EFFICIENCY AND DEREGULATION IN THE MALAYSIAN ELECTRICITY SECTOR

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ABSTRACT

The Malaysian electricity sector was deregulated in the early 1990s as a response to the inadequate power supply and since then, has seen the inception of the independent power producers (IPPs). Through their supply of electricity to the national utilities, the nation's power reserve margin has improved although many allegations from various reports have questioned the power purchase agreement terms arguing that the private producers were significantly gaining at the expense of the national utilities. Using DEA, we found that the national utilities have recorded a decline in their performance and efficiency in the wake of the post-IPPs era.

JEL Classification: L51, L5, L52, L94.

Keywords
Malaysian Electricity Sector, Efficiency, Productivity, Data Envelopment Analysis, Malmquist Index, Independent Power Producer, Deregulation

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1. INTRODUCTION

The power and electricity sector is perhaps one of the more crucial sectors in most countries. It is even more critical to developing countries given the contrasting experiences that many have had with privatizing the sector. In essence, many regard the industry to possess natural monopoly qualities and perhaps more importantly, it also served as a tool for realizing many governments' policy goals. However, it is with competition that can provide the necessary efficiency incentives thus the initiative to introduce private players. Evidently, many developing economies started to liberalize their power sector since the late 1980s in the form of independent power producers (IPPs) which have since then, became a significantly large market. The liberalization of the sector has been found to lead to higher prices although such high prices nonetheless, did reflect the actual market demand in many of the cases. However, in many countries, much of the criticisms are targeted at the many controversial governmental bailouts of these electricity conglomerates and their questionable subsidies[1].

In Malaysia, privatization of the electricity sector has been initiated since the early part of the 1990s although the regulations in the industry have not yet been significantly dismantled. The nation's electricity sector was opened to privatization in 1992 in the form of independent power producers (IPPs) to reduce the power dependency on the state-owned utilities after the massive 1992 blackout which shut down much of the country's power. These IPPs thus entered into long-term power purchase agreements (PPAs) with the government although it is this arrangement that also proved to be controversial years later on[2]. Having said that, the Malaysian electricity sector has grown progressively since the inception of the privatization program and is in fact, boasting a reserve margin[3] (38% in 2005) that is respectable even by international standards[4]. In fact, the Malaysian electricity tariff rates (domestic users) came up much lower when compared to Thailand, Taiwan, Korea, Singapore, Philippines and Hong Kong for the year 2002[5].

1.1 The Electricity Sector in Malaysia

The electricity and power supply industry is comprised of three main integrated utilities; Tenaga Nasional Berhad (TNB) [which serves the West Malaysia], Sabah Electricity Sdn Bhd (SESB) and Sarawak Electricity Supply Corp. (SESCo), the last two serving the East Malaysian states of Sabah and Sarawak respectively. They are complimented by twenty six independent power producers (IPPs)[6], dedicated power

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[1] Most of the IPPs are compensated for any changes in the fuel prices while much of their fixed costs investment are protected against market risks through the use take-or-pay contracts or capacity charges (Albouny & Bousba, 1998).

[2] There are claims that not only that the IPPs are guaranteed purchase of the energy they produced and also enjoyed a subsidized supply of energy, they are also subjected to very few risks. See NST Online, 7 August 2008.

[3] A measure of available capacity over and above the capacity needed to meet normal peak demand levels (http://www.energyvortex.com/energydictionary/reserve_margin__reserve_capacity.html)

[4] The Malaysian Energy Commission (2003).

[5] Comparison by Energy Commission (2002) using the rates by TNB and SESB.

[6] TNB and SESCo own some of the IPPs, one in the case of the former and two in the case of the latter.

producers and co-generators. In Malaysia, the IPPs generate and sell electricity to the three main incumbent utilities[7].

Tenaga Nasional Berhad (TNB in short, also the largest electricity utility) is the corporatised national electricity board which was established in 1990. Prior to that, the electricity sector comprised of one company, namely the National Electricity Board (NEB) which was established and operated under the Ministry of Energy, Telecommunications and Post in 1949[8]. TNB became fully privatized through an offer for the sale of its share to the public and subsequent listing on the Kuala Lumpur Stock Exchange (KLSE) in February 1992. Meanwhile, the Sabah Electricity Sdn Bhd (owned by TNB and the Sabah state government) was founded in 1998 to replace the Federal Government's Sabah Electricity Board. In the case of the state of Sarawak, the Sarawak Electricity Supply Corp. is the state power entity and it is owned by the Sarawak government (55%) and Sarawak Enterprise Corporation Bhd (45% stake). Overall, the independent power producers (IPPs) generate and sell electricity to these three utilities, generating approximately half of the total electricity supply of the country.

The three integrated utilities undertakes the generation, transmission, distribution and supply activities and are investor-owned entities although the government maintains its position as the major holder. However, competition in this industry comes in the form of giving licenses to the private sector to build, own and operate the power generating plants[9] as independent power producers (IPP) and thus supply electricity to the three utilities through negotiated power purchase agreements (PPAs). As of December 2005, there are about 26 IPPs in the country supplying a total installed capacity of 18,874 MW for the year (The Malaysian Energy Commission, 2005).

Nonetheless, the pursuant of the IPPs from the liberalization of the power sector was envisaged by the government to achieve several objectives which included reducing the public sector's size while also improving efficiency in the sector as well. However, the IPPs are also not without their controversies, especially in the context of their negotiated power purchase agreements (PPAs). Recently, the national utility has called for fresh talks with the IPPs due to several developments, one of them being the fact that its own IPP[10] has been able to operate power plants that are more efficient and hence charging lower rates compared to those that are privately-owned. It is also reported that the national utility is asking for more risk-sharing agreements, in which it will only pay for what it requires[11] rather than the current

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[7] Ministry of Energy, Water and Communications.

[8] The enactment of the Energy Supply Act in 1990 led to the transfer of NEB's assets to the then newly corporatised Tenaga Nasional Berhad (TNB), which incidentally saw the start of the privatization era in the power sector in Malaysia.

[9] In 1993, the Government of Malaysia heralded in the era of the private power sector in the country by awarding B.O.O. licences (i.e. licence to build, operate and own the power plants). However, the finalisation of Power Purchase Agreement (PPA) between TNB and IPP's took considerable time in the initial stages of the development of private power industry in Malaysia. See Lim (1994).

[10] TNB Janamanjung Sdn Bhd is a wholly-owned subsidiary of TNB. It boasts a licence capacity of 2100MW.

[11] See The Star online 11 July 2008.

arrangement in which the national utility is forced to purchase the power even if it doesn't need it[12].

1.1 Objective of Paper

The objective of the paper is to assess the impact of the independent power producers (IPPs) on the efficiency of the Malaysian power sector. As deregulation and privatization would lead to greater market competition and hence better efficiency, the introduction of the private operators should improve the sector's productivity. This paper focuses on the sector's efficiency and productivity and aims to provide an analysis of the Malaysian power sector's experience with privatization. The outline of the rest of the paper is as follows. Section 2 covers some of the existing literature on efficiency in the electricity sector in Asia while section 3 explains the data and methodology used in the study. The main empirical results are presented in Section 4. Section 5 concludes.

2. LITERATURE REVIEW

Meibodi (1998) use DEA and stochastic frontier in the study of efficiency in the Iranian electricity industry. Comparing to a host of developing countries involving 26 countries, he found that the overall DEA efficiency for the years 1987-88 for Iran was 74.7%, with managerial (in)efficiency (0.773) being a more pressing issue compared to scale (in)efficiency (0.967) therefore concluding that Iran could ideally reduce its input consumption by 25.3% without reducing its outputs. Meanwhile, an inter-country comparison exercise saw Iran's electricity sector efficiency ranked 24th out of 26 developing countries.

Yunos and Hawdon (1997) studied the efficiency of the Malaysia National Electricity Board using DEA with a relative comparison to the Electricity Generating Authority in Thailand (EGAT) and also the CEGB[13] in the United Kingdom. Using an input-orientated model, the inputs selected were installed capacity (MW), labour, total system losses and thermal efficiency while the output variable chosen was gross electricity production. Comparing the DEA efficiency scores of the Malaysian electricity board to its Thai and UK counterparts from 1975 to 1990, they found that it was slightly less efficient compared to the Thai electricity board. During that time, the total factor productivity gains for the Malaysian electricity board were mainly about catching-up rather than technological improvements (technical change). Finally, Malaysia's national board was ranked 18th among a sample of 28 developing countries' electricity utilities.

3. METHODOLOGY

3.1 Data Envelopment Analysis

Data Envelopment Analysis (DEA) is an analytical tool that can assist in the identification of best practices in the use of resources among a group of decision-

[12] Ibid.

[13] Central Electricity Generating Board (of the British electricity industry) operated from 1957 to 1990 until the privatization of the 1990s.

making units or departments. It is a mathematical programming production frontier approach and relative efficiency is measured in relation to the constructed frontier. The frontier is nevertheless, constructed using a piecewise linear combination that connects the set of "best practice observations" in the sample, yielding a convex efficient frontier.

The term Data Envelopment Analysis was first used in 1978 by Charnes, Cooper and Rhodes. Their approach applied the efficiency concept outlined by Farrell. Farrell (1957) decomposed efficiency of a firm into its technical and price (allocative) efficiency components. Technical efficiency reflects the ability of a firm to obtain maximal output from a given set of inputs, while allocative efficiency affects the ability of a firm to use the inputs in optimal propositions, given their respective prices and the production technology. The combination of these two measures provides a measurement of total economic efficiency (or cost efficiency).

In any event, technical efficiency (TE) as measured by DEA can be identified by using an input or an output orientation. When using an input orientation, technical efficiency is measured as proportional reduction in input usage; with the output level being held constant. On the other hand, when using an output orientation, technical efficiency is measured as a proportional increase in outputs, with the inputs being held constant. Under the assumption of CRS[14], the two measures will generate equal value while with an assumption of VRS[15], the results will differ. According to Coelli et al. (1998)[16], the CRS linear programming problem, under the input orientation, can be defined as:

$$\begin{aligned} &\min_{\theta,\lambda} \theta, \\ &\text{st} \quad -y_i + Y\lambda \geq 0, \\ &\theta_{xi} - X\lambda \geq 0, \\ &\lambda \geq 0 \end{aligned} \qquad (1)$$

where θ is a scalar, λ is a *Nx1* vector of constants while λX and λY are the input and output vectors respectively. The value of θ will be the efficiency score for the i-th firm. It will satisfy θ less than or equal to 1, with a value of 1 indicating a point on the frontier and hence a technically efficient DMU. To account for VRS, the same equation can be modified with the convexity constraint: $N1'\lambda = 1$, where N1 is a Nx1 vector of ones. Such convexity constraint ensures that an "inefficient unit" is only benchmarked against similar size peers[17].

3.2 The Malmquist Index

For the productivity analysis, Fare *et al* (1994) have shown that the DEA methodology can be used to obtain estimates of Malmquist total factor productivity (TFP) index numbers. Essentially, The Malmquist Index approach is a chained index approach, which measures changes in productivity relative to a base year.

[14] Constant returns to scale.

[15] Variable returns to scale

[16] Coelli, T.J., D.S. Prasada Rao and G.E. Battese (1998), *An Introduction to Efficiency and Productivity Analysis*, Kluwer Academic Publishers, Boston.

[17] For the purpose of restricting the length of the paper and also the fact that the approach chosen in this paper is of an input-orientation one, the explanation for output-orientation is thus omitted.

Changes in productivity can be decomposed into components due to changes in technical efficiency (catching up) and movements due to changes in technology (technological change). Meanwhile, changes in a firm's technical efficiency can be decomposed into change due to pure technical efficiency change (managerial efficiency) and changes due to scale efficiency (plant size optimality). The Malmquist DEA approach derives an efficiency measure for one year relative to the prior year, while allowing the best frontier to shift.

The Malmquist TFP index measures the TFP change between two data points by calculating the ratio of the distances of each data point relative to a common technology. If the period *t* technology is used as the reference technology, the Malmquist (input-oriented) TFP change index between period s (base period) and period t can be written as

$$m_0^t(y_s, x_s, y_t, x_t) = \frac{d_0^t(y_t, x_t)}{d_0^t(y_s, x_s)} \quad (2)$$

Alternatively, if the period *s* reference technology is used, it is defined as

$$m_0^s(y_s, x_s, y_t, x_t) = \frac{d_0^s(y_t, x_t)}{d_0^s(y_s, x_s)} \quad (3)$$

Note that in the above equations the notation $d_0^s(x_t, y_t)$ represents the distance from the period t observation to the period s technology. When $t = s$, this distance is equivalent to the technical efficiency scores defined earlier. A value of m_0 greater than 1 indicates TFP growth from the period *s* to period *t* while a value of less than 1 will otherwise, indicate a TFP decline.

Fare *et al.* (1994) specifies an output based Malmquist productivity change index:

$$m_0(y_s, x_s s, y_t, x_t) = \left[\frac{d_0^s(y_t, x_t)}{d_0^s(y_s, x_s)} \times \frac{d_0^t(y_t, x_t)}{d_0^t(y_s, x_s)}\right]^{\frac{1}{2}} \quad (4)$$

An equivalent way of writing this would be

$$m_0(y_s, x_s, y_t, x_t) = \frac{d_0^t(y_t, x_t)}{d_0^s(y_s, x_s)}\left[\frac{d_0^s(y_t, x_t)}{d_0^t(y_t, x_t)} \times \frac{d_0^s(y_s, x_s)}{d_0^t(y_s, x_s)}\right]^{\frac{1}{2}} \quad (5)$$

The above equation (technical efficiency change) can be broken into two parts, namely the efficiency change component and the technical change component[18].

$$\text{Efficiency change} = \frac{d_0^t(y_t, x_t)}{d_0^s(y_s, x_s)} \qquad (6)$$

and

$$\text{Technical change} = \left[\frac{d_0^s(y_t, x_t)}{d_0^t(y_t, x_t)} \times \frac{d_0^s(y_s, x_s)}{d_0^t(y_s, x_s)}\right]^{\frac{1}{2}} \qquad (7)$$

3.3 Data and Model

The DEA analysis takes on a time-series data set analysis approach, with each of the annual performance being considered as a decision-making unit itself. Essentially, this approach follows the paper by Sueyoshi (1996) who treated each annual data set as a decision-making unit in his analysis of the performance of the Nippon Telegraph & Telephone company (NTT) for the period from 1953 – 1992[19]. His approach captured an important feature of the industry from the angle of DEA efficiency analysis, i.e. *a comparative exercise involving the annual performances of one particular firm*. In this paper, a similar exercise is applied to all three of the national electricity utilities, i.e. TNB, SESB and SESCo. The time frame covers the period from 1993 to 2008 data. The time-series DEA scores for each of the respective national utilities (i.e. TNB, SESB and SESCo) are then subjected to a correlation exercise (Pearson) to ascertain if annual performances are correlated to the introduction of the IPPS.

In terms of the DEA model, the inputs and outputs selected here are based on electricity generating capabilities and are as follows. The small number of input and output variables used is partly due to lack of data availability although this move also gave the advantage of having a greater discriminatory DEA power since our sample only consisted of 16 observations (i.e. years)[20]. We included two models to provide a more robust analysis. The two input-output DEA models are as follows:

18 The efficiency change (6) can be decomposed into scale efficiency and "pure" technical efficiency components. In addition, technical change above in equation (7) also refers to technological change while efficiency change is also referred to by many as technical efficiency change.

19 Sueyoshi (1997) used such an approach since his sample only involved one entity, i.e. the Nippon Telegraph & Telephone company (NTT). Under his approach, each of the annual performance becomes a decision-making unit by itself. The inputs selected in his paper were total assets, total employees and total access lines while the outputs had variable charge revenues, fixed charge revenues and other miscellaneous revenues. His empirical findings found technical and allocative efficiency in the years of 1953 to 1955 and 1987 – 1992. He thus concluded that the company's privatization in 1985 had positively contributed to the company's performance.

20 16 annual observations, staring from 1993.

MODEL 1

Inputs	Outputs
Installed capacity (MW) Amount of employees	Total output generated (GWh)

MODEL 2

Inputs	Outputs
Installed capacity (MW) Amount of employees	Total output generated (GWh) Load Factor (%)

4. FINDINGS

4.1 DEA analysis on The National Utilities: A Time-series Approach

The relative DEA scores according the years from 1993 – 2008 for all three of the national utilities are shown in Tables 1 and 2. The pattern of the scores indicated the performance of the utilities when matched against the respective years over the sample period and it is interesting since the period covered began at the time when the IPPs were just introduced, a period which saw the issuance of the first license in 1994[21]. The results from both models indicated a diminishing trend from 1993 to 2008 for TNB although the same cannot be ascertained in the cases of SESB and SESCo. Both did not seem to adhere to such trend possibly because there are lesser IPPs in East Malaysia and thus their impact less significant to the output levels of the two national incumbents located in East Malaysia (SESB and SESCo). In fact, there were no privately-owned IPPs in Sarawak up until 2007[22].

[21] YTL Power Generation Sdn Bhd (Paka, Terengganu and Pasir Gudang plants) were awarded the IPPs contacts on 7th April 1993 but their operations started a year later.

[22] Up until 2006, Sarawak does not have any IPPs but has an associated power producer named Sejingkat Power Sdn. Bhd, which is a generating company, 49% owned by SESCo and the remaining 51% by Sarawak Enterprise Corporation Bhd. (SECB). It is situated at Sejingkat, Sarawak and has a capacity of 2 units of 50MW. Unit 1 was commissioned on 19 February 1998 and Unit 2 was commissioned on 15 May 1998 (Ministry of Energy Green Technology and Water, accessed from www.ktak.gov.my/system/print_details.asp?tt=content&contentid=151 on 21 August 2009. Meanwhile, in July 1997, the State Government of Sarawak granted a 33-year licence to SECB's wholly-owned subsidiary, Sarawak Power Generation Sdn Bhd to develop, work and operate independent power plants in Bintulu, Kuching and Miri for the generation and supply of electricity to or for the use of SESCo in the State of Sarawak (http://www.mphb.com.my/utilities/sarawak_intro.htm, accessed 21 August 2009. However, two new private IPPs joined the fray in 2007 (as per Energy Commission Report 2007) thus bringing the number of IPPS in the power industry in Sarawak to four players. They are Mukah Power Generation and PPLS Power Generation Sdn Bhd. The latter is coal-fired power station wholly-owned subsidiary of SESCo.

Table 1: DEA scores for TNB, SESB and SESCo for 1993 – 2008 (single- output model)

YEAR	TNB	SESB	SESCO
1993	1.000	0.714	0.723
1994	0.944	0.784	0.843
1995	0.943	0.709	0.953
1996	0.862	1.000	1.000
1997	0.852	0.597	0.883
1998	0.877	0.487	0.822
1999	0.865	0.513	0.812
2000	0.998	0.564	0.888
2001	0.951	0.645	0.926
2002	1.000	0.642	0.812
2003	0.732	0.667	0.871
2004	0.659	0.949	0.912
2005	0.777	1.000	1.000
2006	0.840	0.923	1.000
2007	0.797	0.714	0.723
2008	0.854	0.784	0.843
MEAN	0.872	0.728	0.889

Table 2: DEA scores for TNB, SESB and SESCo for 1993 – 2008 (2-output model)

YEAR	TNB	SESB	SESCO
1993	1	1	1
1994	1	1	0.931
1995	0.996	0.92	1
1996	0.91	1	1
1997	0.901	0.849	0.906
1998	0.923	0.799	0.833
1999	0.919	0.758	0.819
2000	0.998	0.825	0.891
2001	0.964	0.771	0.926
2002	1	0.732	0.818
2003	0.732	0.7	0.871
2004	0.659	0.949	0.912
2005	0.777	1	1
2006	0.84	0.923	1
2007	0.797	1	1
2008	0.854	1	0.931
MEAN	0.892	0.873	0.922

Perhaps this also explains the fact that SESCo's results in both models were fairly stable throughout the period of analysis (1993-2008) (see Table 1 and 2). From the comparison of performances among the trio, it appears that TNB is public entity (among the trio) most adversely affected and it is also not surprising that the majority of the IPPs are concentrated in the Peninsular Malaysia where TNB, as the national utility operates. Interestingly, SESCo, operating in the state of Sarawak which had the least number of IPPs, averaged highest in the DEA scores using both model 1 and 2

Table 3: Pearson Correlation Tables for TNB, SESB and SESCo

Variables	Pearson Correlation Scores
TNB DEA Scores (Model 1) and Annual Total Installed Capacity of Private Producer	-0.629*
TNB DEA Scores (Model 2) and Annual Total Installed Capacity of Private Producer	-0.728*
TNB DEA Scores (Model 1) and Annual Number of IPPs	-0.519**
TNB DEA Scores (Model 2) and Annual Number of IPPs	-0.630*
SESB DEA Scores (Model 1) and Annual Total Installed Capacity of Private Producer	0.065
SESB DEA Scores (Model 2) and Annual Total Installed Capacity of Private Producer	-0.715
SESB DEA Scores (Model 1) and Annual Number of IPPs	0.012
SESB DEA Scores (Model 2) and Annual Number of IPPs	-0.274
SESCo DEA Scores (Model 1) and Annual Total Installed Capacity of Private Producer	0.097
SESCo DEA Scores (Model 2) and Annual Total Installed Capacity of Private Producer	0.419
SESCo DEA Scores (Model 1) and Annual Number of IPPs	-0.011
SESCo DEA Scores (Model 2) and Annual Number of IPPs	0.363

*significance at $p = 0.01$.
**significance at $p = 0.05$
***significance at $p = 0.10$

Meanwhile, the Pearson correlation (see Table 3) revealed significant negative correlation between the total installed capacity (and total number of IPPs) and TNB's time-series annual DEA efficiency scores in both models. The results are unsurprising though, given the many controversies associated with their roles (IPPs) in the sector, especially on the issue of over-production of power. Nonetheless, given that the relationships were highly significant and also recorded strong negative correlation, the findings do not seem to augur well for the case of energy dependency on IPPs by TNB. Meanwhile, no significant relationships were established in the cases of both SESB and SESCo in terms of their DEA scores (time-series annual DEA scores) and the total installed capacities of the IPPs (and the number of IPPs) in the respective states of Sabah and Sarawak. As both states had lesser IPPs, this finding further fuels the suspicions behind many of the criticisms levied against the private power producers, which are concentrated in the Peninsular Malaysia thus explaining the pattern of correlation found in the case of TNB. From Table 3, it seems that the influence of IPPs is weakest in the case of SESCo (Sarawak) which unsurprisingly, only started having IPPs in 2004. Even then, two out of the four IPPs in Sarawak is owned by SESCo.

Meanwhile, the mean DEA scores for both models were also tabulated according to the pre- and post-IPPS era in the case of all three incumbents, namely, TNB, SESB and SESCO. The time-frame covering both eras in this analysis is between the years of 1993 to 2008 for each of the three incumbents. The period of coverage is as follows for all three national utilities.

	PRE –IPPS ERA	POST-IPPS ERA
TNB	1993	1994-2008
SESB	1993-1996	1997-2008
SESCO	1993-2003	2004-2008

Unsurprisingly again, the pre-IPPS era in the cases of both models had higher scores compared to post-IPPs era for TNB (both models had 100% scores in pre-IPPs era mean performance but only 0.863 and 0.885 respectively in the case of post-IPPs era, see Table 4). SESB also had lower mean DEA scores in both models in the case of post-IPPS era indicating adverse incumbent's performance as a result of the emergence of the IPPs. However, no such pattern was detected in the case of SESCO in both models. Given that there were only four IPPs in Sarawak as of 2008 and are mostly owned by SESCO, such findings are interesting and consistent with the findings from the Pearson correlation exercise (see Table 3). From the findings of TNB and SESB (which incidentally, involved much greater numbers of IPPs and private capacity of power generation), the presence of the IPPs appeared to have adversely affected the national utilities' operational efficiency.

Table 4: Efficiency of Power Incumbents Pre and Post IPPs Era

Time-series DEA Model 1	Pre-IPPs Era	Post-IPPs Era
TNB	1	0.863
SESB	0.802	0.707
SESCO	0.867	0.896
Time-series DEA Model 2	Pre-IPPs Era	Post-IPPs Era
TNB	1	0.885
SESB	0.980	0.859
SESCO	0.909	0.969

4.2 Performance of the Malaysia's public power sector in comparison with other Asian countries

This section assesses the performance of the power sector of the nation (i.e. the performance of the country's national electricity enterprises[23]) as compared to other Asian (selected) countries' equivalences. Such an exercise was pursued to provide an assessment of the country's electricity sector's performance (in relation to other Asian countries, those that are both superior and inferior to the country in terms of their levels of economic development). In addition, the period of analysis covers from 1980 – 2007 thus providing a comparison between the country's public power sector in the pre-IPPs era (1980-1994) and post-IPPs era (1995 – 2007). The DEA analysis from 1980-2007 consisted of 10 Asian countries; namely Brunei, Hong Kong, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand. Meanwhile, the DEA analysis employed is an input-oriented approach which consisted of one output and two inputs; the output being the total power generation (denoted in GWh) by the public sector (national utilities) while the inputs being accounted by the total fuel usage (denoted in ktoe) and total generating capacity (denoted MW) by the public sector. The data are compiled from the Institute of Energy Economics (Japan) website[24], which relied on the institute's Energy Data and modeling center.

From Table 5**,** (please refer to the Appendix) the results revealed that Malaysia's (public sector) power sector's technical efficiency pattern declined over the period from 1980 to 2007. Since the power sector started purchasing electricity from the IPPs beginning 1995 (TNB began purchasing electricity in 1995), we compared the average DEA efficiency scores for the pre-IPPs era (1980-1994) and post-IPPS period (1995-2007). The results indicated that the public power sector performed better before the entry of the private producers (or other private power generators) as the pre-IPPs era (1980-1994) had an average DEA technical scores (assuming variable returns to scale) of 0.896 as compared to the post-IPPs era's (1995-2007) mean DEA technical efficiency scores of 0.755. Meanwhile, in terms of a constant return to scale approach, the mean DEA score for the pre-IPPs era is also higher than the post IPPs-era; the former notching a 0.915 score compared to the latter's 0.758[25]. In addition, the country's public sector is also among those countries that defined the efficiency frontier (both in the context of variable and constant returns assumption) in four out of the 15 pre-IPPs years (1981, 1982, 1983 and 1984). None of the 13 post IPPs-era years were efficient in contrast. Finally, from 1980 to 2007, the annual efficiency scores (under both constant and variable returns to scale assumptions) of the public sector saw declining patterns (see Figures 1 and 2).

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[23] Consisting of TNB, SESB and SESCo.

[24] http://www.ieej.or.jp/egeda/

[25] An unreported OLS regression was also conducted linking the scores (DEA efficiency scores of Malaysia's national utility for both the variable and constant returns to scale data scores) against a dummy variable for era (1= post-privatization era [1995-2007]; 0 = pre-privatization era [1980-1994]). The results revealed a negative and significant (at 1%) relationship between the DEA scores and the dummy variable thus indicating a decline performance of the national utility in the post-privatization years. In addition, the t-test on the difference of means between the pre-and post privatization scores are also significant (for both the constant and variable returns to scale data scores).

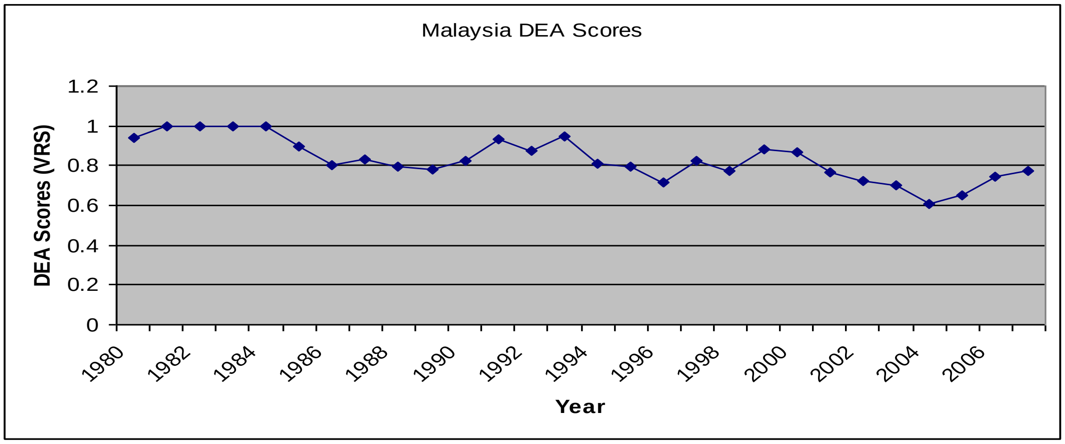

Fig. 1: Malaysian DEA Technical Scores (under variable returns to scale)

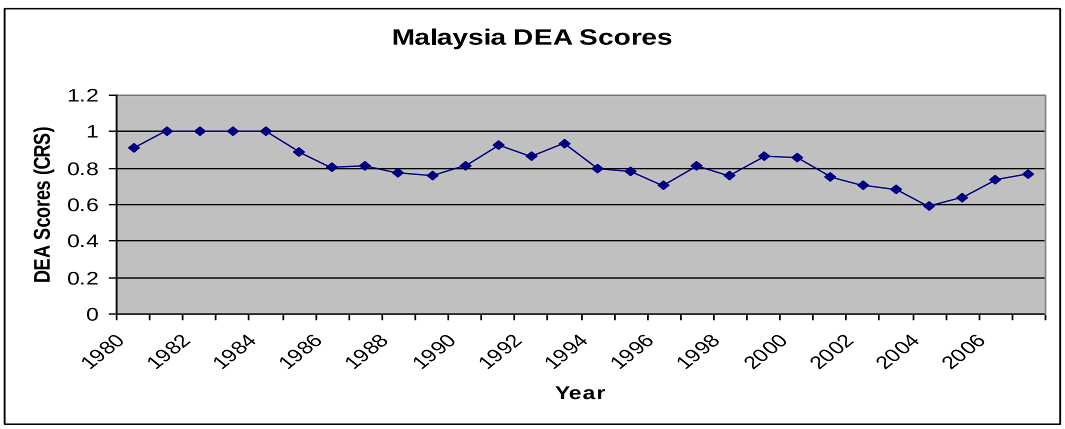

Fig. 2: Malaysian DEA Technical Scores (under constant returns to scale)

Meanwhile, in terms of the total factor productivity, very little separated the mean TFP growth rates for the pre-IPPs era and the mean TFP growth rates for the IPPs-era; the former having an increase of 0.68% while the latter grew a little more, but only at 0.75%. In this respect, it appears that the introduction of the private producers and the deregulation of the sector did not result in significantly big improvement in productivity of the public enterprise. In fact, in terms of technological improvements, the mean technical change is even higher in the case of the pre-IPPs era (1.0134) compared to the post IPPs-era (1.0085) (see Table 6). This indicates that technological improvement is slightly lower after the deregulation of the industry. Elsewhere, scale efficiency improvement was fairly similar in the cases of the pre and post-IPPs era although the former is again, slightly better off (1.0008 against 1.0004). Nevertheless, deregulation has led to some improvement in technical (managerial) efficiency change (recording a 0.08% improvement) as compared to the pre-privatization era which saw a drop of 0.8%. Overall, in terms of total factor productivity improvements, it appears that the sector's deregulation and the subsequent introduction of private players did lead to much improvement on the performance of the national utility enterprise.

Table 6 : Malmquist Index Total Factor Productivity Scores for Malaysia relative to selected Asian countries' Public Power sector (1981-2007)*

Year	Technical efficiency	Technological change	Pure technical efficiency	Scale efficiency	Total Factor Productivity change
1981	1.093	0.909	1.067	1.024	0.993
1982	1.000	0.989	1.000	1.000	0.989
1983	1.000	1.011	1.000	1.000	1.011
1984	1.000	0.950	1.000	1.000	0.950
1985	0.890	0.955	0.898	0.992	0.850
1986	0.902	1.000	0.897	1.006	0.901
1987	1.010	1.105	1.031	0.979	1.116
1988	0.954	1.101	0.955	0.999	1.050
1989	0.986	1.068	0.983	1.003	1.052
1990	1.068	1.021	1.058	1.010	1.090
1991	1.136	1.023	1.133	1.003	1.162
1992	0.935	0.977	0.939	0.995	0.913
1993	1.083	1.069	1.078	1.004	1.158
1994	0.852	1.009	0.855	0.997	0.860
Mean (81-94)	0.9935	1.01336	0.99243	1.00086	1.00679
1995	0.978	1.009	0.985	0.993	0.987
1996	0.902	1.064	0.902	0.999	0.960
1997	1.156	0.903	1.146	1.009	1.043
1998	0.933	1.071	0.939	0.994	0.999
1999	1.136	1.018	1.136	1.001	1.157
2000	0.994	0.983	0.991	1.003	0.977
2001	0.880	1.094	0.880	1.001	0.963
2002	0.940	1.054	0.940	1.000	0.990
2003	0.966	0.908	0.970	0.996	0.876
2004	0.870	0.967	0.868	1.002	0.841
2005	1.077	1.037	1.071	1.005	1.117
2006	1.149	0.993	1.148	1.001	1.141
2007	1.037	1.009	1.035	1.002	1.047
Mean (95-07)	1.001385	1.008462	1.000846	1.000462	1.007538

***Note: Figures for the other 9 countries in the sample not included.**

5. CONCLUSION

Overall, the findings indicated that the Malaysian national electricity utilities (i.e. TNB, SESB and SESCo) and the overall national electricity sector (all three combined) declined in efficiency and productivity. Essentially, the trend of the national utilities' performances saw adverse results in the wake of the introduction of the private power producers. Among the three national utilities, TNB, the national utility in the Peninsular Malaysia (which incidentally, had the most number of IPPs and utilized the most in private capacity) was most severely affected in terms of efficiency. In any event, even at an aggregate level of analysis (the assessment of all three representing the public sector in an aggregate form), the evidence also did not augur well for the move to deregulate the sector and introduce private producers. In this case, the public power sector as a whole saw a decline in efficiency in the wake of deregulation in the sector. The empirical evidence in this paper appears to support such a claim.

REFERENCES

Albouy, Y. & R. Bousba (1998), "The Impact of IPPs in Developing countries – Out of the Crisis and into the Future", Public Policy for the Private Sector, Note No. 162.

Banker R. D. (1984), "Estimating Most Productive Scale Size Using Data Envelopment Analysis", European Journal of Operational Research, vol. 17, pp. 35 - 44.

Charnes A., W. Cooper & Rhodes R. (1978), "Measuring the Efficiency of Decision Making Units", European Journal of Operational Research, vol. 2, pp. 429–44.

Coelli T, A Guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program. CEPA Working Paper 96/08.

Coelli T. and Walding S. (2006), "Performance Measurement in the Australian Water Supply Industry: A Preliminary Analysis". In Coelli, T. and Lawrence D. (eds.) 2006, Performance Measurement and Regulation of Network Utilities. Edward Elgar Publishing, Cheltenham.

Coelli T., Rao D. S. P., O'Donnell C. & Battese G. E. (2005), "An Introduction to Efficiency and Productivity Analysis". 2nd Edition. Springer, New York.

Coelli T., Rao D. S. P. and Battese G. E. (1998), "An Introduction to Efficiency and Productivity Analysis". Kluwer Academic Publishers, Boston.

Fare R., Grosskopf S., Norris M. and Z. Zhang (1994), "Productivity Growth, Technical Progress and Efficiency Changes in Industrialized Countries", American Economic Review, vol. 84, pp. 66 – 83.

Farrell M. J. (1957), "The Measurement of Productive Efficiency", Journal of the Royal Statistical Society, vol. 120, pp. 253-290.

Lim E. J. (1994), "Private Power Generation in Malaysia: An Independent Power Producer's Perspective", Second Afro – Asian Conference on Power Generation. Transmission and Distribution, Kuala Lumpur.

Meibodi, A. E. (1998), "Efficiency considerations in the Electricity Supply Industry: the case of Iran", University of Surrey.

Palast, G. (2001), "IMF's Four Steps to Damnation", Observer.

Rector, J. (2005), "The IPP Investment Experience in Malaysia", Working Paper No. 46, Center for Environmental Science and Policy, Stanford University.

Sueyoshi, T. (1997), "Measuring Efficiencies and Returns to Scale of Nippon Telegraph & Telephone in Production and Cost Analyses", Management Science, 43 (6), pp.779-796.

The Malaysian Energy Commission, "Statistics of Electricity Supply Industry in Malaysia", 2002, 2003, 2004, 2005, 2006, 2007, 2008, and 2009.

Yunos, J.M. & D. Hawdon (1997), "The Efficiency of the National Board in Malaysia: An inter-country comparison using DEA", Energy Economics, vol. 19, pp 255 – 269.

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http://www.energyvortex.com/energydictionary/reserve_margin__reserve_capacity.html (retrieved on 23 April 2012)

http://www.ktak.gov.my/system/print_details.asp?tt=content&contentid=151 (retrieved on 21 August 2009)

http://www.mphb.com.my/utilities/sarawak_intro.htm (retrieved on 21 August 2009)

"Independent power producers: It's time for giving back" NST Online, 7 August 2008. (retrieved on 29 September 2008).

Meibodi, A. E. (1998), "Efficiency considerations in the Electricity Supply Industry: the case of Iran", University of Surrey (retrieved from http://www.surrey.ac.uk/economics/files/apaperspdf/SEED%2095.pdf).

"TNB calls IPPs for talks: Independent power producers asked to come up with list of demand" The Star Online, 11 July 2008 (retrieved from http://biz.thestar.com.my/news/story.asp?file=/2008/7/11/business/21796626&sec=business on 29 September 2008).

APPENDIX

Table 5: DEA Technical Efficiency scores for Selected Asian countries' Public Power sector (1980-2007)

Year	Countries in Respective Years	CRS TE	VRS TE
1980	1. Brunei	0.543	1
	2. Hong Kong	0.804	0.819
	3. Indonesia	0.893	0.913
	4. Japan	0.984	1
	5. Korea	0.843	0.844
	6. Malaysia	0.915	0.937
	7. Philippines	1	1
	8. Singapore	0.737	0.765
	9. Taiwan	1	1
	10. Thailand	0.889	0.902
1981	1. Brunei	0.615	1
	2. Hong Kong	0.874	0.876
	3. Indonesia	0.916	0.933
	4. Japan	0.913	1
	5. Korea	0.968	0.99
	6. Malaysia	1	1
	7. Philippines	1	1
	8. Singapore	0.877	0.899
	9. Taiwan	1	1
	10. Thailand	0.913	0.916
1982	1. Brunei	0.469	1
	2. Hong Kong	0.865	0.886
	3. Indonesia	0.905	0.931
	4. Japan	0.915	1
	5. Korea	1	1
	6. Malaysia	1	1
	7. Philippines	1	1
	8. Singapore	0.891	0.932
	9. Taiwan	1	1
	10. Thailand	0.939	0.953
1983	1. Brunei	0.544	1
	2. Hong Kong	0.848	0.849
	3. Indonesia	0.974	0.98
	4. Japan	0.875	1
	5. Korea	0.929	0.978
	6. Malaysia	1	1
	7. Philippines	0.924	0.934
	8. Singapore	0.786	0.811
	9. Taiwan	1	1
	10. Thailand	0.925	0.926
1984	1. Brunei	0.634	1
	2. Hong Kong	0.852	0.852
	3. Indonesia	0.961	0.961
	4. Japan	0.884	1
	5. Korea	0.951	0.961

	6. Malaysia	1	1
	7. Philippines	0.867	0.877
	8. Singapore	0.878	0.891
	9. Taiwan	1	1
	10. Thailand	0.86	0.861
1985	1. Brunei	0.686	1
	2. Hong Kong	0.903	0.932
	3. Indonesia	0.732	0.733
	4. Japan	0.976	1
	5. Korea	0.991	1
	6. Malaysia	0.89	0.898
	7. Philippines	0.992	0.996
	8. Singapore	1	1
	9. Taiwan	1	1
	10. Thailand	0.918	0.937
1986	1. Brunei	0.707	1
	2. Hong Kong	0.96	0.965
	3. Indonesia	0.788	0.79
	4. Japan	0.921	1
	5. Korea	0.964	0.97
	6. Malaysia	0.803	0.805
	7. Philippines	1	1
	8. Singapore	1	1
	9. Taiwan	1	1
	10. Thailand	0.976	0.978
1987	1. Brunei	0.59	1
	2. Hong Kong	0.871	0.88
	3. Indonesia	0.69	0.703
	4. Japan	0.837	1
	5. Korea	1	1
	6. Malaysia	0.81	0.83
	7. Philippines	0.825	0.842
	8. Singapore	0.83	0.863
	9. Taiwan	1	1
	10. Thailand	0.995	1
1988	1. Brunei	0.591	1
	2. Hong Kong	0.748	0.757
	3. Indonesia	0.627	0.64
	4. Japan	0.809	1
	5. Korea	1	1
	6. Malaysia	0.773	0.793
	7. Philippines	0.832	0.853
	8. Singapore	0.819	0.85
	9. Taiwan	1	1
	10. Thailand	1	1
1989	1. Brunei	0.644	1
	2. Hong Kong	0.742	0.751
	3. Indonesia	0.64	0.654
	4. Japan	0.791	1
	5. Korea	1	1
	6. Malaysia	0.762	0.779
	7. Philippines	0.796	0.815

	8. Singapore	0.81	0.837
	9. Taiwan	1	1
	10. Thailand	1	1
1990	1. Brunei	0.695	1
	2. Hong Kong	0.685	0.692
	3. Indonesia	0.696	0.702
	4. Japan	0.769	1
	5. Korea	1	1
	6. Malaysia	0.814	0.825
	7. Philippines	0.827	0.926
	8. Singapore	0.841	0.861
	9. Taiwan	1	1
	10. Thailand	1	1
1991	1. Brunei	0.729	1
	2. Hong Kong	0.732	0.739
	3. Indonesia	0.764	0.77
	4. Japan	0.746	1
	5. Korea	1	1
	6. Malaysia	0.925	0.935
	7. Philippines	0.771	0.859
	8. Singapore	0.768	0.785
	9. Taiwan	0.976	0.976
	10. Thailand	0.999	1
1992	1. Brunei	0.707	1
	2. Hong Kong	0.773	0.782
	3. Indonesia	0.737	0.744
	4. Japan	0.784	1
	5. Korea	1	1
	6. Malaysia	0.865	0.878
	7. Philippines	0.778	0.867
	8. Singapore	0.751	0.772
	9. Taiwan	0.994	0.996
	10. Thailand	0.962	0.968
1993	1. Brunei	0.741	1
	2. Hong Kong	0.745	0.752
	3. Indonesia	0.604	0.614
	4. Japan	0.86	1
	5. Korea	1	1
	6. Malaysia	0.937	0.947
	7. Philippines	0.796	0.887
	8. Singapore	0.754	0.8
	9. Taiwan	1	1
	10. Thailand	0.921	0.924
1994	1. Brunei	0.639	1
	2. Hong Kong	0.494	0.567
	3. Indonesia	0.638	0.644
	4. Japan	0.838	1
	5. Korea	1	1
	6. Malaysia	0.798	0.809
	7. Philippines	0.812	0.914
	8. Singapore	0.822	0.856

	9. Taiwan	1	1
	10. Thailand	1	1
Average TE for Malaysia Public (1980-1994)		0.915	0.896
1995	1. Brunei	0.551	1
	2. Hong Kong	0.512	0.579
	3. Indonesia	0.996	1
	4. Japan	0.927	1
	5. Korea	1	1
	6. Malaysia	0.781	0.797
	7. Philippines	0.791	0.879
	8. Singapore	0.843	0.895
	9. Taiwan	1	1
	10. Thailand	0.988	0.993
1996	1. Brunei	0.511	1
	2. Hong Kong	0.532	0.583
	3. Indonesia	0.948	0.949
	4. Japan	0.915	1
	5. Korea	1	1
	6. Malaysia	0.704	0.719
	7. Philippines	0.777	0.861
	8. Singapore	0.768	0.823
	9. Taiwan	1	1
	10. Thailand	1	1
1997	1. Brunei	0.631	1
	2. Hong Kong	0.56	0.638
	3. Indonesia	0.99	0.993
	4. Japan	1	1
	5. Korea	1	1
	6. Malaysia	0.814	0.824
	7. Philippines	0.8	0.885
	8. Singapore	0.869	0.907
	9. Taiwan	1	1
	10. Thailand	1	1
1998	1. Brunei	0.577	1
	2. Hong Kong	0.555	0.604
	3. Indonesia	0.867	0.872
	4. Japan	0.884	1
	5. Korea	1	1
	6. Malaysia	0.759	0.774
	7. Philippines	0.739	0.787
	8. Singapore	0.866	0.914
	9. Taiwan	1	1
	10. Thailand	0.912	0.919
1999	1. Brunei	0.55	1
	2. Hong Kong	0.54	0.583
	3. Indonesia	0.914	0.918
	4. Japan	0.828	1
	5. Korea	1	1

	6. Malaysia	0.863	0.879
	7. Philippines	0.774	0.861
	8. Singapore	0.882	0.932
	9. Taiwan	1	1
	10. Thailand	0.837	0.844
2000	1. Brunei	0.584	1
	2. Hong Kong	0.544	0.597
	3. Indonesia	0.97	0.974
	4. Japan	0.932	1
	5. Korea	1	1
	6. Malaysia	0.857	0.87
	7. Philippines	0.823	0.894
	8. Singapore	0.819	0.858
	9. Taiwan	1	1
	10. Thailand	0.817	0.823
2001	1. Brunei	0.548	1
	2. Hong Kong	0.54	0.575
	3. Indonesia	1	1
	4. Japan	0.909	1
	5. Korea	1	1
	6. Malaysia	0.755	0.766
	7. Philippines	0.838	0.91
	8. Singapore	0.798	0.845
	9. Taiwan	1	1
	10. Thailand	0.792	0.796
2002	1. Brunei	0.545	1
	2. Hong Kong	0.545	0.589
	3. Indonesia	1	1
	4. Japan	0.892	1
	5. Korea	1	1
	6. Malaysia	0.709	0.72
	7. Philippines	0.992	1
	8. Singapore	0.901	1
	9. Taiwan	0.929	0.934
	10. Thailand	0.753	0.756
2003	1. Brunei	0.57	1
	2. Hong Kong	0.564	0.599
	3. Indonesia	1	1
	4. Japan	0.714	1
	5. Korea	1	1
	6. Malaysia	0.685	0.698
	7. Philippines	0.878	0.976
	8. Singapore	1	1
	9. Taiwan	0.922	0.926
	10. Thailand	0.897	0.9
2004	1. Brunei	0.633	1
	2. Hong Kong	0.728	0.758
	3. Indonesia	0.67	0.678
	4. Japan	0.747	1
	5. Korea	1	1
	6. Malaysia	0.596	0.606

	7. Philippines	0.837	0.84
	8. Singapore	1	1
	9. Taiwan	0.807	0.813
	10. Thailand	0.824	0.832
2005	1. Brunei	0.704	1
	2. Hong Kong	0.597	0.615
	3. Indonesia	0.844	0.85
	4. Japan	0.832	1
	5. Korea	1	1
	6. Malaysia	0.641	0.649
	7. Philippines	0.77	0.787
	8. Singapore	1	1
	9. Taiwan	0.796	0.798
	10. Thailand	0.827	0.833
2006	1. Brunei	0.717	1
	2. Hong Kong	0.664	0.679
	3. Indonesia	0.794	0.799
	4. Japan	0.808	1
	5. Korea	1	1
	6. Malaysia	0.737	0.745
	7. Philippines	0.784	0.795
	8. Singapore	1	1
	9. Taiwan	0.801	0.803
	10. Thailand	0.861	0.867
2007	1. Brunei	0.734	1
	2. Hong Kong	0.646	0.66
	3. Indonesia	0.83	0.834
	4. Japan	0.831	1
	5. Korea	1	1
	6. Malaysia	0.764	0.771
	7. Philippines	0.829	0.839
	8. Singapore	1	1
	9. Taiwan	0.802	0.804
	10. Thailand	0.833	0.838
Average TE for Malaysia Public (1995-2007)		0.758	0.755