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Article

Measuring technical efficiency of state-owned enterprises in Asia Pacific and European regions: a data envelopment analysis

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Measuring technical efficiency of state-owned enterprises in Asia Pacific and European regions: a data envelopment analysis

Suraya Adnan^a, Nurazilah Zainal^b , Bany Ariffin Amin Noordin^a, Fakarudin Kamarudin^a and Jalila Johari^a

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ABSTRACT

This paper assesses the efficiency of the State-Owned Enterprise (SOE) in Asia-Pacific and European regions by adapting a non-parametric analysis, Data Envelopment Analysis (DEA) to compute technical efficiency (TE). There are two TE models available namely constant returns-to-scale (CRS) and Variable Return to Scale (VRS). The VRS has comforted the CRS model, which brings to an assumption that not all DMU operates at optimal scale. This model is able to decompose TE into two; i.e. Pure Technical Efficiency (PTE) and Scale Efficiency (SE). Therefore this investigation abides VRS by computing TE, PTE and SE on 170 SOEs in both economies countries for the period of 2010–2017. It is initially looking at the yearly efficiency trends as a measurement towards the ability of SOEs to produce the maximum output from a given set of inputs or, the ability to reduce inputs to produce the same amount of output over a certain period of time. It has discovered that SOE in emerging economies countries exhibit significantly higher TE in comparison to SOE in advanced economies countries. This study also reveals that PTE (managerial inefficiency) is the root cause of SOE's under-achievements in both economies countries.

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1. Introduction

State-Owned Enterprise (SOE) is generally defined as a corporate entity governed by national law in which the state exercises ownership in it (Australian Government, 2015; Powell, 1987; Roper & Schoenberger-Orgad, 2011; Tan et al., 2003). Since its inception, SOE becomes as a stimulant to embody shareholders' interests and befits as the center of ideology and political strategies to sanction in local economic activities (Cazurra et al., 2014). Drawing on its significance, SOE presence is likewise as a savior for capital intensive and 'off-road' projects which such projects were incapable borne by private firms, apart from its essential obligation as a provider to public goods and services i.e. utilities, basic materials, banks and others (Efird, 2010; Kennedy & Jones, 2003).

SOE are shown to be relevant through its worthy contributions to the world economy by dominating 75% market share of global oil reserves and productions via the 13 largest oil SOEs (The World Bank, 2014). Fortune Global 500 list (ranking platform of 500 largest companies in the world), reported that nearly 10% or 49 firms were SOEs in the year 2005, and the number has been double-up to 95 in 2012, where China SOEs are leading the numbers by 61(Kwiatkowski & Augustynowicz, 2015). In 2019, from a total of 129 China firms were marked among the largest corporation by revenue, 82 are all SOEs (Colvin, 2019).¹

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Yet until these days, the catastrophe of confidence marked SOE's credibility and increased public criticism on its performance related to corporate governance practices. The anecdote of 1MDB has proven that SOEs' governance and performance are still disputable (Government of Malaysia, 2015). State's confusion in performing tasks as policymaker or owner and permitting political intervention in deciding on SOEs' board line-up continues to be delinquent influences (Du et al., 2012; Ennser-Jedenastik, 2014; Giosi & Caiffa, 2020; Jin et al., 2022). Apart from that, as when the decision related to borrowings and credit framework was not really justified with SOEs capital structure objectives, depicted to greater financial risk to the SOE. As a result, a long-term impact will be later encountered by the government (The Swedish National Audit Office, 2018). SOEs supposedly gain advantages to deal effortlessly in business by having politicians and senior civil servants as board membership; however, it is merely a formula or could be the cause SOE still recorded financial troubles (Amiruddin, 2013).

Discoveries on SOEs efficiencies are not much to pioneer, this proves that there is an empirical gap particularly in the definite aspects of efficiency measurements though it has been conferred on a conceptual basis. Hence, the new venture highlights significant implications for SOEs troupes i.e. the management, government policymakers, regulators, academicians, and practitioners. Furthermore, endeavoring into SOE efficiency across nations and counties i.e. AP Region and European nations within emerging and advanced economies, gauge depicts a new paradigm on diversity compositions (OECD, 2011).

Another gap that can be found is the extent to which DEA is used to evaluate the efficiency of SOEs. Most assessment of firms efficiencies applying ratios analysis and Tobin's Q (Lye & Mohamad Yusof, 2011; Yu et al., 2014). Its univariate condition can simplify and systematically understand accounting figures in finding weak points in a firm or for forecasting purposes (Yu et al., 2014). Ratio's ability in control size and therefore it has to obey with restrictive setting such as the necessity of maintain the homogeneity in data (Lev & Sunder, 1979; McLeay & Trigueiros, 2002) and according to Faello (2019) that due to its one dimensional nature, resulted to limit on the improvement in decision making process, when relating to multiple data. However, in the real world, particularly in the business realm, firms always depict as a complex entity, and it is almost impossible to have a homogeneity structure between firms. This study aims to measure efficiency of public listed SOE. Thus, to assess a public listing firm is insufficient if only one dimension element is used for analysis. Extensive analysis comprising the way of SOE uses tangible and intangible resources collectively shall contribute a reliable findings (Kamasak, 2017). Therefore, many assumptions are required to make it possible. As a result, almost all the assumptions required for valid ratio analysis tend to be disturbed in practice (Lev & Sunder, 1979). This has caused this study to look for other alternative approaches, one of which is Data Envelopment Analysis (DEA).

DEA has been used in many efficiency assessments in the public sector where the efficiency are aiming on producing outputs or delivering services (schools and hospital) (Aparicio et al., 2018; Erdkhadifa & Himmati, 2022; Seran et al., 2022; Wei et al., 2012). The greatness of using DEA as a performance measure refers to its use in the form of a single objective score, position and potential target for improvement for each business unit determined to be inefficient (Li et al., 2022; Seran et al., 2022). In addition, DEA also creates benchmarks and facilitates clear structural information to achieve the entity's goals and targets. Thus, DEA functions as part of a performance measurement framework by helping to establish targets for performance improvement, and shifting the focus from individual measures to overall measures of relative efficiency. Furthermore, the DEA is able to give the explanation, as TE may decomposes the source of firm efficiency into Pure Technical Efficiency (PTE) and Scale Efficiency (SE), which would provide significant additional information in the context of managerial influences in deciding the use of resources as well as the best use of technology (Bozec & Dia, 2007; Isik & Hassan, 2002; Luo et al., 2016). Therefore, this comprehensive and more robust technique makes DEA a more appropriate methodology for this study.

2. Literature review

2.1. SOE significance

Government 'sculpted' as a benevolent entity in fulfilling social objectives and able to commit and requires thorough information regarding policy-related parameters (Martimort, 2006; Vagliasindi, 2008).

Thus, incorporating SOE became a solution provider for the national economy to restore market limitations Cazorra et al. (2014) and primary driving force to promote state economic growth (Efird, 2010). Globalization, market development, and business competitiveness have pushed SOE to act not only as a national economic tool, SOE imperatively needs to portray the 'corporate' appearance, 'breathing' and framing its strategy to compete in the comprehensive market. Thus, through hybrid objectives, SOEs are obliged to the position at the anticipated level of efficiency and profitability.

The majority owned SOEs in most developed countries accounts for about USD2 trillion of assets and more than six million jobs in the OECD member countries (OECD, 2011). Between 2008 and 2012, SOEs in the EU accounts 40% share of total turnover, predominantly in the energy and railway sectors (Commission E, 2016). Meanwhile, in Asia Pacific Region (emerging economies countries) i.e. China in the initial scenario was poorest; but presently, China's SOE has developed gradually, embracing the best transformation strategy through centralised ownership model and applying opening up policies (Fan & Hope, 2013). Hence, in 2019, China has marked as the prominent country listed in the Fortune Global 500 (Colvin, 2019).

However, the verdict between SOE and private firms is always linked to specific gaps. SOE is always associated with more lower results, i.e. SOE 12 percent less in ROE and US\$66 million less in net income as compared to private firms (across 500 largest companies outside US) (Boardman & Vining, 1989). Other SOE governance challenges to execute as compared to private firms are, (1) Entity objectives: SOE hybrid objectives to restore market imperfection (public interests) and to pursue commercial agenda (social interests) (Fan et al., 2007; Liu & Wang, 2011; The World Bank, 2010; Wong, 2004), and (2) Agency issues: SOE's managers are not only concerned on self-interests but need to fulfill politicians and bureaucrats demand, whereas managers in private are merely focusing on his incentives (Cazorra et al., 2014; Fan et al., 2007; The World Bank, 2010).

2.2. Data envelopment analysis

Firm performance is regularly spotting at its level of liquidity, sensible leverage ratio, positive profitability growth, and others, which can be easily measured through ratio analysis (Black & Bhagat, 2000; Lye & Mohamad Yusof, 2011; Omran, 2004; Sraer & Thesmar, 2007). The efficiency measurement envisioned in this research involves a lot of information through various inputs or outputs so that it can obtain a condensed result (Ali & Lerme, 1997). Hence, DEA is seen suitable and usable to measure relative efficiency of a homogeneous set of decision making unit (DMUs) on the basis of multiple inputs and multiple outputs (Cooper et al., 2007; Erdkhadifa & Himmati, 2022; Li et al., 2022). From those inputs and outputs data, the best-practice frontier is formed. To distinguish the most efficient DMU, is the one that lies on the best efficient frontier and it brings into a value of one in the model.

DEA which was originally suggested by Farrell (Farrell, 1957). The DEA frontier is formed as the piecewise linear combination based only on the observed input and output data, or, DMU (Jarbouli et al., 2015). This method does not require explicit specification in a form of input and output prices. Therefore, due to its flexibility, DEA (referring to TE) has been extensively used in numerous researches especially in the public sector enterprises. It was started with the Constant Returns to Scale Model (CRS) under the CCR Model by Charnes et al. (1978). CRS assumption is referring to the scale of operations is significantly associated with efficiency and it is only secure on Overall Technical Efficiency (OTE). Therefore, CRS assume percentage changes in outputs will reflects the relatively the same percentage in inputs (Kundi & Sharma, 2016). However, based on BCC Model by Banker et al. (1984), this model has comforting the CCR model by introducing the Variable Return to Scale (VRS), which bring to another assumption, that not all DMU is operate at optimal scale. Basically, this model separates the analysis in twofold manner i.e. Pure Technical Efficiency (PTE) and Scale Efficiency (SE). PTE is the TE measurement is free from scale and it is fully on managerial efficiency. Whereby, SE is a reflection on scale and size of operation efficiency (Cooper et al., 2007).

There are three advantages in applying DEA (Erdkhadifa & Himmati, 2022; Government, 2015), (1) DEA incorporates multiple inputs and outputs that only requires in quantities (not prices). Therefore, it is the most suitable for analysing efficiency of government service providers. (2) DEA is able to determine the possible source of inefficiency and efficiency. Meaning, DEA provides 'decomposing' inefficiency technical

and allocative inefficiency. Addition to that, DEA also allow technical inefficiency to be decomposed to scale effects, the effects of unwanted input which can't be disposed of and a residual component. (3) DEA may provide a set of potential role models that an organization can look to, for ways to improve its operation. DEA is able to incorporate differences in operating environments beyond management control. DEA can be a useful tool for benchmarking and change implementation program.

The decomposition of TE into PTE and SE would distinct the sources of efficiency as well as inefficiency by comparing the TE score. Coelli et al. (1998) established that if TE score of a firm is identical as the PTE score, therefore the source of efficiency is the SE; and the factor of inefficiency is therefore pure technical inefficiency (PTIE) which reflects on managerial inefficiency. In contrast, if TE score is different from PTE score, therefore the cause of efficiency is from PTE; and the factor of inefficiency is from Scale Inefficiency (SIE). Though, those actions also mirror the impact of managerial choice and decision making (Cooper et al., 2007; Isik & Hassan, 2002; Seran et al., 2022). Thus, TE (a combination of PTE and SE) is expected to deliver significant additional evidence in the context of managerial influences in deciding on utilization of resources as well as the best use of technology (Bozec & Dia, 2007; Isik & Hassan, 2002; Luo et al., 2016; Wang et al., 2022).

This stud uses income as a measurement of output, considering SOE are listed firm which need to sustain a good reputation in its main business by recorded positive income generated. Meanwhile, for inputs, labor will include number of employee, while capital will contain net value of fixed assets and total intangible assets with the assumption of all SOE are considering capital intensive and labor intensive firms and lastly operating expenses will comprise total operating expenses.

3. Methodology

The data for this study was obtained from selected emerging and advanced economies namely; Asia Pacific and European Regions. The main list is among the public listed firms' population in twenty-one selected countries with a total of 275 SOEs. After considering non-financial SOEs and covering industrial, utilities, telecommunications, consumer services, and goods as well as basic material sectors, 170 SOEs are eventually selected. 58 SOEs from advanced economies countries and 112 from emerging economies countries, 11 countries are applying centralised ownership arrangement, and the remaining are applying the non-centralised ownership models².

Data are from the year 2010 to 2017 on public listed SOEs generated via the Thomson Reuters DATASTREAM database as it has the required information (such as Total Assets, Beta, etc.) globally. DATASTREAM database has the ability to transmit the financial data in the same currency, although originally it was in home currencies. For this research, all data is converted to US dollar (USD) and thus, data standardization in the same currency unit can be obtained.

3.1. Model specification

Data Envelopment Analysis (DEA) originally proposed by Farrell (1957), known as non-parametric linear programming based technique, that usable to measure relative efficiency of a homogeneous set of decision making unit (DMUs) (on the basis of multiple inputs and multiple outputs). DEA route begins with jumbled up of inputs and outputs data, forming 'a piece-wise frontier', or, 'the best efficient frontier'. Kindly noted, each DMU is given an efficiency score; between 0 and 1, with the understanding that score equal to 1 specifying the most efficient DMU relative to all DMUs samples (Luo et al., 2016).

The CCR Model, formed by Charnes et al. (1978) and Charnes et al. (1978), proposing the measurement of overall technical efficiency (TE) with the assumption on production possibility set, is based on constant return to scale (CRS). CRS assumed percentage changes in outputs will reflects the relatively the same percentage in inputs (Kundi & Sharma, 2016). Following (Kamarudin et al., 2015), they defining some notation by assuming there are data on N inputs and M outputs on each of I , DMU's. For the i -th DMU, these are represented by the column vectors x_i and q_i respectively. The $N \times 1$, input matrix X , and $M \times 1$ output matrix, Q , represent the data for all I SOEs. The ratio of all outputs over all inputs such as, $u'q_i / v'x_i$, where u is $M \times 1$ vector or output weights and v is a $N \times 1$ vector of input weights. As such, the following mathematical programming is used to solve the optimal weights (Coelli et al., 1998):

$$\max_{u,v} (u'q_i / v'x_i)$$

$$\text{Subject to } (u'q_j / v'x_j \leq 1, j=1,2,\dots,l,$$

This ratio formulation has a problem whereby it has infinite number of solutions; therefore, to overcome this issue, one can impose the constraint $v'x_i = 1$, by,

$$\max_{\mu,v} (\mu'q_i),$$

$$\text{Subject to } v'x_i = 1,$$

$$\mu'q_j - v'x_j \leq 0, \quad j=1,2,\dots,l$$

$$\mu, v \geq 0,$$

where there is a change in the notation from u and v , to μ and v . This is used to demonstrate on the different linear programming problem. Using the dual form of the above issue, an equivalent envelopment equation can be derived as:

$$\min_{\theta,\lambda} \theta,$$

$$\text{subject to } -q_i + Q \geq 0,$$

$$\theta x_i - X \geq 0,$$

$$\lambda \geq 0,$$

where,

θ is a scalar and

λ is a $l \times 1$ vector of constant

Here, the envelopment form produces fewer constraints than the multiplier form ($N \times M < l + 1$). The θ value is the efficiency score for the i -th firm. The CRS assumption however only appropriate when firms are operating at an optimal scale (Coelli et al., 1998). Taking into account the challenging economic circumstances of today i.e. imperfect competition, government regulations, financing limitations, even more, hybrid identity of SOE, that is tied to the government's policy and also need to perform efficiently. Therefore, extended discussion has comforting the CCR model by introducing the Variable Return to Scale (VRS) via BCC Model by Banker et al. (1984), which bring to another assumption, that not all DMU is operate at optimal scale.

The CRS linear programming problem can be simplified to account the Variable Returns to Scale (VRS) by adding convexity constraints; $11' \lambda = 1$ (Coelli et al., 1998):

$$\begin{aligned} \min_{\theta, \lambda} \quad & \theta, \\ \text{subject to} \quad & -q_i + Q\lambda \geq 0, \\ & \theta x_i - X\lambda \geq 0, \\ & 11' \lambda = 1, \\ & \lambda \geq 0, \end{aligned}$$

Where,

$11'$ is a 1×1 vector of ones.

This approach forms a convex hull of intersecting planes which envelope the data points more tightly than the CRS conical hull and thus provides technical efficiency scores greater than or equal to those obtained using the CRS model (Coelli et al., 1998; Kamarudin et al., 2015).

The VRS decomposes TE into two namely Pure Technical Efficiency (PTE) and Scale Efficiency (SE). The PTE is referring on managerial efficiency (Isik & Hassan, 2002), whereas, SE is a reflection on scale and size of operation efficiency (Cooper et al., 2007). As the drive of this investigation is to identify the causes of inefficiency in relation to ownership structure, therefore, decision-based factor related (manager's direct judgement) will get the most attention. Hence, VRS assumption is the furthestmost realistic and meets the need of this research.

Indicating the accurate inputs and outputs stand its importance in gaining to an effective interpretation and acceptance to those concerned. However, numbers of literatures (in terms of SOE field) are still debating as regards to proper definition of inputs and outputs in estimating efficiency. Bozec & Dia (2007) were considering on board structure and SOE efficiency, using operating costs and employees as inputs, and volume of oil produced and sales measure as outputs. Whereas, Lin et al. (2009)'s study on high-tech SOEs, used total assets, proportion of state-owned share and employees to be measured as inputs, while ROA and assets turnover were used as outputs. Another study relating to the impact of corporate governance on SOE and non-SOE efficiency in China by He et al. (2015), jumbled net value of fixed assets and employee - inputs, while, gross revenue and profit - outputs. This study decided to use income as a measurement of output, considering sample SOEs among listed firm which necessity to sustain a good reputation in positive income generated. While, determination of inputs are; (1) labor will comprise number of employee (most literatures used), (2) capital will embrace net value of fixed assets as well as total intangible assets, with the assumption of sample SOEs are consisting of capital intensive and labor intensive SOEs, and (3) operating expenses considering total operating expenses.

4. Empirical results

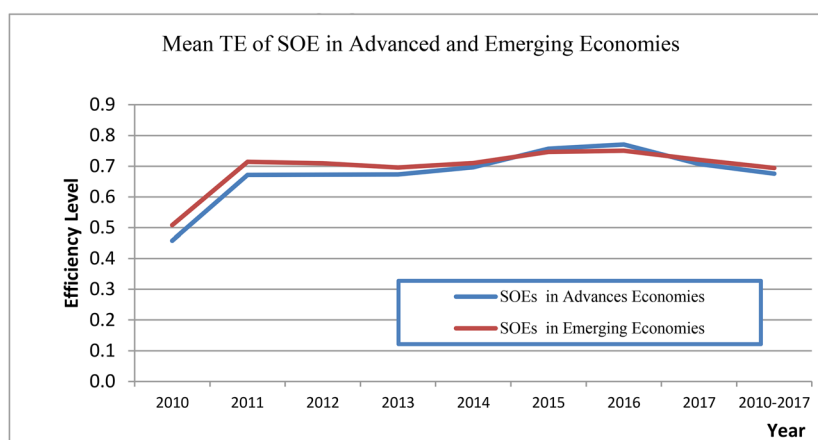
4.1. Efficiency of all SOE in the selected advanced and emerging economies countries of Asian Pacific region and European nations

The total DMU should be more than the total of input and output in order to get flexibility in the selection of weights to assign to input and output values as referring to 'The Rule of Thumb' proposed by Cooper et al. (2007). Looking to this study, the collection of total DMU is 170, which more than the total input and output used (3 inputs + 1 Output), approves the selection of variables.

Table 1. Efficiency scores of All SOE in the selected advanced and emerging economies countries of Asian Pacific Region and European nations.

Efficiency Measures	SOEs in Selected Asian Pacific Region and European Nations					
	ALL SOEs		SOEs in Advanced Economies		SOEs with in Emerging Economies	
	No. of DMUs	Mean	No. of DMUs	Mean	No. of DMUs	Mean
Panel A : All SOE 2010						
Technical Efficiency	170	0.491	58	0.458	112	0.508
Pure Technical Efficiency	170	0.574	58	0.599	112	0.560
Scale Efficiency	170	0.893	58	0.826	112	0.927
Panel B : All SOE 2011						
Technical Efficiency	170	0.700	58	0.672	112	0.714
Pure Technical Efficiency	170	0.768	58	0.779	112	0.763
Scale Efficiency	170	0.919	58	0.872	112	0.943
Panel C : All SOE 2012						
Technical Efficiency	170	0.697	58	0.672	112	0.709
Pure Technical Efficiency	170	0.753	58	0.763	112	0.748
Scale Efficiency	170	0.931	58	0.891	112	0.952
Panel D : All SOE 2013						
Technical Efficiency	170	0.688	58	0.673	112	0.695
Pure Technical Efficiency	170	0.745	58	0.765	112	0.734
Scale Efficiency	170	0.931	58	0.888	112	0.953
Panel E : All SOE 2014						
Technical Efficiency	170	0.705	58	0.696	112	0.710
Pure Technical Efficiency	170	0.761	58	0.777	112	0.753
Scale Efficiency	170	0.933	58	0.904	112	0.948
Panel F : All SOE 2015						
Technical Efficiency	170	0.750	58	0.757	112	0.747
Pure Technical Efficiency	170	0.790	58	0.809	112	0.781
Scale Efficiency	170	0.955	58	0.941	112	0.961
Panel G : All SOE 2016						
Technical Efficiency	170	0.757	58	0.770	112	0.751
Pure Technical Efficiency	170	0.793	58	0.815	112	0.782
Scale Efficiency	170	0.959	58	0.950	112	0.964
Panel H : All SOE 2017						
Technical Efficiency	170	0.716	58	0.707	112	0.721
Pure Technical Efficiency	170	0.768	58	0.784	112	0.760
Scale Efficiency	170	0.938	58	0.908	112	0.954
Panel 1 : All SOE 2010 - 2017						
Technical Efficiency	1360	0.688	464	0.676	1324	0.470
Pure Technical Efficiency	1360	0.744	464	0.761	1324	0.497
Scale Efficiency	1360	0.932	464	0.846	1324	0.643

Sources: DATASTREAM database and authors' own calculations.

**Figure 1.** The comparison of efficiency level of SOE between advanced and emerging economies countries.

Source: DATASTREAM database and authors' own calculations.

Table 1 explains the mean technical efficiency (TE) scores of 170 SOEs in the selected advanced and emerging economies countries of the Asian Pacific Region and European nations. It also exhibits by column with mean TE value for SOEs in advanced economies and SOEs in emerging economies, which beneficial to make a comparison later on. Meanwhile, the row displays yearly mean TE data for 2010

(Panel A), 2011 (Panel B), 2012 (Panel C), 2013 (Panel D), 2014 (Panel E), 2015 (Panel F), 2016 (Panel G) and 2017 (Panel H). It also provides profound findings on the decomposes of TE, i.e. managerial efficiency (PTE) and scale efficiency (SE) that stimuli the overall efficiency level of SOEs (Isik & Hassan, 2002).

The discoveries addressing that the mean TE of all 170 SOEs are in upsurge trend from 49.1% to 70.0% during the period 2010 to 2011, and recorded a decrease of 69.7% to 68.8% from 2012 to 2013, followed by an increase momentum to 70.5%, 75.0% and 75.7% in 2014, 2015 and 2016. Meanwhile, in 2017, the mean TE slightly decreases to 71.6%. Figure 1 displays the pictographic trend level of TE from 2010 to 2017, begin with low efficiency in 2010, which could be explained on the recovering periods after the global financial crisis year 2008.

Concentrating at the findings between the two economies settings, the mean TE of SOEs in emerging economies in year 2010 until 2014 are higher than advanced economies. However, the mean efficiency pattern has been intercepted by SOE in advanced economies in year 2015 and 2016 though only a very small gap and more efficient than emerging countries. In 2017 SOEs in emerging economies hold back a value of 72.1% and SOEs in advanced economies marked at 70.7%. The score is implying that on the average, the emerging sector could have increased its current production by 27.9% without adding or using an extra unit of input. Therefore, the sector was efficient as compared to advanced economies sector which need to increase it production a bit higher by 29.3% without adding more inputs. It is well known that advanced countries are those who have advanced technology structure, high level of gross domestic product per capita and very significant degree of industrialisation. However, that assumption is still debatable as shown from the above findings.

The obvious reason is due to slow economic growth and level of productivity in advanced economies that are affected by aging population scenario. This situation has led to a huge and crucial financial burden as higher expenditure has to be allocated for health care, higher expenditure for pensions, unemployment insurance and higher expenditure to support the family. (Abdul & Awan, 2015; Hagemann & Nicoletti, 1989; Jones-Finer, 2000).

There are fiscal challenges in advanced economies, namely decent spending, high unemployment rates, rising public debt, and declining corporate profits (IMF, 2010). The main issue faced in advanced economy countries i.e. the U.S.A average population growth was 1.73 percent in 1950 declining to 0.54 percent in 2011; Britain was 1.73 percent (1950) to 0.94 percent (2011) (Hagemann & Nicoletti, 1989). On the other hand, the aging percentage of the population increased from 12.60 per cent in 1985 to more than 12 per cent in 2012 which would directly involve a reduction in the working age population affecting productivity growth. As a result, this scenario also impacted on increasing of dependency ratio (Jones-Finer, 2000).

Conversely, rapidly growing in emerging economies since the 2000s as they have learned from their former mistakes as they failed to cope with the 1997 currency crisis attack (Abdul & Awan, 2015).

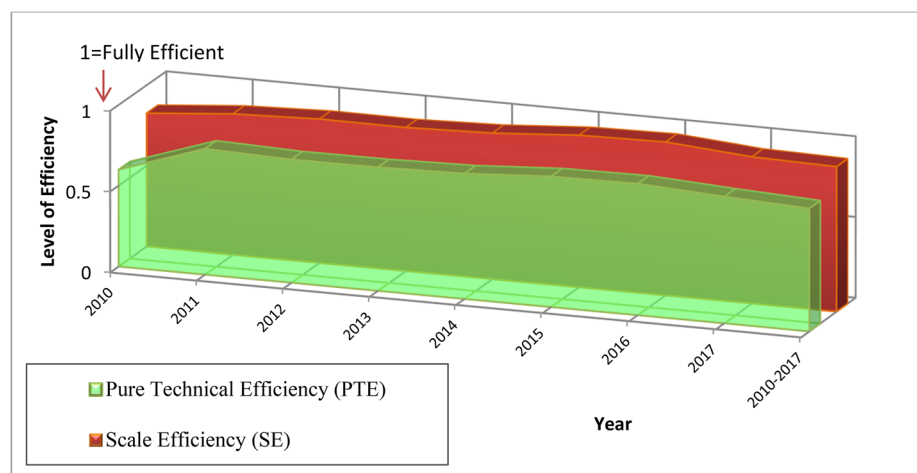


Figure 2. Decomposition of TE into PTE and SE for SOE in advanced economies.
Source: DATASTREAM database and authors' own calculations.

Reduced external debt level and depending on home-grown resources are among the reasons. For example, China maintains its expansionary fiscal policy to balance growth generated from internal and external forces (IMF, 2010).

Viewing intensely into the inefficiency factors that prompted both economies, evidently, it turns out to be due to lack of efficiency in the managerial aspect (PTE). The PTE scored ranged from 20.7% to 42.6%, which higher than scale efficiency (SE) with only 4.1% to 10.0%, confirming on lack of management strategies. Figure 2 illustrates the decomposition of TE into PTE and SE for SOE in advanced economies. Meanwhile, Figure 3 shows the decomposition of TE into PTE and SE for SOE in emerging economies. These findings are further confirmed by the non-parametric robustness analysis i.e. Mann-Whitney (Wilcoxon) and Kruskal-Wallis tests (Table 2).

5. Conclusions

This study investigated the State-Owned Enterprise level of efficiency in advanced and emerging economies. SOE acted as government corporate entity which most fingered on strategic sectors such as energy, minerals, infrastructure, and other needy utilities. SOE primarily performed as a tool for domestic economic solutions and to control on any market imperfections. The states has 'control' on SOE, therefore, it has been treated as the center of political ideology and strategy (Cazurra et al., 2014; Li et al., 2022). High debts, feeble profitability, poor efficiency, and imperfect output quality are among of issues related to SOE poor performances which reflecting the inefficient decisions made by the nominated board (management).

This study examines the level of SOE technical efficiency in selected advanced and emerging countries. Research on SOEs is still handful of attention and it should be further explored due to its importance in the domestic and world economies. Over the years, many literatures discovered that SOE's roles to the economy has become escalating confirming SOEs relevancy in the economy (Efird, 2010; Erdkhadifa & Himmati, 2022; Najid & Abdul Rahman, 2011; Seran et al., 2022)

The selection of countries from the Asian-Pacific Region and European countries is due to three reasons: (1) the economy outlook for Asian-Pacific Region continues to be the most dynamic of the world economy (Kwiatkowski & Augustynowicz, 2015; OECD, 2015; Ooi & Lai, 2009); (2) Diversity countries selected with varying cultural and social factors, legal system, government ownership structure and economic development (Aguilera & Jackson, 2003); and (3) the selected countries (Asian-Pacific Region and European) consist of both type of economies i.e. advanced and emerging.

In overall, there are three main objectives of the study. Firstly, this study is aiming to examine the SOE level of technical efficiency. DEA used as an efficiency measurement methodology which least study has been implemented before. The DEA methodology is able to elicit findings related to the measurement

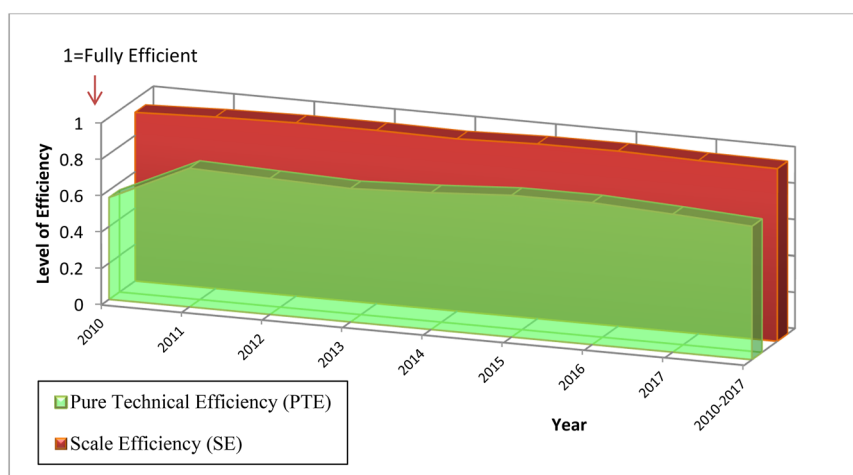


Figure 3. Decomposition of TE into PTE and SE for SOE in emerging economies.
Source: DATASTREAM database and authors' own calculations.

Table 2. Robustness test for efficiency scores of All SOE in the selected advanced and emerging economies countries of Asian Pacific Region and European nations.

Individual tests Hypothesis	Test groups					
	Parametric test		Non-parametric test			
	t-test		Mann-Whitney [Wilcoxon Rank-Sum] test		Kruskal-Wallis Equality of Populations test	
Test statistics	$t(Prb > t)$		$z(Prb > z)$		$X^2(Prb > X^2)$	
	Mean	t	Mean Rank	z	Mean Rank	X^2
YEAR 2010						
Technical Efficiency (TE)						
SOE in Advanced Economies	0.458	−2.161***	77.069	−1.607*	77.069	2.583*
SOE in Emerging Economies	0.508		89.866		89.866	
Pure Technical Efficiency (PTE)						
SOE in Advanced Economies	0.599	1.161	91.431	−1.131	91.431	1.279
SOE in Emerging Economies	0.560		82.429		82.429	
Scale Efficiency (SE)						
SOE in Advanced Economies	0.826	−3.118***	77.733	−0.148	77.733	2.199
SOE in Emerging Economies	0.927		89.522		89.522	
YEAR 2011						
TE						
SOE in Advanced Economies	0.672	−1.788***	74.414	−2.114**	74.414	4.467**
SOE in Emerging Economies	0.714		91.241		91.241	
PTE						
SOE in Advanced Economies	0.779	0.624**	86.707	−0.230	86.707	0.053
SOE in Emerging Economies	0.763		84.875		84.875	
SE						
SOE in Advanced Economies	0.872	−4.048***	59.707	−4.919***	59.707	24.913***
SOE in Emerging Economies	0.943		98.857		98.857	
YEAR 2012						
TE						
SOE in Advanced Economies	0.672	−1.464***	76.802	−1.658*	76.802	2.750*
SOE in Emerging Economies	0.709		90.004		90.004	
PTE						
SOE in Advanced Economies	0.763	0.534***	84.612	−0.169	84.612	0.029
SOE in Emerging Economies	0.748		85.960		85.960	
SE						
SOE in Advanced Economies	0.891	−3.335***	72.595	−2.474**	72.595	6.121**
SOE in Emerging Economies	0.952		92.183		92.183	
YEAR 2013						
TE						
SOE in Advanced Economies	0.673	−0.881**	79.414	−1.160	79.414	1.346
SOE in Emerging Economies	0.695		88.652		88.652	
PTE						
SOE in Advanced Economies	0.765	1.117**	88.948	−0.658	88.948	0.433
SOE in Emerging Economies	0.734		83.714		83.714	
SE						
SOE in Advanced Economies	0.888	−3.451***	67.241	−3.483***	67.241	12.133***
SOE in Emerging Economies	0.953		94.955		94.955	
YEAR 2014						
TE						
SOE in Advanced Economies	0.696	−0.554**	80.776	−0.901	80.776	0.811
SOE in Emerging Economies	0.710		87.946		87.946	
PTE						
SOE in Advanced Economies	0.777	0.899**	87.853	−0.449	87.853	0.202
SOE in Emerging Economies	0.753		84.281		84.281	
SE						
SOE in Advanced Economies	0.904	−2.538***	75.905	−1.830*	75.905	3.350*
SOE in Emerging Economies	0.948		90.469		90.469	
YEAR 2015						
TE						
SOE in Advanced Economies	0.757	0.395	86.586	−0.207	86.586	0.043
SOE in Emerging Economies	0.747		84.938		84.938	
PTE						
SOE in Advanced Economies	0.809	1.131*	89.836	−0.827	89.836	0.684
SOE in Emerging Economies	0.781		83.254		83.254	
SE						
SOE in Advanced Economies	0.941	−1.440**	82.526	−0.569	82.526	0.323
SOE in Emerging Economies	0.961		87.040		87.040	
YEAR 2016						
TE						
SOE in Advanced Economies	0.770	0.859**	89.379	−0.74	89.379	0.547

(Continued)

Table 2. Continued.

Individual tests Hypothesis	Test groups					
	Parametric test		Non-parametric test			
	t-test		Mann-Whitney [Wilcoxon Rank-Sum] test		Kruskall-Wallis Equality of Populations test	
Test statistics	$t(Prb > t)$		$z(Prb > z)$		$X^2(Prb > X^2)$	
	Mean	t	Mean Rank	z	Mean Rank	X^2
YEAR 2010						
SOE in Emerging Economies	0.751		83.491		83.491	
PTE						
SOE in Advanced Economies	0.815	1.351**	90.853	−1.021	90.853	1.043
SOE in Emerging Economies	0.782		82.728		82.728	
SE						
SOE in Advanced Economies	0.950	−1.145*	78.293	−1.357	78.293	1.891
SOE in Emerging Economies	0.964		89.232		89.232	
YEAR 2017						
TE						
SOE in Advanced Economies	0.707	−0.636**	81.586	−0.746	81.586	0.557
SOE in Emerging Economies	0.721		87.527		87.527	
PTE						
SOE in Advanced Economies	0.785	1.006**	88.500	−0.572	88.500	0.327
SOE in Emerging Economies	0.760		83.946		83.946	
SE						
SOE in Advanced Economies	0.908	−2.925***	67.078	−3.513***	67.078	12.343***
SOE in Emerging Economies	0.954		95.040		95.040	

Source: DATASTREAM database and authors' own calculations.

The superscripts *, ** and *** represent statistical significance at the 10%, 5% and 1% confidence levels, respectively.

of SOE efficiency. Second, the results show that SOE in emerging economies countries exhibit significantly higher TE level in comparison to SOE in advanced economies countries. These findings are consistent with previous study regarding firms in emerging economies countries have been aware of and learned from previous world economic recessions. In fact, the spirit of these economic players in tackling the challenges of economic development makes them more competitive (Abdul & Awan, 2015; Le et al., 2021). This is evidenced as testified that 82 SOE from a total 129 Chinese companies became among the largest companies by revenue in 2019 (Colvin, 2019). Third, this study reveals that Pure Technical efficiency (PTE) (managerial inefficiency) is the root cause of under-achievements of SOEs in both, emerging countries as well as advanced countries.

In surmise, this new discovery contributes in many fields and aspects. (1) SOE Management; TE is able to reveal and provide a better understanding of the outlined factors associated with SOE efficiency. The findings found management inefficiency as a source of inefficiency to the performance of SOEs, therefore rationalizing the characteristics of decision makers in SOEs or boards of directors as they correspond to the nature of each SOE should be discussed in detail. (2) Shareholders/government policy makers, regulators will better understand related to a good governance structure. (3) Academics and practitioners, will be more aware and improve a better understanding and new exploration can be initiated based on this study. Furthermore, the effort to obtain a cross-county diversity sample (i.e. AP Region and European countries) in emerging and advanced economies illustrates a new trend and pattern on the perspective of efficiency as well as in the context of governance effectiveness.

Notes

1. In emerging market, SOE's contribution in local economy is significant. Malaysian listed SOE which also known as Government Link Investment Companies (GLIC) (Choudhary et al., 2013; Ministry of Finance, 2021; Najid & Abdul Rahman, 2011; Said et al., 2016) facilitated savings of 16 million Malaysians and provide funding over 30% ventures capital entrepreneurs in year 2020. It manages over 1.7 trillion of assets which equivalent to more than 120% of Malaysian GDP representing 25% of Bursa Malaysia's market capitalisation (Ministry of Finance, 2021). Meanwhile in China, the early scenario was poorest country, as such no infrastructure, industrial capability was limited, education and healthcare were scarce and social security was non-existent during

the period where People's Republic of China was established in 1949. Hence, China SOEs became the rescuer by undertook gradually the nation building tasks and these days they have becoming formidable competitors locally as well as in the global market (Fan & Hope, 2013).

2. In the early arrangement, ministries were responsible not only providing the services or products but also accountable in fashioning sectoral policy – decentralised (OECD, 2017), though the needs to proficiently manage on specific functional area and able to execute “check and balances” between technical and financial oversight, thus the dual ownership arrangement has been introduced (The World Bank, 2014). Later, in capturing the needs of transparency in every level of execution as well as separation of politic influences, the centralised ownership arrangement becomes the best structure. The centralised ownership role will be separated and taken over by a specialised ownership agency or to a designated government ministry (Arrobbio, 2015; OECD, 2018). OECD (2016) elucidated that the main reason Singaporean model seen to be so successful was due the establishment of Temasek as an industrial holding company.

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No potential conflict of interest was reported by the author(s).

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