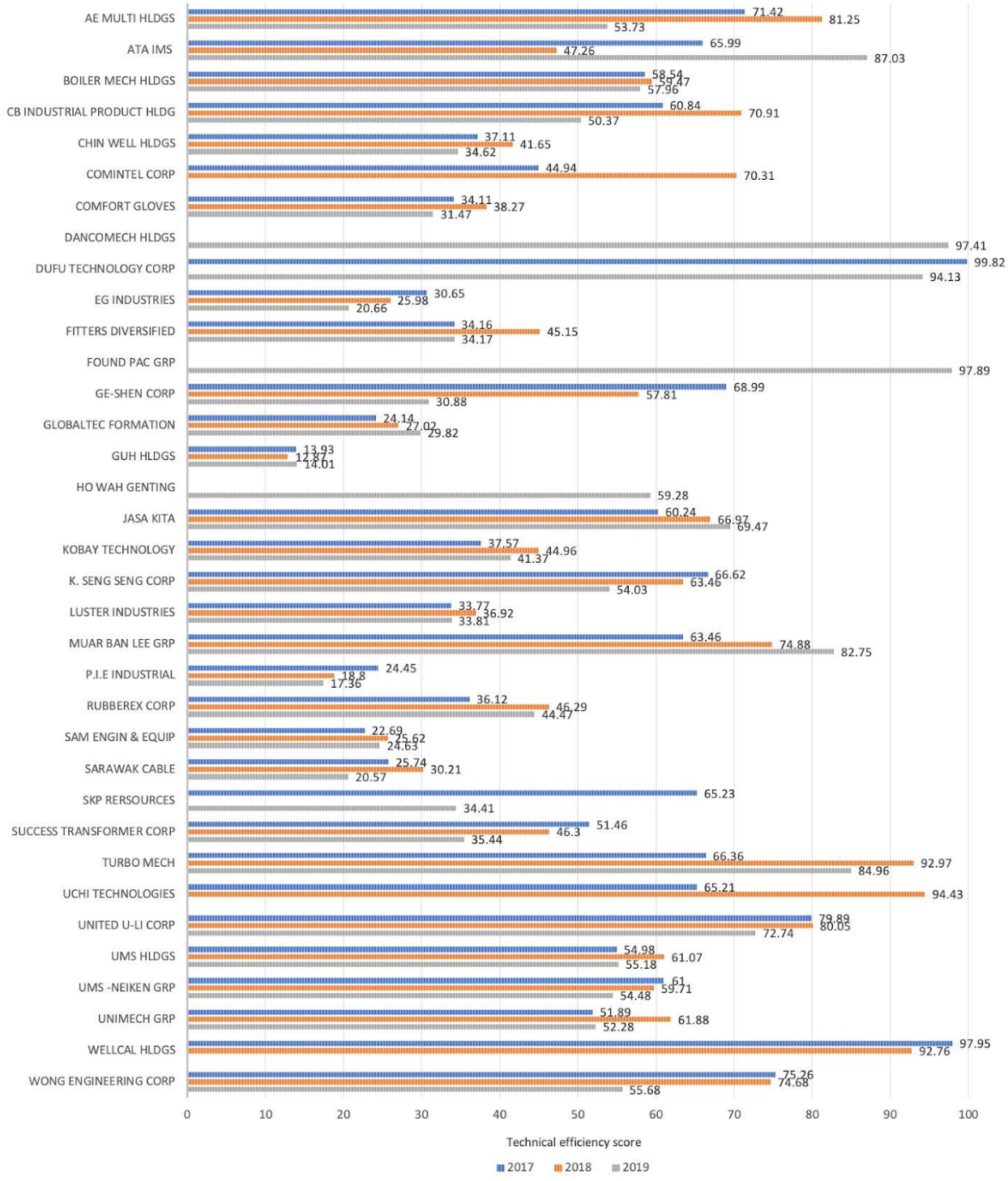


Figure 60: Machinery & Equipment technical inefficiency of the non-frontier firms

Focusing on a non-frontier firm with an average performance, Boiler Mech Holdings, for instance, the firm's performance had been fluctuating around 60 percent throughout the three different years. The lowest recorded performance was in 2019, rated at 57.96 percent efficient. This scoring implies that to be on the frontier, Boiler Mech Holdings needs to conserve its inputs consumption by 42.04 percent, or the firm should be operating at 57.96 percent of its existing inputs. The firm performance in the earlier years was slightly better such that the efficiency scores were 58.54 percent in 2017 and 59.47 percent in 2018.

The Benchmark Peers

With reference to the following Table 8, from a total of seven frontier firms for the Machinery and Equipment subsector in 2019, the most practical benchmark and role model for the non-frontier firms are CN Asia Corporation, followed by Eita Resources Bhd and Uchi Technologies Bhd. Although Uchi Technologies Bhd was not on the frontier in 2017 and was rated only 65.21 percent efficient, the firm however significantly improved its performance in 2018 to 94.43 percent before joining the frontier firm bandwagon in 2019. As the lambdas values in Table 8 illustrates, Uchi Technologies Bhd in 2019 had become an excellent benchmark and role model for majority of the non-frontier firms.

The Laggards

The overall movement of the bottom ranked or laggard firms in Machinery and Equipment subsector is quite unstable. Figure 61 presents the top laggards based on the technical efficiency score obtained by the respective firms from year 2017 to 2019. Despite being ranked as the bottom six, Globaltec Formation Bhd and Sam Engineering Equipment Bhd increased their rankings every consecutive year. On the other hand, EG Industries Bhd and P.I.E. Industrial Bhd recorded further deterioration in their respective 2017 rankings starting from year 2018.

	Non-frontier firms	CN	EITA	UCHI
1.	AE MULTI	(0.62)	(0.03)	(0.00)
2.	ATA IMS	(0.00)	(0.77)	(0.00)
3.	BOILER MECH	(0.32)	(0.03)	(0.65)
4.	CB INDUSTRIAL PRODUCT	(0.13)	(0.00)	(0.74)
5.	CHIN WELL	(0.00)	(0.13)	(0.87)
6.	COMFORT GLOVES	(0.66)	(0.24)	(0.10)
7.	DANCOMECH	(0.74)	(0.00)	(0.24)
8.	DUFU TECHNOLOGY CORP	(0.00)	(0.80)	(0.00)
9.	EG INDUSTRIES	(0.81)	(0.19)	(0.00)
10.	FITTERS DIVERSIFIED	(0.62)	(0.00)	(0.36)
11.	FOUND PAC	(0.71)	(0.00)	(0.14)
12.	GE-SHEN CORP	(0.00)	(0.11)	(0.00)
13.	GLOBALTEC FORMATION	(0.59)	(0.13)	(0.01)
14.	GUH HOLDINGS	(0.72)	(0.12)	(0.00)
15.	HO WAH GENTING	(0.00)	(0.05)	(0.00)
16.	JASA KITA	(0.39)	(0.00)	(0.00)
17.	KOBAY TECHNOLOGY	(0.00)	(0.20)	(0.00)
18.	K. SENG SENG	(0.66)	(0.08)	(0.00)
19.	LUSTER INDUSTRIES	(0.61)	(0.13)	(0.00)
20.	MUAR BAN LEE	(0.35)	(0.07)	(0.58)
21.	P.I.E INDUSTRIAL	(0.00)	(0.17)	(0.00)
22.	RUBBEREX	(0.43)	(0.28)	(0.00)
23.	SAM ENGIN & EQUIP	(0.00)	(0.57)	(0.00)
24.	SARAWAK CABLE	(0.00)	(0.18)	(0.00)
25.	SKP RERSOURCES	(0.00)	(0.99)	(0.00)
26.	SUCCESS TRANSFORMER	(0.00)	(0.43)	(0.00)
27.	TURBO MECH	(0.92)	(0.00)	(0.06)
28.	UNITED U-LI	(0.65)	(0.00)	(0.29)
29.	UMS HOLDINGS	(0.69)	(0.00)	(0.20)
30.	UMS -NEIKEN	(0.61)	(0.04)	(0.00)
31.	UNIMECH	(0.08)	(0.41)	(0.51)
32.	WONG ENGINEERING	(0.25)	(0.03)	(0.00)

Notes:
Figures in parentheses are Lambda values

Table 8: Machinery & Equipment Non-Frontier firms' peers for 2019

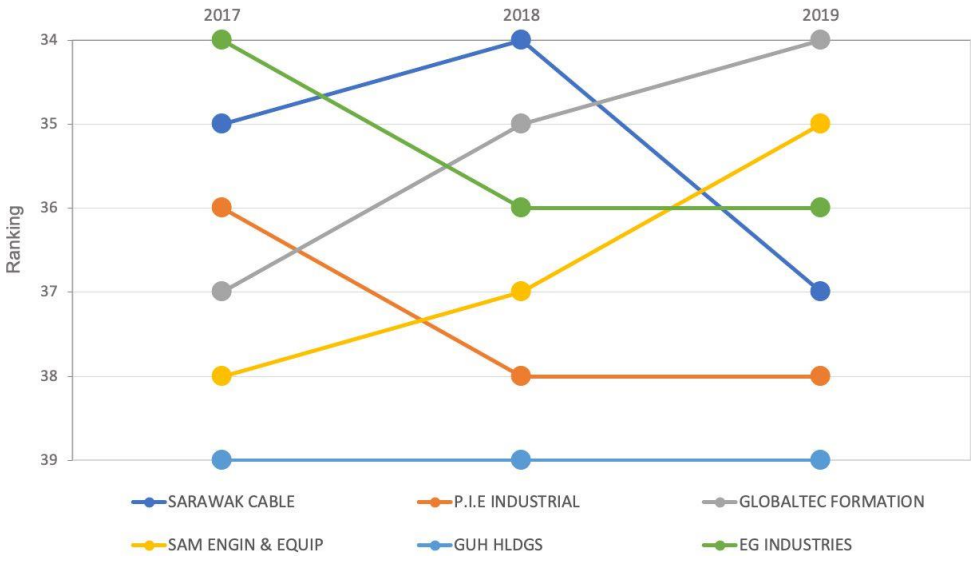


Figure 61: Machinery & Equipment subsector laggards

The improvement targets for inefficient firms to become efficient based on the practice of frontier firms in 2019 is presented in Figure 62 next. Considering Sam Engineering & Equipment Bhd as an example, the firm is recommended to slash its overall input to almost 80 percent of current utilisation to be fully efficient based on the practice of its primary benchmark peer, Eita Resources Bhd. Precisely, the firm needs to reduce total assets by 77.46 percent, total equity by 77.34 percent and wages & salaries by 75.37 percent to become a frontier firm in Machinery and Equipment subsector.

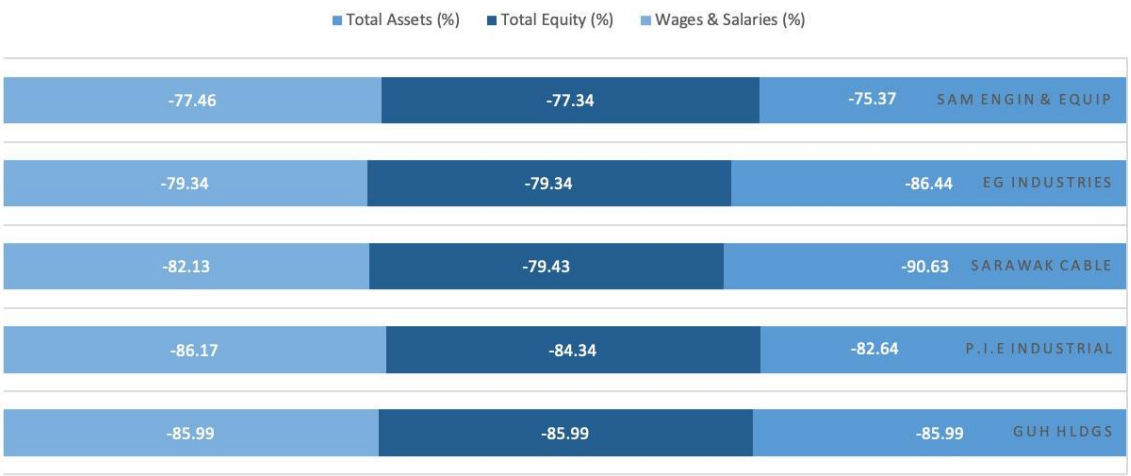


Figure 62: Targets for Machinery & Equipment subsector laggards (2019)

The Productivity Trends

The overall Machinery and Equipment subsector saw a slower positive TFP growth over the period of 2017-2019 from 4.7 percent to 3 percent (Figure 63(a)). The slower growth in TFP was mainly contributed by the decline in the technical change and the scale effects that recorded a negative rate of growth, particularly for period 2018-2019.

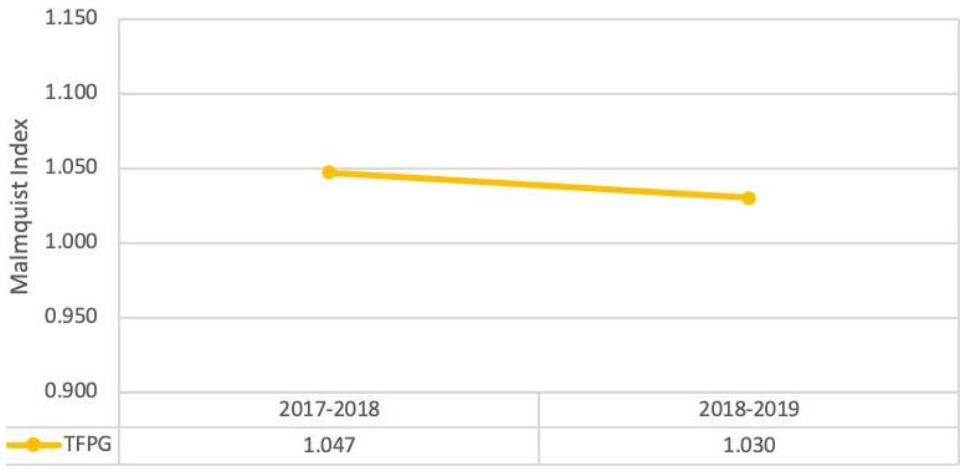


Figure 63(a): Machinery & Equipment productivity trends

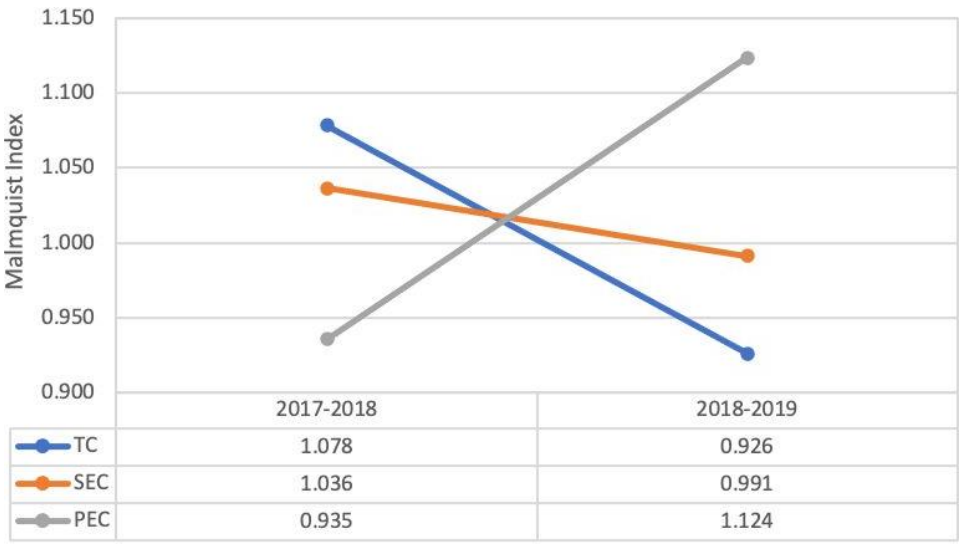


Figure 63(b): Machinery & Equipment productivity decomposition

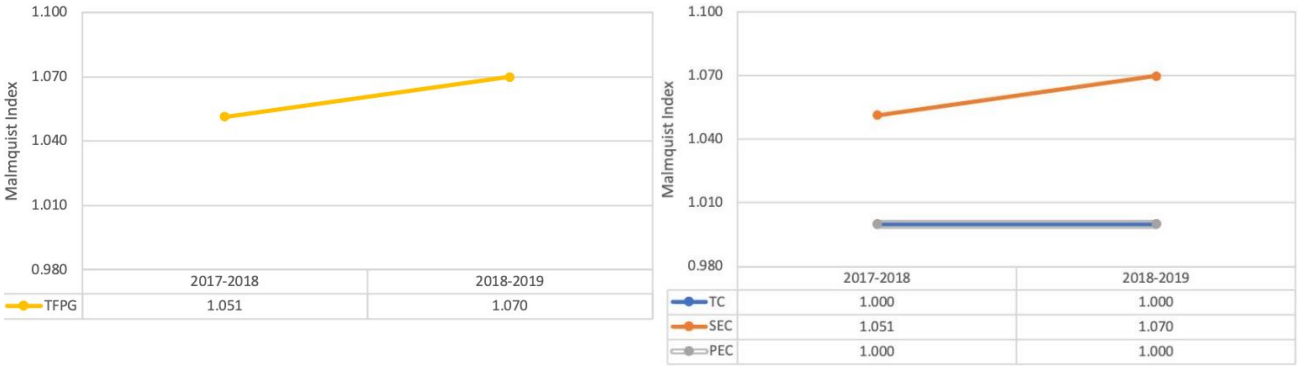


Figure 64(a): Machinery & Equipment Frontier firms productivity trends and decompositions

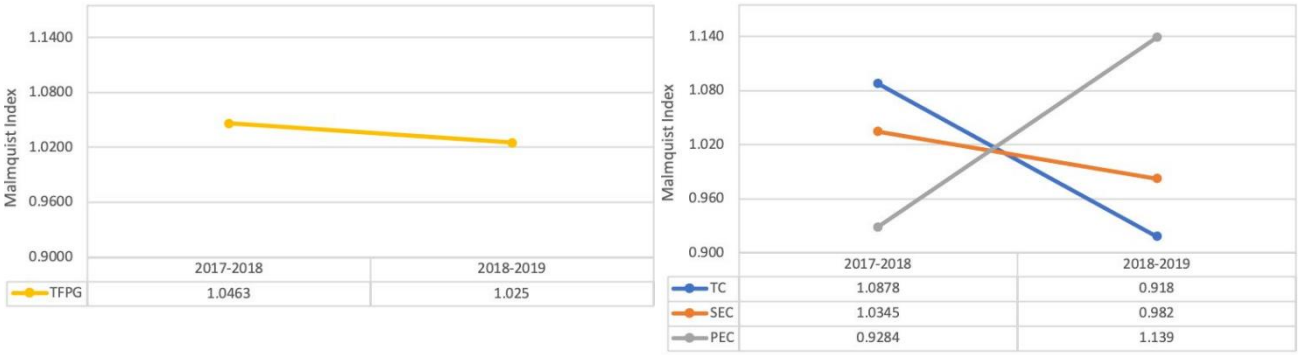


Figure 64(b): Machinery & Equipment Non-Frontier firms productivity trends and decompositions

Figure 64(a) and 64(b) illustrate the productivity trends based on the average productivity change in frontier firms and non-frontier firms. On average, the productivity growth of both groups recorded positive TFP trends. Nevertheless, the non-frontier firms recorded much slower positive growth over time. For the frontier firms, the positive growth of TFP in the later stage was dominated by the scale efficiency. Unlike the non-frontier group, the main contributor to the TFP growth was an improvement in the pure efficiency.

Productivity comparison between firms indicates that over the period of 2017 to 2019, on average, GE Shen Corporation performed significantly better relative to other firms with a recorded improvement of around 57 percent. The Comintel Corporation on the other hand, recorded the highest average declining trend in TFP of about 42 percent over the same period.

Professional Services

There are 21 firms that have been shortlisted and categorised under the Professional Services subsector. Based on market capitalization, one firm is listed in the top Mid 70 index which is Astro Malaysia Holdings Berhad. The remaining 20 companies are ranked 100 and above. George Kent (Malaysia) Berhad is the only company within the list with the holding company incorporated abroad.

Market Capitalization

FTSE Bursa Malaysia KLCI index: 0
FTSE Bursa Malaysia Mid 70 index: 1
FTSE Bursa Malaysia Small Cap Index: 20

Foreign-based

Holding companies incorporated abroad: 1

21 Professional Services

AWC BERHAD
UEM EDGENTA BERHAD JCB
NEXT BERHAD PJBUMI
BERHAD
ASIA MEDIA GROUP ASTRO
MALAYSIA MEDIA PRIMA
BERHAD

PELANGI PUBLISHING
SASBADI HOLDINGS SENI
JAYA CORP STAR MEDIA
GROUP
ADVANCECON HOLDINGS
BREM HOLDING ECONPILE
HOLDINGS

GDB HOLDINGS GEORGE
KENT (M'SIA) HOCK SENG
LEE
IREKA CORP
MELATI EHSAN HOLDINGS
PROTASCO
ZECON

2017	4	out of 21 firms were on the efficient frontier
2018	5	out of 21 firms were on the efficient frontier
2019	5	out of 21 firms were on the efficient frontier

Figure 65: Number of firms on the frontier for Professional Services subsector by year

The Frontier Firms

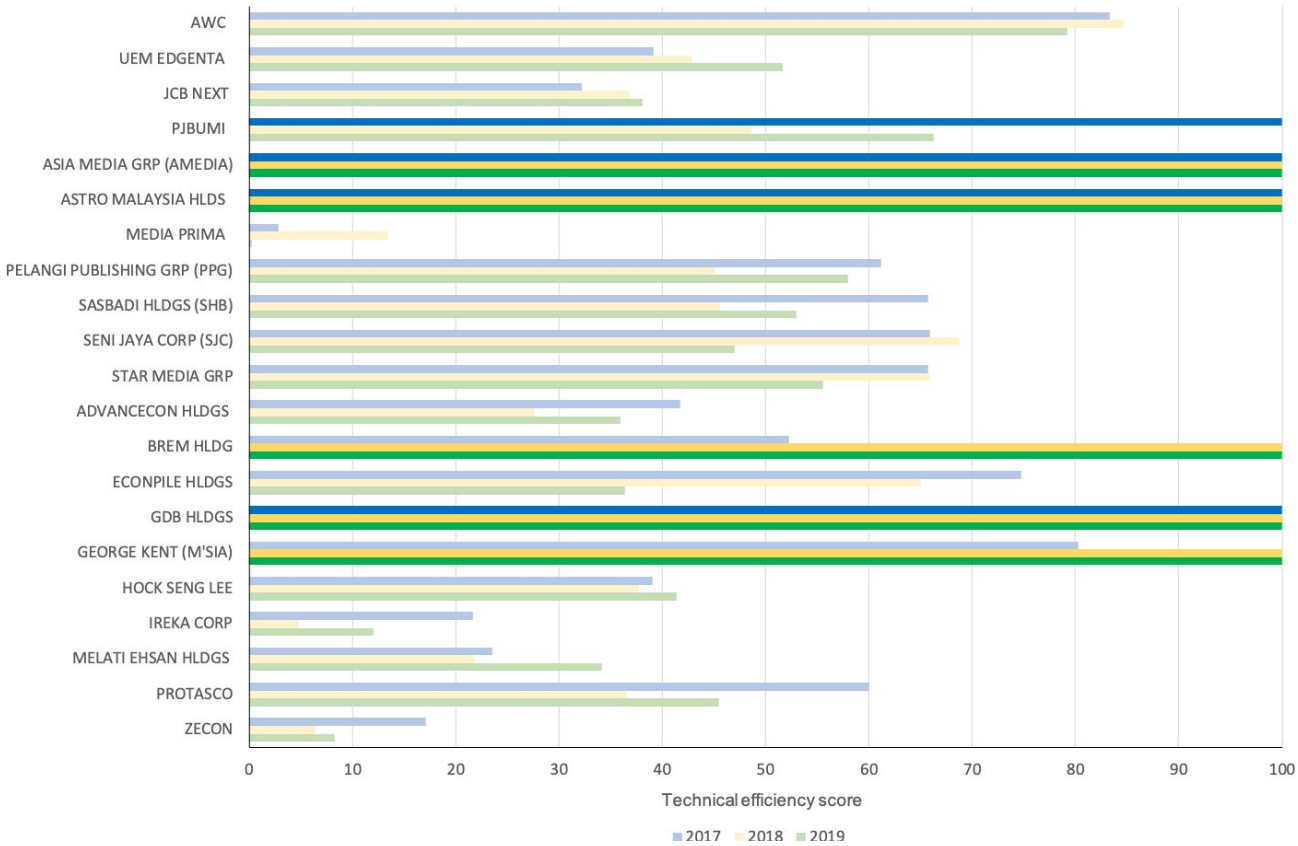


Figure 66: Professional Services technical efficiency score and frontier firms

Figure 66 presents the technical efficiency scores and the frontier firms for the three consecutive years, 2017-2019. Analysis of the annual performance indicates that there were 4 firms that had been identified as the frontier firms for year 2017. On the other hand, year 2018 and 2019 saw the number of frontier firms increased to 5. The listing of the frontier firms is as follows::

Frontier Firms in 2017

ASIA MEDIA GROUP
ASTRO MALAYSIA
GDB HOLDINGS
PJBUMI

Frontier Firms in 2018

ASIA MEDIA GROUP
ASTRO MALAYSIA GDB
HOLDINGS BREM
HOLDINGS GEORGE
KENT (M'SIA)

Frontier Firms in 2019

ASIA MEDIA GROUP
ASTRO MALAYSIA GDB
HOLDINGS BREM
HOLDINGS GEORGE
KENT (M'SIA)

The count of frontier firms for Professional Services subsector between 2017 and 2019 increased from 4 to remained at 5 firms in the more recent years. Over the period of 2017-2019, only 3 firms had been consistently rated as frontier firms for the Professional Services subsector:

1. Asia Media Group Berhad
2. Astro Malaysia Holdings Berhad
3. GDB Holdings Berhad

Among the three firms that continuously were on the frontier for the period of 2017-2019, Astro Malaysia Holdings was the only firm that sustained its ranking in the Professional Services subsector (Figure 67). Asia Media Group (AMEDIA) climbed from the 3rd ranking in 2017 to the 2nd and subsequently maintain the rank. In contrast, GDB Holdings declined from its 2nd ranking in 2017 to the 3rd ranking in 2018 and 2019.

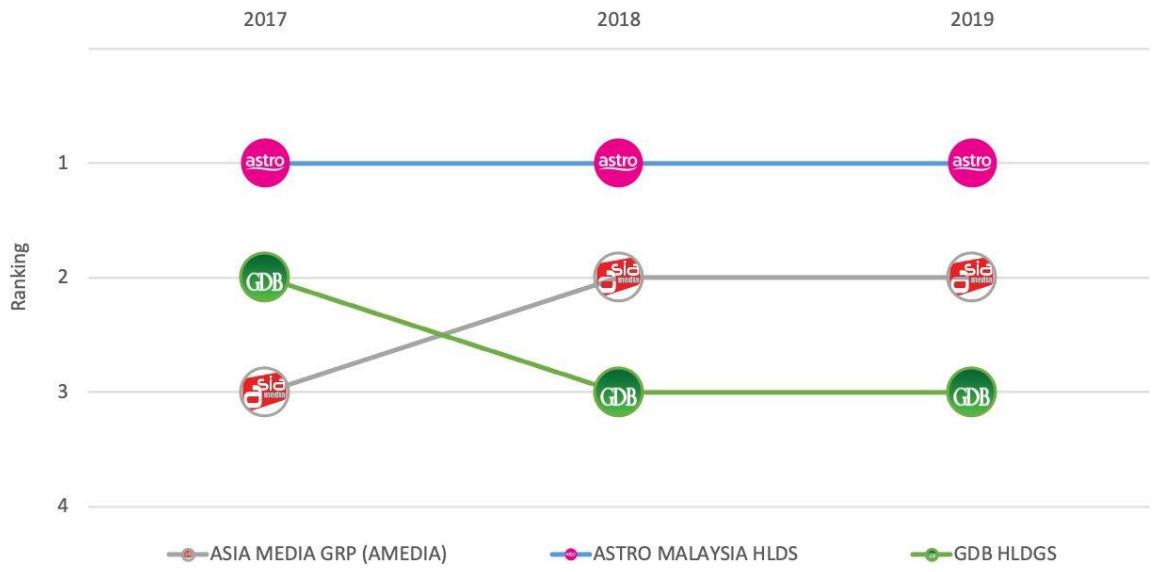


Figure 67: Professional Services frontier firms' ranking

The Non-Frontier Firms

As summarised in Figure 68, the overall technical efficiency score for the non-frontier firms averaged at 48.61 in 2017, 40.73 in 2018, and 41.40 in 2019. The scores indicate that on average, the non-frontier firms should be operating at about two-fifth lesser than the reported amount of inputs to produce the given output level. Moreover, among those rated as the non-efficient: (i) two of them leapt onto the frontier in 2018 and remained until 2019 including Brem Holdings and George Kent Malaysia Bhd; (ii) two of them consistently improved performance including UEM Edgenta Bhd and JCB Next Bhd; (iii) 12 of them had fluctuating performance whilst the remaining had a successive declining performance including Econpile Holdings and Zecon Bhd.

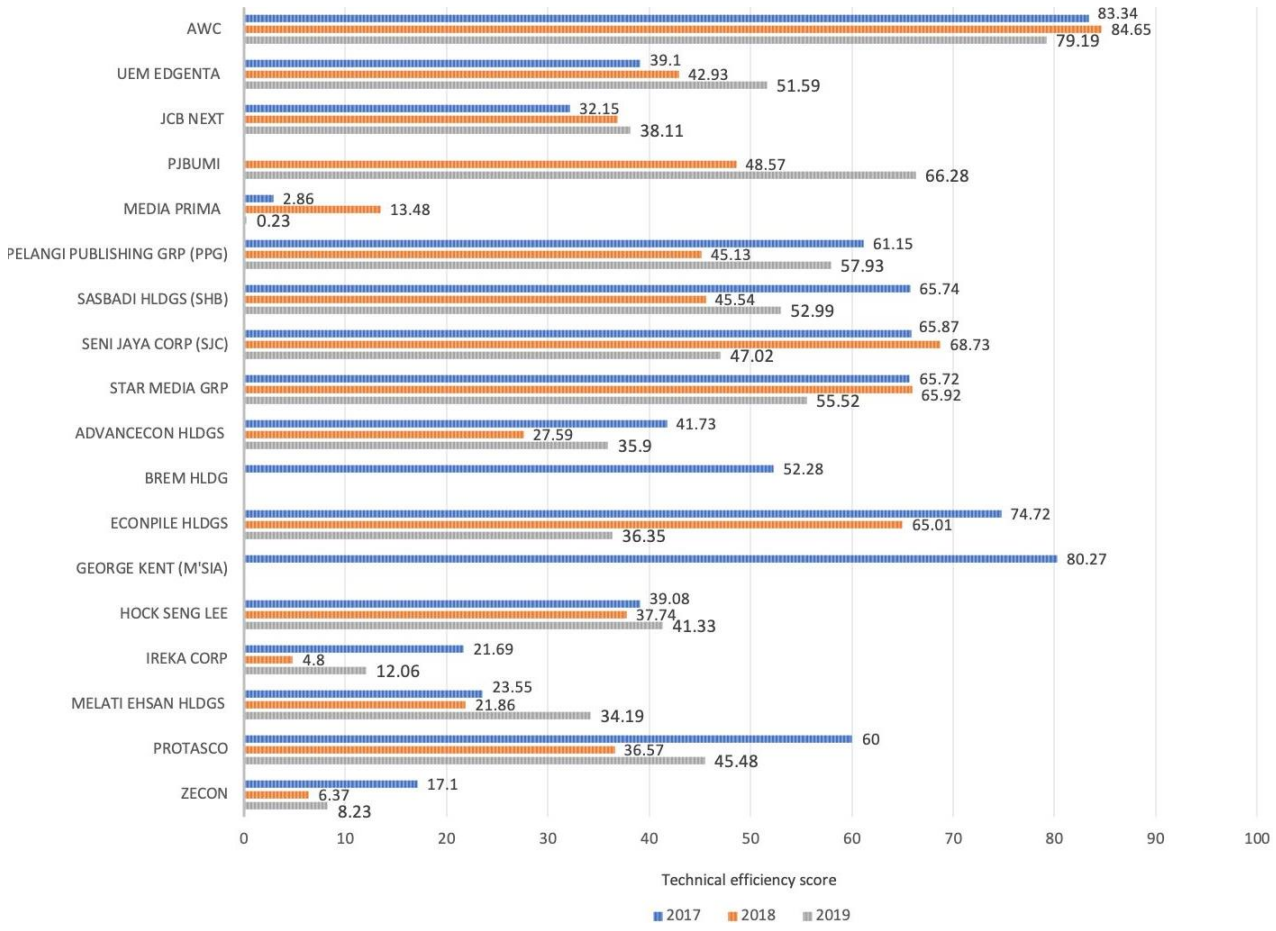


Figure 68: Professional Services technical inefficiency of the non-frontier firms

The UEM Edgenta Bhd for instance was rated 39.1 percent efficient in 2017, 42.93 percent efficient in 2018 and 51.59 percent efficient in 2019. The improvement in its efficiency score throughout the periods implies that UEM Edgenta Bhd managed to improve its input utilisation gradually. Based on the practice of its benchmark, for UEM Edgenta to become efficient, the firm needed to reduce its input consumption by 60.9 percent in 2017, by 57.07 percent in 2018 and 48.41 percent in 2019. Again, the declining improvement targets required by UEM Edgenta over time means that the firm had improved its performance over time.

The Benchmark Peers

Table 9 presents the lambda values as a measure of feasible benchmark peers for the non-frontier firms in 2019. Based on the number of frequency and values of lambdas, the ideal benchmark for Professional Services subsector would be Asia Media Group for the majority of the non-frontier firms. Besides, the Asia Media Group almost solely referenced in setting improvement targets for AWC Bhd, PJ Bumi Bhd, Pelangi Publishing Group (PPG), Sasbadi Holdings (SHB), Star Media Group, Advancecon Holdings and Ireka Corporation. All these listed firms were having high values of lambdas with reference to the Asia Media Group.

On the other hand, the GDB Holdings was the practical benchmark peer for only half of the non-frontier firms. These were, PJBumi Bhd, Seni Jaya Corporation, EconPile Holdings, Hock Seng Lee Bhd, Ireka Corporation, Melati Ehsan Holdings, Protasco Bhd and Zecon Bhd. Moreover, the lambda values for half of these firms were less than 0.20, that implies lesser importance as a yardstick benchmark relative to the Astro Malaysia Holdings and Asia Media Group.

	Non-frontier firms			
1.	AWC	(0.95)	(0.05)	(0.00)
2.	UEM EDGENTA	(0.76)	(0.24)	(0.00)
3.	JCB NEXT	(0.89)	(0.00)	(0.00)
4.	PJBUMI	(0.97)	(0.00)	(0.01)
5.	MEDIA PRIMA	(1.00)	(0.00)	(0.00)
6.	PELANGI PUBLISHING	(0.99)	(0.01)	(0.00)
7.	SASBADI HOLDINGS	(0.98)	(0.02)	(0.00)
8.	SENI JAYA CORP	(0.87)	(0.00)	(0.13)
9.	STAR MEDIA GROUP	(0.91)	(0.09)	(0.00)
10.	ADVANCECON HOLDINGS	(0.98)	(0.02)	(0.00)
11.	ECONPILE HOLDINGS	(0.44)	(0.02)	(0.54)
12.	HOCK SENG LEE	(0.00)	(0.00)	(0.60)
13.	IREKA CORP	(0.92)	(0.01)	(0.08)
14.	MELATI EHSAN HOLDINGS	(0.58)	(0.00)	(0.38)
15.	PROTASCO	(0.42)	(0.06)	(0.52)
16.	ZECON	(0.83)	(0.00)	(0.15)

Notes:
Figures in parentheses are Lambda values

Table 9: Professional Services non-frontier firms' peers for 2019

The Laggards

The shift in the ranking of the five most laggard firms in Professional Services subsector is generally unstable. Figure 69 illustrates the bottom ranked firms for year 2017 to 2019. A total of 6 firms were inconsistently ranked as the bottom five based on their efficiency scores for 2017, 2018 and 2019. Over these years, Melati Ehsan Holdings remained as the bottom 4th, whereas Zecon Bhd remained as the 2nd least efficient firm. JCB Next Bhd managed to improve its efficiency since 2018 and was excluded from the top laggards thereon. In contrast, although Media Prima Bhd had improved its ranking in 2018, their position deteriorated in 2019.

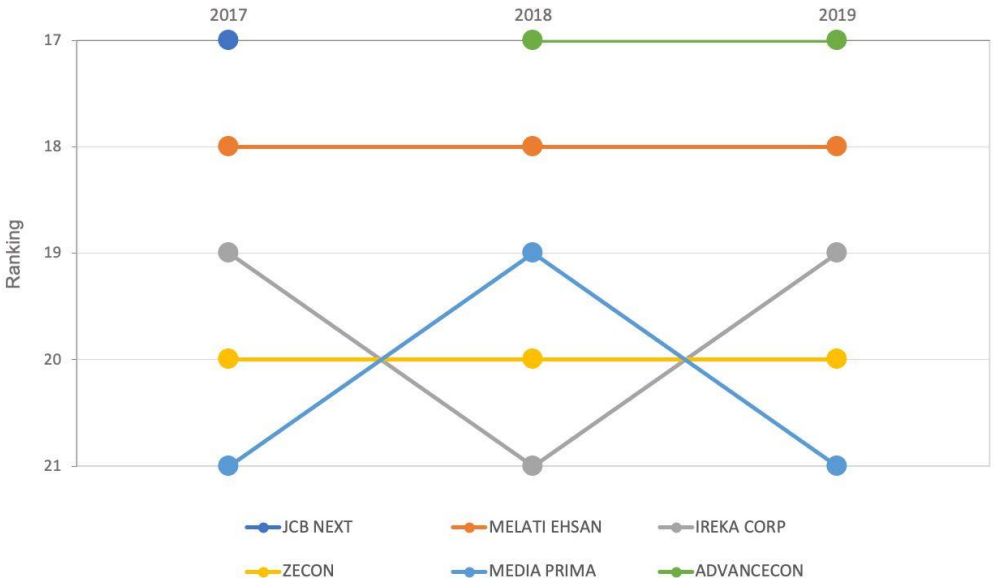


Figure 69: Professional Services subsector laggards

Figure 70 denotes the proposed reduction in inputs for the five most laggard firms in 2019 in order to replicate the best practice of relevant frontier firms in Professional Services subsector. The improvement targets for Advancecon Holdings relative to its benchmark peer, Asia Media Group for example, requires reduction by 64.1 percent of total assets, reduction by a massive 93.74 percent of total equity and 70.24 percent of wages & salaries. This target would enable the Advancecon Holdings to maintain its input-output ratio and achieve the same level of existing output.

Figure 70: Targets for Professional Services subsector laggards (2019)

The Productivity Trends

The overall Professional Services subsector saw a positive TFP growth over the period of 2017-2019 from 1.4 percent to 12.6 percent (Figure 71(a)). The significant growth in TFP was mainly contributed by the continuous improvement in the pure efficiency change that recorded positive growth of 11.7 percent and 10.7 percent for 2017-2018 and 2018-2019, respectively.

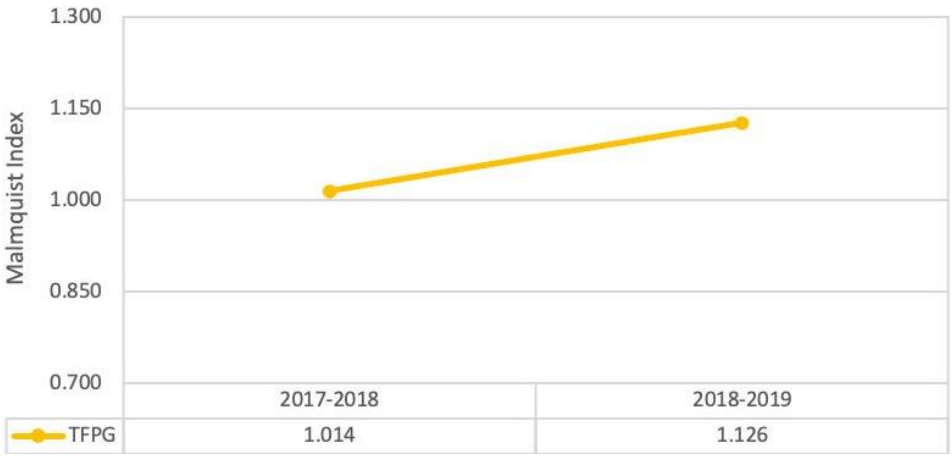


Figure 71(a): Professional Services productivity trends

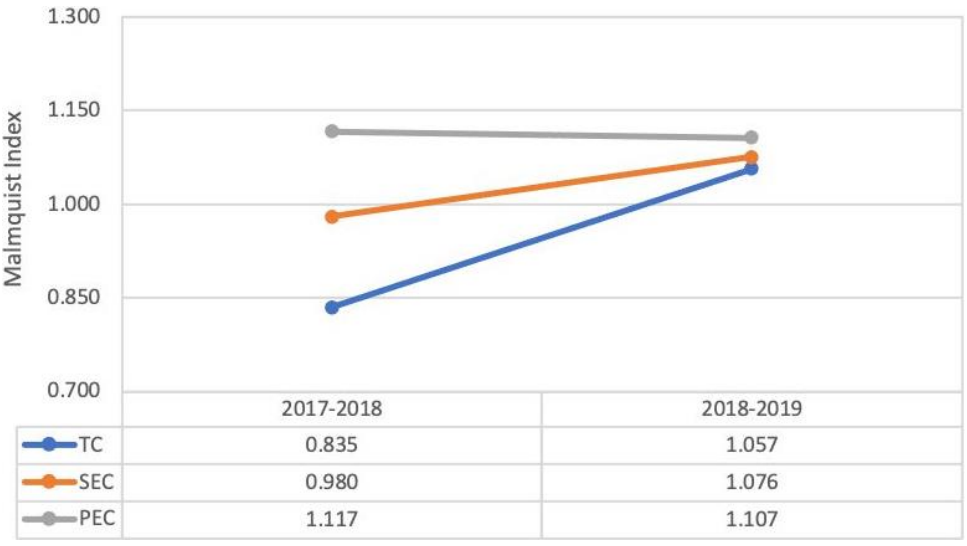


Figure 71(b): Professional Services productivity decomposition

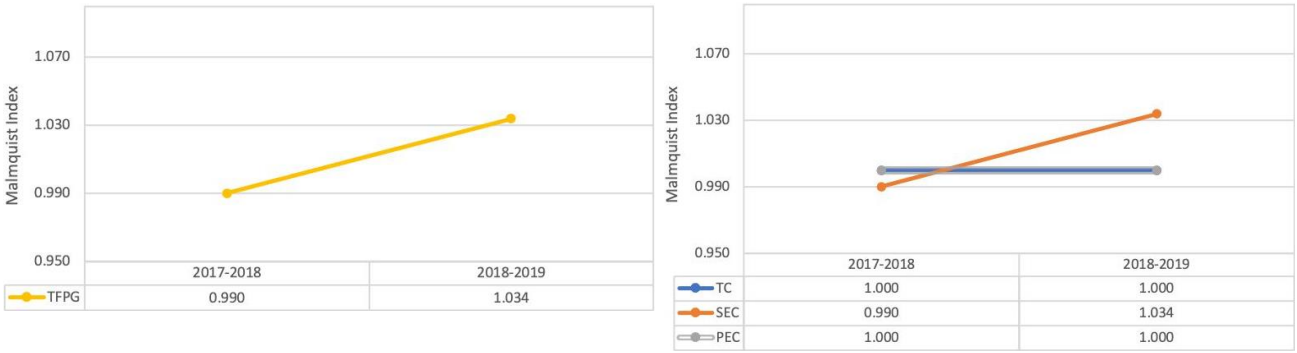


Figure 72(a): Professional Services Frontier firms productivity trends and decompositions

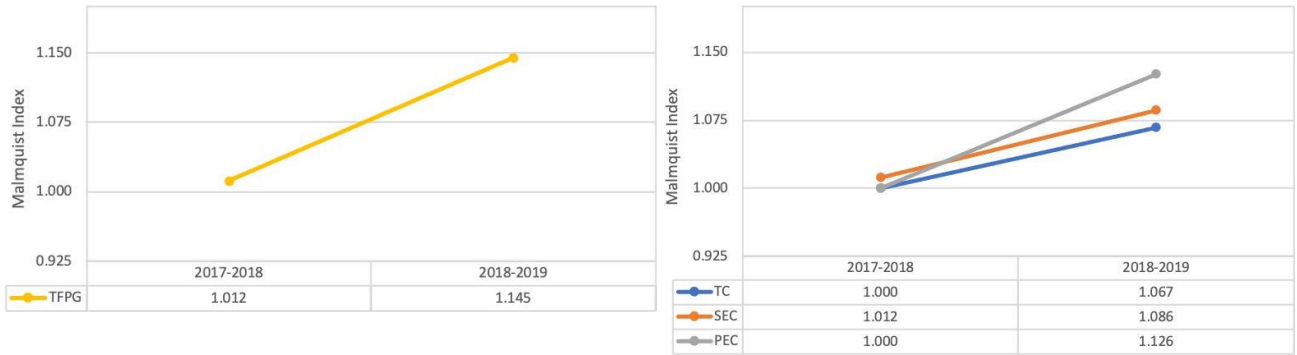


Figure 72(b): Professional Services Non-Frontier firms productivity trends and decompositions

Figure 72(a) and 72(b) illustrate the average productivity trends based on the frontier firms and the non-frontier firms. On average, the productivity growth of the non-frontier firms were catching up progressively againsts the frontier firms for both periods, 2017-2018 and 2018-2019. Unlike the non-frontier firms, the frontier group however recorded a deterioration of TFP by 1 percent in 2017-2018.

The productivity comparison between firms indicates that over the period of 2017 to 2019, on average, Econpile Holdings and Seni Jaya Corporation performed significantly better relative to other firms in terms of productivity growth rate. The Brem Holdings and JCB Next Bhd on the other hand, recorded the greatest fall in the TFP trend over the same period.

Conclusion

A more in-depth insight into the practice of the frontier firms is useful for several reasons. First, the frontier firms directly contribute to propelling the sectoral productivity to a greater height that later manifested to substantial economic growth. Secondly, the frontier firms productivity bring upon trickle-down effects through the diffusion of new technologies and noble business practices to the immediate subsector and the overall economy. Indirectly, this resulted in greater opportunities for non-frontier firms to learn and assimilate the best practices of their role model peers for better productivity outcomes.

All in all, this particular study accomplished three main objectives:

1. Identification of the frontier and non-frontier firms for benchmarking purposes

   The frontier firms, according to subsector, have been identified based on their technical efficiency scores' performance and productivity trends have been analysed over three-year intervals. Their robustness in becoming a benchmark for the non-frontier firms have also been explored. Further, firm-specific benchmark peer(s) has been identified for firms evaluated as the non-efficient to improve their performance at their prevailing operating scale.

2. Decompositions of productivity level and growth

   The analyses of productivity trends have been presented and compared between the frontier and non-frontier groups for each priority subsectors. The productivity change was further decomposed into technical change, pure efficiency change and scale efficiency change to provide justifications for the sources of growth experienced over time.

3. Identification of resource misallocation at the firm-level

   For the non-frontier firms and laggard firms, improvement potentials have been measured, and reduction in input consumption have been recommended. The firms are expected to be able to increase efficiency pertaining to current resource utilisation without affecting their respective output production volume and needing to revamp their transformation process significantly. The customised targets derived by hypothetically replicate the practice of firm-specific benchmark peers henceforth deemed feasible.

The major findings of the analyses for every subsector are deliberated according to the five research deliverables:

a) The frontier firms: The count and pattern of frontier firms performance over time has been analysed and adopted as a yardstick in setting achievable improvement targets for the non-frontier firms. In general, 18% is the lowest, and 67% is the highest proportion of frontier firms found in a subsector between 2017 and 2019.

b) The non-frontier firms: For firms identified as inefficient, their technical efficiency scores suggest a possible reduction in current composite input consumption without compromising the current level of outputs to render them efficient.

   The lowest yearly average efficiency score was recorded by Professional Services subsector; 48.61 in 2017, 40.73 in 2018, and 41.40 in 2019.

   The highest yearly average efficiency score was recorded by Tourism subsector, which also had a more stable overall performance; 64.52 in 2017, 66.26 in 2018 and 62.71 in
   2019.

   The Agro Food subsector, nonetheless, had declining yearly average efficiency score; 80.79 in 2017, reduced to 63.99 in 2018 then further reduced to 56.30 in 2019.

c) The benchmark peers: The importance of peers to a particular non-frontier firm is calculated and presented as lambda values. The recommended peers would have similar composite inputs to output ratio to that of non-frontier firms being matched.

The most frequently cited peers with significant lambdas according to subsector are Pan Malaysia Holdings for Tourism; FSBM Holdings for Electrical & Electronics; Petronas Chemicals Group and Samchem Holding for Chemicals & Chemical Products; Aturmaju Resources Bhd for ICT; Amway (Malaysia) Holding for Retail and Food & Beverages; CN Asia Corporation for Machinery & Equipment; and Asia Media Group for Professional Services.

d) The laggards: For every inefficient firm, improvement targets to become efficient are recommended to hypothetically replicate their individual benchmark peers.

In summary, 19% is the lowest, and 55% is the highest proportion of non-frontier firms ranked as the bottom five for a subsector, at least once although not consistently grouped into the cluster according to years between 2017 and 2019.

e) The productivity trends: The efficiency performance between two adjacent periods have been analysed for the overall subsector, frontier and non-frontier firms. Productivity change was further decomposed into sources of productivity components that are technical efficiency, pure efficiency and scale efficiency.

Drawing on the analysis of productivity growth in accordance with subsector, the pattern of productivity change could be classified into three clusters:

a) Productivity change from negative growth in 2017/2018 to positive growth in 2018/2019; the case for Tourism and Chemicals & Chemical Products.
b) Productivity growth at an increasing rate between 2017/2018 and 2018/2019: the case for Retail and Food & Beverage; and Professional Services.
c) Productivity growth at a declining rate between 2017/2018 and 2018/2019: the case for Electrical and Electronics; ICT; Agro; and Machinery and Equipment.

Figure 73 summarizes the productivity trends for the 8 subsectors considered for this study as well as the firms that are consistently on the frontier over the period of 2017 to 2019.

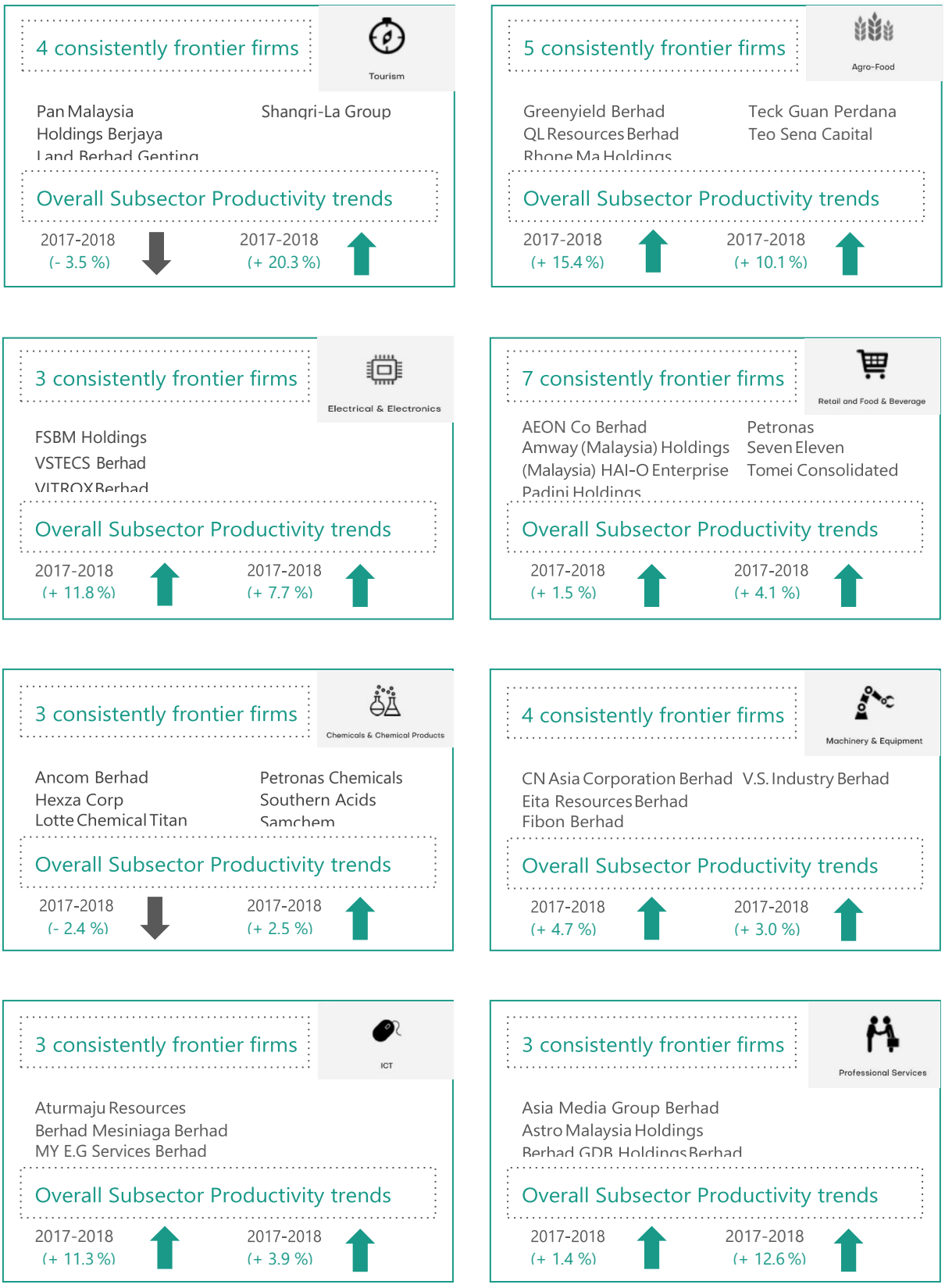


Figure 73: Summary of consistently frontier firms and productivity trends (2017-2019)

In summary, there are few other general observations which could be deduced from this study that are worth highlighting:

1. Firms generally stay on the frontier for a short time and inherently unstable over the period 2017 to 2019. The only subsector that consistently had similar firms performing as the frontier over the period is Agro Food. The other subsectors, however, recorded little volatility with the majority of the subsectors recorded a lesser number of frontier firms as compared to the earlier years.
2. Among eight different subsectors, the highest volatility in efficiency and productivity across different years (2017-2019) was recorded by Electrical and Electronics and Machinery and Equipment subsectors. On the other hand, Retail and Food & Beverage subsector registered a relatively consistent pattern throughout 2017 to 2019.
3. In five subsectors, namely Electrical and Electronics; ICT; Agro Food; Retail and Food & Beverage; and Professional Services, the average productivity trends for the non-frontier firms were catching-up against the frontier firms. However, for the Chemicals and Chemical Products; and Machinery and Equipment subsectors, the productivity gap between the frontier and the non-frontier firms were widening throughout the 2017 to 2019. For Tourism subsector on the other hand, the performance between the frontier and non-frontier firms were relatively stable over the same period.
4. The main sources of productivity growth over the period of 2017 to 2019 were significantly different among subsectors. While Tourism subsector gained tremendously from the improvement in scale efficiency in more recent years, other subsectors, however, recorded a more moderate positive growth. The only exception, in this case, was the Machinery and Equipment subsector which recorded negative growth in 2018-2019. It was different for the case of Electrical and Electronics in which the technical change dominantly contributed the productivity growth. On the other hand, the Chemicals and Chemical Products

subsector continuously recorded declining trend (negative growth) in pure efficiency for 2017 to 2019. The same was true for the ICT, and Electrical and Electronics subsectors for 2018-2019 wherein the latter has however seen a relatively much larger dropped.

Overall, the process of performance measurement has the value of identifying performance variations, and hence providing encouragement and direction for productivity improvement. The necessity of productivity for achieving sustainable growth demands future studies and complementary analysis to explore the underlying operational productivity drivers further. This process shall be supported and supplemented with a heightened awareness of data management at all levels to enhance further the ability to measure productivity performance.

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