

Financial Efficiency of SMEs in the Northern Corridor Economic Region: a DEA Analysis[#]

Hooy Chee Wooi*

Universiti Sains Malaysia

Hooy Guat Khim**

Universiti Sains Malaysia

Tajul Ariffin Masron***

Universiti Sains Malaysia

Abstract: Given the important role of SMEs as an endogenous growth factor in the local economy, ensuring strong and competitive development for this segment of industry has become a key concern in making the Northern Corridor Economic Region (NCER) a success. This paper gauges the operating efficiency of SMEs in NCER in channelling financial resources to revenue and profit. Data Envelopment Analysis (DEA) was used to analyse 1047 SMEs in Kedah, Penang and Perak for the financial year 2007. DEA shows that only 20 SMEs scored 100 per cent efficiency, and they are mostly from Kedah and Perak. Most of them belong to Wholesale and Retail Trade and Restaurant and Hotels, followed by Financing Insurance, Real Estate, Investment and Business Services, and Manufacturing. This sectoral representation for the efficient SMEs is consistent with the distribution of SMEs in the NCER population. From our DEA analyses, we conclude three findings: first, financial efficiency is not related to company size; second, oversize in capital (inputs) is more critical than profit (output) generation in determining relative efficiency; third, the distribution of financial efficiency is not balanced across the three states in NCER. The first and third points are consistent with the Korean case reported in Yang (2006).

Keywords: DEA, efficiency, finance, NCER, SMEs

1. Introduction

Small and medium enterprises (SMEs) have been widely recognised as the backbone of the Malaysian economy due to their contribution in promoting endogenous growth for industry expansion and development (Saleh and Ndubisi 2006). For their role in providing tax revenue, output, employment and product diversity, this industry segment has gained the attention

* The first and third authors gratefully acknowledge a research grant from Universiti Sains Malaysia (1001/PMGT/816054). The second author is currently a post-graduate candidate in USM. The usual disclaimer regarding errors and omissions applies.

* Chee Wooi, Hooy, Finance Section, School of Management, Universiti Sains Malaysia, 11800 Minden, Penang
Email: cwhooy@usm.my

** Guat Khim, Hooy, Accounting Section, School of Management, Universiti Sains Malaysia, 11800 Minden, Penang
Email: gthkm@yahoo.com

*** Tajul Ariffin Masron, Finance Section, School of Management, Universiti Sains Malaysia, 11800 Minden, Penang
Email: tams@usm.my

of policymakers and the research community recently. With the competitive business environment under globalisation and deregulation, SMEs however, are contending with a number of challenges. Among the major constraints are limited access to capital financing, a low degree of professionalism, difficulties in recruiting qualified personnel, dependency on clients and suppliers, heavy regulatory burdens, and the absence of economies of scale, among others (see Burns 2001; Wang 2003). Some of these challenges are also common to Malaysian SMEs (see Moha 1999; SMIDEC 2004; Saleh and Ndubisi 2006) but the relative significance of these factors is not well documented in the literature. As a result, policymakers have to devise policies with little or incomplete information about these factors and this might deter the development of the SMEs.

The launch of the Northern Corridor Economic Region (NCER) that spans from 2007 to 2025 marks the direction of the Malaysian government in accelerating economic growth in the North of Peninsular Malaysia. NCER encompasses the states of Kedah, Penang, Perak and Perlis. The NCER programme not only aims to maximise economic potential and development of the northern region, it also carries the mission to gear the region towards higher value-added production as well as a better knowledge-based economic structure, emphasising the expansion and transformation of agriculture, manufacturing, tourism and logistics sectors in the region. In this context, SMEs can act as the endogenous mechanism in generating domestic-led investment. The development of SMEs is not only important to providing a catalyst in nurturing growth opportunities in the region, but also in helping to evade much dependency on foreign direct investment. Thus, ensuring a sound and competitive development for the SMEs in the northern region has become a key concern for the policymakers. To make NCER a success, it is essential to identify the strengths and weaknesses of the SMEs in the region.

Finance is one of the key factors to a successful business. SMEs not only need to have a sound and solid financial structure, they also need to understand the source of capital financing that specifically matches their needs. However, there is a lack of empirical evidences to examine how efficient SMEs are in utilising their financial resources. The present study aims to gauge the performance of SMEs with respect to their relative efficiency in channeling financial resources – we shall call it financial efficiency henceforth. In this study, we aim to answer three questions. First, are the better capitalised SMEs more efficient in having higher profitability? This issue is critical since a financially inefficient SME, regardless of how large the company size or how efficient its technical efficiency, is unlikely to compete and survive. Second, which of the financial inputs or outputs do SMEs in NCER need to focus on? This issue is relevant to the SMEs as well as to the authorities in monitoring and supervising the development of SMEs in the region. Third, across states and sectors, are the SMEs performing equally well in terms of financial efficiency? This issue is more related to policymakers in deciding and fine-tuning the allocation of SME funding in the region. To answer the above questions, this paper employed a frontier efficiency technique called Data Envelopment Analysis (DEA) to analyse a balanced sample of 1047 SMEs in NCER for the financial year 2007. This technique has been applied to study SME efficiency quite recently. More on this technique is discussed in Section 2 and Section 3.

The rest of this paper is organised as follows: Section 2 provides a brief literature review, Section 3 discusses the methodology, and Section 4 reports the process of data

compilation. The DEA results are discussed in Section 5, and finally Section 6 offers the concluding remarks.

2. Literature Review

From our knowledge, the studies of Tan and Batra (2003) and Yang (2006) are the only two that applied frontier efficiency techniques in research on efficiency issues in SMEs. Tan and Batra (2003) examined how skills, technology and productivity in manufacturing SMEs vary across different firm sizes. They covered six emerging countries, comprising Colombia, Guatemala, Indonesia, Malaysia, Mexico and Taiwan. The sample they collected from each country was not consistent in size and period as the data for Colombia, Indonesia and Mexico were for year 1992 while the data for Guatemala, Malaysia and Taiwan were for years 1999, 1994 and 1986, respectively. The sample size also varied, from a small sample size of 300 companies for Indonesia and Guatemala to 56,047 companies for Taiwan. The paper applied a parametric stochastic production frontier (SPF) model, which is one of the five major frontier efficiency techniques, covering a list of variables including various measures of companies' financial status, production process and workers' quality. Basically Tan and Batra (2003) found technical efficiency to rise with company size, but small companies were not inherently inefficient. They also reported that a common set of factors has played an important role in determining the efficiency levels of SMEs across the six emerging markets. These include education and training of workers, investment in new technology, automation, and quality control.

Yang (2006), on the other hand, examined the issue of production efficiency across capital and non capital regions for the case of Korean SMEs. The study analysed the technical efficient and resource utilisation of 267 Korean SMEs that received government funding for the sample years 2000-2002. In their study, another frontier efficiency technique, DEA, was used. DEA is basically a non parametric input/output analysis. The inputs used in the study were companies' capital, fixed assets, number of staff members, fund raising (sum of finances), and other policy funds (sum of other operating funds); while two outputs were included, business profit and total sales. The choice of inputs and outputs shows that Yang (2006) basically focused on SMEs' financial efficiency. From their results, they concluded that large SMEs are relatively more efficient but the efficiency level is not balanced across different regions; SMEs in the capital area are relatively more efficient. Other important findings are related to channeling of government funds.

3. Methodology

In this study DEA frontier analysis was chosen to benchmark the relative efficiency of the SMEs in the NCER. DEA is a non parametric frontier analysis developed by Charnes *et al.* (1978). Among the five frontier techniques, DEA was chosen as this approach is comparatively robust (Seiford and Thrall 1990) and popular (Cooper *et al.* 2004).¹ DEA does

¹ Besides DEA, another non parametric frontier analysis is Free Disposal Hull (FDH) suggested by Deprins *et al.* (1984). The other three frontier approaches are parametric based; they are SFA proposed by Aigner *et al.* (1977), Meeusen and van den Broeck (1977) and Battese and Corra (1977); the thick frontier approach (TFA) suggested by Berger and Humphrey (1991), and the distribution-free approach (DFA) developed by Berger (1993).

not require an explicit specification of the underlying input/output production process. This relaxes many restrictive parametric assumptions and avoids limitations in traditional efficiency measurement approaches.

DEA is a unit free technique that analyses multiple input and multiple output process. This model has been popular for analysing firm level efficiency and has been widely used in rating commercial banks, non profit organisations, government agencies, universities, hospitals, and airports. Only recently, the use of this model has been extended to measure country level efficiency; see for example, Taskin and Zaim (2001), Ali and Nakosteen (2005), Tan and Hooy (2007) and Tan *et al.* (2008). In the area of SMEs, there are only two applications found, that is, Tan and Batra (2003) and Yang (2006).

DEA essentially forms a frontier using the relatively efficient SMEs. The process of DEA benchmarking is to construct a non parametric envelope frontier over the data points such that all observed SMEs lie on or below the frontier. DEA then determines which particular SME operates on the efficiency frontier and which unit does not. All the SMEs that lie on the frontier are known as the reference peers. DEA then establishes a relative scoring system led by the benchmark efficiency score of unity. In other words, DEA identifies a group of optimally performing SMEs that are defined as efficient SMEs and assigns them a score of unity. These efficient SMEs are then used to create an efficient frontier or "data envelope" which all SMEs are to be compared against. To put things into a framework, the relative efficiency score E_k for k -SMEs, or so-called decision making units (DMU), is given as follows:

$$E_k = \frac{\sum_{j=1}^n V_{jk} Y_{jk}}{\sum_{i=1}^m U_{ik} X_{ik}} \quad (1)$$

where Y_{jk} and X_{ik} denote the j -th k -output and i -th k -input for k -SMEs (the k -th DMU), respectively. V_{jk} and U_{ik} are the weight placed on the j -th k -output and i -th k -input respectively

and $\sum_{j=1}^n V_{jk} = \sum_{i=1}^m U_{ik}$ for all k ($k=1,2,\dots,9$). This paper applied the basic constant returns-to-scale DEA model. The weights were assumed to be uniform across the inputs and outputs. Transforming the model into a linear fractional programming formula, the focus is to solve the normalised, that E_k is e_k :

$$\text{Maximising } e_k = \sum_{j=1}^n V_{jk} Y_{jk} \quad (2)$$

Subject to the constraints of:

$$\sum_{i=1}^m U_{ik} X_{ik} = 1$$

$$\begin{aligned}
 & \sum_{j=1}^n V_{jk} Y_{jk} - \sum_{i=1}^m U_{ik} X_{ik} \leq 0 \\
 & V_{jk} \geq 0, \quad j=1,2,\dots,n \\
 & U_{ik} \geq 0, \quad i=1,2,\dots,m \\
 & \sum_{j=1}^n V_{jk} = \sum_{i=1}^m U_{ik}
 \end{aligned}$$

As a whole, the optimisation procedure in DEA serves to ensure that the particular SME being evaluated is given the highest score possible by maximising its relative efficiency ratio, at the same time maintaining equity for all other SMEs (see Cooper, Seiford and Tone, 2000). The most efficient SMEs were assigned a value of unity (100%); this is the highest score that none of the other SMEs can exceed, the rest of the lesser performers are in descending rank according to their efficiency scores.

Despite examining the relative performance of SMEs, which is reported in Section 5.2, the DEA model also allows us to look at the strengths of the identified efficient SME(s) as well as drilling into the weak points of the inefficient SME(s). As the DEA benchmarking process traces how far the inefficient SME(s) are situated from the efficient frontier at the nearest point, that is, the group of the reference peers, it allows us to gain additional information on the benchmarking process. One, we can trace the frequency of the group of reference peers for each SME, and see which of the reference peer appears to be the most frequently referred efficient SME, in other words, the universal best efficient SME. Second, as the DEA analysis is done on a multiple-input-output framework, we can also see relatively which of the inputs and outputs are the most frequently referred in benchmarking with the efficient reference peer(s). With this, we can understand the strength of the efficient SMEs. Third, the slack variables in the linear programming process can be referred as the indicators for future improvement. This is the target improvements for the inefficient SME, benchmarking to its group of reference peers, so that the inefficient SME can achieve efficiency at least as the reference peer(s). In terms of input, the percentage to gain in the target improvements refers to the percentage of input to be reduced, while in terms of output, the percentage to gain suggests the additional units of output needed to be achieved based on the actual inputs. The first two analyses focus on the group of reference peers. They are reported in Section 5.3. The results of the third analysis on the inefficient SMEs are reported in Section 5.4.

4. Data Compilation

Our data was sourced from Suruhanjaya Syarikat Malaysia (SSR) (Companies Commission of Malaysia). The original data covered SMEs in the four states in the NCER, comprising Kedah, Penang, Perak and Perlis. The inputs and outputs used were collected from the balance sheet and income statement for the financial year 2007. However, the SSM database only records basic items of the two accounts, so we faced a constraint in data selection; the inputs and outputs were chosen based on availability in the SSM data source.

As SSM does not record company staff numbers (employees) and a breakdown of the details of the two financial accounts, the procedures of Yang (2006) could not be followed

Table 1. Sample screening process

Screening stages	Kedah	Penang	Perak	Perlis	Total
Original SSM Record	-	-	-	-	16988
First Screen (by state code)	-	-	-	-	23
After First Screen	2958	8235	5562	210	16965
Second Screen (by post code)	22	58	125	5	210
After Second Screen	2936	8177	5437	205	16755
Third Screen (by business type)	151	349	477	7	984
After Third Screen	2785	7828	4960	198	15771

closely. We decided to use fixed asset, current asset and paid up capital as financial inputs, and revenue and profit before tax as financial outputs.

In the SSR database, there were 16,988 SMEs in NCER. However, as a small number of companies did not have a complete record of certain important information, we had to screen them. First, we had to take out companies without any information on the originality of the business state code (chrbusinessstatecode), as these companies could not be allocated to any four of the NCER states. As a result, we omitted 23 companies and were left with 16,965 SMEs. The screening process is reported in Table 1.

We then screened the remaining SMEs by their state of origin based on business post code (vchbusinesspostcode). In this round, again we had to omit a total of 210 SMEs that did not have a business post code, which resulted in 16,755 SMEs remaining. Table 2 provides a brief description of these 16,755 SMEs based on their size, measured by two different proxies, that is, total asset and paid up capital. The purpose to use two proxies for size is to check which of these two proxies provide a better company distribution. As reported in Table 2, Penang has the largest number of registered companies, a total of 8,177 SMEs, followed by Perak, Kedah and Perlis, with 5,437, 2,936 and 205 SMEs, respectively. The distribution of the companies in NCER is quite normal. The centre of the distribution is category 4 (< 10 million but ≥ 1 million) under total assets but the centre of the distribution changed to category 5 (< 1 million but $\geq 100,000$) under paid-up capital, except for Perlis which centred at category 5 for both size proxies. This shows that most companies are medium in size, no matter how we measure size. However, under paid-up capital, there is a significant number of very small companies (in category 8) across the four states; this distorts the bell shape normal distribution. For this reason, we think total assets is a better proxy for size in NCER. The following analyses are thus based on total assets as a proxy for company size.

In the third round, we screened again the 16,755 companies by the availability of their business code (vchbusinesscode) that identifies the sector which they are involved in. In this round, there were 984 companies without a business code or business descriptive in Malay texts (vchbusinessdescmalay).² The remaining sample, which is a total of 15,771 SMEs, is tabulated in Table 3 by the type of business. From Table 3, it can be seen that *Wholesale and Retail Trade and Restaurant and Hotels* is the largest sector in NCER,

² The SSM database is in Malay, the official language of Malaysia

Table 2. Number of companies by size

State	Kedah		Penang		Perak		Perlis	
	Total assets	Paid-up capital	Total assets	Paid-up capital	Total assets	Paid-up capital	Total assets	Paid-up capital
Size measure (in ringgit)								
Category 1: ≥ 1 billion	3	1	8	0	6	0	1	1
Category 2: < 1 billion but ≥ 100 million	55	10	184	39	64	22	1	0
Category 3: < 1 billion but ≥ 10 million	389	105	1094	315	636	127	15	3
Category 4: < 10 million but ≥ 1 million	1381	490	3586	1350	2566	961	85	33
Category 5: < 1 million but $\geq 100,000$	1027	1619	3038	4286	1983	2972	95	124
Category 6: $< 100,000$ but $\geq 10,000$	75	351	245	1072	171	790	8	21
Category 7: $< 10,000$ but $\geq 1,000$	4	27	13	75	8	44	0	1
Category 8: $< 1,000$ but ≥ 0	2	333	9	1040	1	520	0	22
Category 9: $< 0^*$	0	0	0	0	2	1	0	0
Total	2936	2936	8177	8177	5437	5437	205	205

Note: * The existence of Category 9 (company size in negative value) might be due to record error.

Table 3. Number of companies by business type

Business code	Original category	Kedah		Penang		Perak		Perlis	
0	Unclear records	1	0.04%	1	0.01%	0	0.00%	0	0.00%
1	Dormant	28	1.01%	57	0.73%	156	3.15%	2	1.01%
111210-122000	Agriculture, Hunting, Forestry and Fishing	76	2.73%	114	1.46%	276	5.56%	2	1.01%
200000-290140	Mining and Quarrying	16	0.57%	22	0.28%	72	1.45%	2	1.01%
300000-399730	Manufacturing	531	19.07%	1508	19.26%	826	16.65%	22	11.11%
420000	Electricity, Gas and Water	10	0.36%	23	0.29%	14	0.28%	1	0.51%
500000-553000	Construction	280	10.05%	559	7.14%	432	8.71%	30	15.15%
610000-646400	Wholesale and Retail Trade and Restaurant and Hotels	1003	36.01%	2848	36.38%	1713	34.54%	72	36.36%
710000-720000	Transport and Communication	154	5.53%	472	6.03%	219	4.42%	19	9.60%
810000-871000	Financing Insurance, Real Estate, Investment and Business Services	505	18.13%	1758	22.46%	962	19.40%	34	17.17%
911100-959200	Community, Social and Personal Services	181	6.50%	466	5.95%	290	5.85%	14	7.07%
Total		2785	100.00%	7828	100.00%	4960	100.00%	198	100.00%

representing around 35 per cent of the number of registered companies available in the four states. This is followed by *Financing Insurance, Real Estate, Investment and Business Services* and *Manufacturing*, respectively, representing about 20 per cent and 16 per cent of the number of companies in the four states. Given the nature of their business, the *Electricity, Gas and Water* and *Mining and Quarrying* sector has the smallest number of companies in the four states. In Perlis additionally, *Agriculture, Hunting, Forestry and Fishing* is also one of the smallest sectors, consisting of two registered companies.

Due to the small number of registered companies in Perlis (only 198 companies), we decided to exclude Perlis from our DEA analysis. Also, we have to follow the conventional wisdom in sectoral analysis to exclude investment companies under *Financing Insurance, Real Estate, Investment and Business Services*. One reason is that the nature of investment companies is very different; they fall under the category of operational type of business and rely heavily on liability rather than assets to generate revenue and profit.

Our next step was to select a sample of SMEs from each of the three states to get a balanced representative for NCER. We decided to carry out the sample selection by company size (total asset). We extracted the top largest 100 SMEs from four categories: category 3 (now inclusive of category 1 and category 2), category 4, category 5 and category 6. With that, we had a total of 400 SMEs for each state, representing four different sizes of SMEs in each state. We assigned a company code for each of the SMEs following the state code used in SSM database: K for Kedah, P for Penang, and A for Perak. A numerical number was then assigned following their ranking by size. For example, the largest SME in Perak was A001 while the smallest was A400.

A preliminary analysis was conducted on the sample of 1200 and found that DEA linear programming could not accommodate the cases with a combination of zero revenue and negative profit. To carry on the DEA analysis, we had no choice but to do another round of screening which left us with 315, 354 and 378 SMEs for Kedah, Penang and Perak, respectively, and which gave a total sample of 1047 SMEs. The complete DEA analysis was carried out on each state separately as well as on the total sample of 1047 SMEs. The results are reported in the next section.

5. DEA Analysis and Discussion

5.1 Descriptive Statistics and Correlation Matrix

The descriptive statistics of our final sample are reported in Table 4. On average, the SMEs in Penang are larger in size and earn more profit relative to those SMEs in Perak and Kedah by any measure for size, that is, fixed assets, current assets or paid-up capital; and regardless of profitability being measured in revenue, or profit before tax. The mean values of all the inputs and outputs for SMEs in Penang are well above those of the same measure for the total sample. For example, the average fixed assets for SMEs in Penang is RM 38,936,976 or 38.9 million, but for those in Kedah and Perak, the averages are RM 21.8 million and RM 38.8 million, respectively. The average for the full sample size is only RM 33.1 million. The size of SMEs in Perak is larger than the SMEs in Kedah but they are mostly below the average size of the full sample. This pattern remains the same for the values of median, that is, the values for SMEs in Penang dominate those in Kedah and in Perak, as well as the average size of the total sample.

Table 4. Descriptive statistics of inputs and outputs (all units in Ringgit Malaysia)

Statistics	Input			Output	
	Fixed assets	Current assets	Paid-up capital	Revenue	Profit
Kedah (354 companies)					
Mean	21,809,499	22,918,538	9,801,769	26,298,390	1,614,387
Median	561,036	1,059,419	500,000	983,761	60,562
Std Dev	104,266,448	58,499,731	48,953,684	81,078,808	42,722,577
Min	0	2,019	0	0	-644,644,000
Max	1,449,177,000	586,193,533	797,958,000	711,133,563	447,048,138
Penang (315 companies)					
Mean	38,936,976	69,756,720	14,249,309	44,652,461	13,522,816
Median	781,121	4,904,386	500,000	0	264,802
Std Dev	140,245,293	180,883,703	45,437,750	319,918,793	55,498,237
Min	0	15,022	2	0	-3,669,784
Max	1,887,729,052	1,600,810,395	500,000,000	4,192,880,438	630,338,911
Perak (378 companies)					
Mean	38,762,365	25,656,336	11,876,921	42,151,043	4,489,106
Median	457,124	1,570,070	417,746	2,372,016	73,688
Std Dev	241,348,800	66,079,846	39,084,024	146,739,587	28,324,540
Min	0	15,143	2	0	-113,376,723
Max	4,037,512,816	524,169,917	354,010,190	1,850,724,420	443,609,897
Full Sample (1047 companies)					
Mean	33,082,984	37,998,686	11,889,049	37,543,696	6,235,016
Median	576,924	2,620,551	500,000	549,489	93,574
Std Dev	175,021,343	113,957,809	44,522,322	201,913,144	43,058,712
Min	0	2,019	0	0	-644,644,000
Max	4,037,512,816	1,600,810,395	797,958,000	4,192,880,438	630,338,911

The standard deviation of fixed assets for SMEs in Penang is smaller than the SMEs in Perak but still exceeds those in Kedah; however for current assets, the variation for SMEs in Penang is the largest, followed by the SMEs in Perak and Kedah. For paid-up capital, the SMEs in Kedah have the largest variation, followed by SMEs in Penang and in Perak. The standard deviation of revenue and profit for SMEs in Penang is also higher than those in Perak and in Kedah, and even the full sample. Large companies in NCER can go beyond RM 4 billion in fixed assets, having current assets exceeding RM 1 billion and paid-up capital beyond RM 0.7 billion. In terms of revenue and profit, the largest values are also from SMEs in Penang, which are RM 4 billion and RM 630 million, respectively.

An important requirement for DEA to perform well is the need to ensure that all input and output sets of variables are free from multicollinearity problems. This is because highly correlated inputs or outputs capture similar information underlying the efficiency process. The pairwise correlation coefficient was referred to check for multicollinearity problems. The correlation matrix of the five variables is reported in Table 5. Generally, we can conclude that both input and output set of variables are free from multicollinearity problems as nearly all the pairwise correlation coefficients were below the conventional threshold of high correlation, 0.7. Only two exceptions were detected: between fixed assets and paid-up capital for Penang (0.8049), and between revenue and profit for Perak (0.7999). These two cases are not really a serious concern as the correlation values just slightly exceeded the threshold. Moreover, when combined for the total sample in Panel 4, the pairwise correlation coefficients among all the variables dropped to a low level of below 0.5. This indicated that we could proceed to DEA analysis safely.

5.2 DEA Efficiency Scores

The results of the DEA efficiency scores for individual state analysis and the total sample analysis are reported in Table 6. We tabulated the efficiency scores into six different efficiency levels and calculated the proportion of efficiency levels achieved in the three individual-state analyses as well as in the total sample analysis. Looking at the tabulation of proportion, obviously the efficiency score distribution is positively skewed, that is, as the score becomes higher, the number of SMEs in the category gets smaller. This is universal across all the four analyses.

In the three individual-state analyses, the number of 100 per cent efficient SMEs is 18, 12 and 9 for Kedah, Penang and Perak, respectively. However, in the total sample analysis, only 20 SMEs managed to achieve 100 per cent efficiency; and out of the 20, Kedah, Penang and Perak had 10, 3, and 7 SMEs, respectively. The proportion of efficient SMEs dropped from 2-5 per cent in the three individual-state analyses to less than 2 per cent in the total sample analysis. Although Penang had more efficient SMEs than Perak in individual-state analyses, when all SMEs were pooled in the total sample, Kedah and Perak seemed to dominate the list of efficient SMEs. Note that at this stage, the order of the efficient units does not imply ranking. The 20 efficient SMEs with 100 per cent scoring are equally efficient. In the DEA scoring process, the ranking for each SME is based on their benchmark to these 20 efficient SMEs. Further analyses on the DEA benchmarking process are provided in Sections 5.3 and 5.4, respectively.

Table 5. Pairwise correlation coefficient of inputs and outputs

Panel 1: Kedah	Fixed assets	Current assets	Paid-up capital	Revenue
Fixed asset	1	-	-	-
Current asset	0.5386	1	-	-
Paid up capital	0.3887	0.5123	1	-
Revenue	-	-	-	1
Profit	-	-	-	0.5575
Panel 2: Penang	Fixed assets	Current assets	Paid-up capital	Revenue
Fixed asset	1	-	-	-
Current asset	0.5272	1	-	-
Paid up capital	0.8049	0.3831	1	-
Revenue	-	-	-	1
Profit	-	-	-	-0.0077
Panel 3: Perak	Fixed assets	Current assets	Paid-up capital	Revenue
Fixed asset	1	-	-	-
Current asset	0.5521	1	-	-
Paid up capital	0.4365	0.6897	1	-
Revenue	-	-	-	1
Profit	-	-	-	0.7999
Panel 4: Total sample	Fixed assets	Current assets	Paid-up capital	Revenue
Fixed asset	1	-	-	-
Current asset	0.4236	1	-	-
Paid up capital	0.4653	0.4552	1	-
Revenue	-	-	-	1
Profit	-	-	-	0.4821

5.3 Analyses on the Efficient SMEs - Peers Identification and Input/Output Contribution

In this section, the focus was on the perfect-score efficient SMEs. These SMEs were tabulated by their type of business and the results are reported in Table 7. Basically, the efficient SMEs were mostly from the business type of *Wholesale and Retail Trade and Restaurant and Hotels* and *Financing Insurance, Real Estate, Investment and Business Services*. In the individual state analysis, each type of business had at least one efficient SME, with the exception of *Electricity, Gas and Water*. For the total sample analysis, none of the SMEs from *Mining and Quarrying* and *Transport and Communication* were efficient. This is somewhat consistent with the sector representative in the tabulation of 15,771 companies in Table 3.

To see which of the 20 SMEs in the total sample were the most referred efficient SMEs, we proceeded to analyse the group of reference peers. The group of reference peers refers to the selected efficient SMEs that each individual company's inputs or outputs are

Table 6. Frequency of efficiency score by values

State	Efficiency	Number of companies				
		Kedah	Penang	Perak	Full Sample	Proportion
Kedah	100%	18	-	-	-	5.08%
	≥ 80% but < 100%	3	-	-	-	0.85%
	≥ 60% but < 80%	15	-	-	-	4.24%
	≥ 40% but < 60%	19	-	-	-	5.37%
	≥ 20% but < 40%	37	-	-	-	10.45%
	≥ 0% but < 20%	262	-	-	-	74.01%
Total		354				100.00%
Penang	100%	-	12	-	-	3.81%
	≥ 80% but < 100%	-	6	-	-	1.90%
	≥ 60% but < 80%	-	6	-	-	1.90%
	≥ 40% but < 60%	-	21	-	-	6.67%
	≥ 20% but < 40%	-	53	-	-	16.83%
	≥ 0% but < 20%	-	217	-	-	68.89%
Total			315			100.00%
Perak	100%	-	-	9	-	2.38%
	≥ 80% but < 100%	-	-	3	-	0.79%
	≥ 60% but < 80%	-	-	8	-	2.12%
	≥ 40% but < 60%	-	-	17	-	4.50%
	≥ 20% but < 40%	-	-	50	-	13.23%
	≥ 0% but < 20%	-	-	291	-	76.98%
Total				378		100.00%
Full sample	100%	10	3	7	20	1.91%
	≥ 80% but < 100%	2	2	2	6	0.57%
	≥ 60% but < 80%	4	3	7	14	1.34%
	≥ 40% but < 60%	15	8	7	30	2.87%
	≥ 20% but < 40%	35	35	37	107	10.22%
	≥ 0% but < 20%	288	264	318	870	83.09%
Total		354	315	378	1047	100.00%

benchmarked for calculating the individual DEA score. As the results involve too much information, the details of the group of reference peers for each SMEs are not reported here to conserve space but are available upon request. Table 8 reports the tabulated frequency of each of the 20 efficient SMEs that have been selected in the group of reference peers for the total sample of 1047 SMEs. Note that with 1047 SMEs, only a total of 1047 Peer 1 can be

Table 7. Frequency of efficient SMEs by type of business

	Kedah %		Penang %		Perak %		All %	
Agriculture, Hunting, Forestry and Fishing	0	0.0	0	0.0	1	11.1	1	5.0
Mining and Quarrying	0	0.0	1	8.3	0	0.0	0	0.0
Manufacturing	1	5.6	1	8.3	0	0.0	1	5.0
Electricity, Gas and Water	0	0.0	0	0.0	0	0.0	0	0.0
Construction	1	5.6	1	8.3	2	22.2	4	20.0
Wholesale and Retail Trade and Restaurant and Hotels	8	44.4	3	25.0	2	22.2	6	30.0
Transport and Communication	1	5.6	0	0.0	0	0.0	0	0.0
Financing Insurance, Real Estate, Investment and Business Services	4	22.2	4	33.3	1	11.1	5	25.0
Community, Social and Personal Services	2	11.1	2	16.7	1	11.1	1	5.0
Dormant	1	5.6	0	0.0	2	22.2	2	10.0
Total	18	100.0	12	100.0	9	100.0	20	100.0

expected, while the rest can be any number less than the total (not all companies have more than 1 reference peer).

The most referred efficient SMEs are arranged in order; from Peer 1 to Peer 4. Among all the 20 efficient SMEs, A327, from the city of Ipoh, appears to be the most referred Peer 1, with 590 times. This is followed by A332 and A397, with 172 and 142 times, respectively. However, A332, also from the city of Ipoh, leads the numbers in Peer 2, followed by A397 and A400. K387 is the top referred Peer 3, follows by K393, while K399 is the most referred Peer 4. All the other non mentioned efficient SMEs have been referred too but the frequency is less than 100 times under each peer category. In total, A332 tops the list, followed by A327 and K387 with 649, 590 and 508 times, respectively. The next most referred group consists of A397 (340 times), K393 (228 times), K399 (228 times), A400 (200 times) and K324 (197 times). The remaining 12 efficient SMEs were referred to less than 30 times in total, and the minimum is 1 time. We cannot refer to the total frequency to judge on the ranking of the efficient SMEs as it does not take into account the weight of different orders of the peer group. Moreover, it is not easy to determine an appropriate weight. Given the close frequency numbers for the top three SMEs, we think the one that dominated Peer 1 should be the most efficient SME, that is, A327. In essence, an obvious pattern in this analysis is that the efficient SMEs from Perak appear to be the leading efficient SMEs and none of the three efficient SMEs from Penang are heavily referred.

As a follow up from the group of reference peers analysis, Table 9 reports the details of the input/output contribution that the DEA algorithm has used in achieving the efficient scores. The input/output contribution for each SME is basically collected from their

Table 8. Frequency of efficient SMEs as reference peers (total sample only)

No	Company code	Peer 1	Peer 2	Peer 3	Peer 4	Total
1	A129	6	0	0	0	6
2	A220	1	0	0	0	1
3	A327	590	0	0	0	590
4	A332	172	477	0	0	649
5	A386	1	1	0	0	2
6	A397	142	121	77	0	340
7	A400	33	103	64	0	200
8	P113	1	2	0	0	3
9	P280	5	24	0	0	29
10	P343	1	4	0	0	5
11	K077	6	3	1	0	10
12	K137	1	1	0	0	2
13	K228	1	0	0	1	2
14	K277	1	4	4	0	9
15	K314	1	5	3	0	9
16	K324	65	67	65	0	197
17	K336	1	1	0	0	2
18	K387	1	36	424	47	508
19	K393	5	92	113	18	228
20	K399	12	26	54	136	228
Total		1046*	967	805	202	3020

Note: * Radial for A229 is 0%, so there is no reference unit for one company.

benchmarking process with the group of reference peers. This analysis is a useful indication of the financial input and output used in determining the relative efficiency scores, their percentage, and those that have been ignored. The values are normalised to show a percentage of the overall input and output contributions. Again, to conserve space, the numerical values produced from DEA are skipped and only the frequency for the full sample is reported. The details are available upon request.

At first glance, the results in Table 9 indicate that contribution of the inputs and outputs are not balanced. Apparently, current assets is the most frequently referred financial input, as it is mentioned more than 71 times as 100 per cent under individual reference peers, and for the rest of the values below 100 per cent, the frequency is also very high; 225 times for 80 per cent and above, 318 times for 60 per cent and above, and 265 times for 40 per cent and above. The remaining low value contributions are 142 times for 20 per cent and above, and 26 times for 0 per cent and above. Such high contributions are not observed for other variables. For example, for fixed asset, it has 100% contribution only once in the reference peer's benchmarking. The rest are concentrated at a very low percentage contribution; fixed asset is reported 88 times to have less than 20-40 per cent contribution, and 949 times to have less than 20 per cent contribution. A similar pattern is observed for the two outputs. In

Table 9. Frequency of input-output contribution in determining the efficiency score

Contribution	Input			Output	
	Fixed assets	Current assets	Paid-up capital	Revenue	Profit
100	1	71	0	1	4
≥ 80% but < 100%	0	225	17	8	6
≥ 60% but < 80%	2	318	96	7	7
≥ 40% but < 60%	7	265	185	18	15
≥ 20% but < 40%	88	142	301	43	62
≥ 0% but < 20%	949	26	448	970	939
<0	0	0	0	0	14*
Total	1047	1047	1047	1047	1047

Note: Contribution in 14 cases recorded a negative value for profit. What this might imply is that some SMEs might need to reduce their profit relatively.

general, we can conclude that current asset is the key factor differentiating the relative performance of the SMEs in NCER.

5.4 Analyses on the Inefficient SME – Target Improvement

In DEA benchmarking analysis, the target improvement for each input and output is reported for each company. These are basically the slack values calculated in DEA linear programming. To conserve space, only the frequency of various target improvement levels is tabulated in Table 10. The details of the target improvement values for each SME are available upon request. This analysis is particularly important for the inefficient SMEs (those that scored less than 100%) to identify the area of weakness for improvement. Also, the average percentage of target improvement across the 1407 SMEs are calculated and reported in Panel B of Table 10.

Looking at Table 10, we can say that more than 80 per cent of the companies need to focus on all the three inputs. In terms of improvement, 803, 868 and 883 SMEs need more than a 80 per cent improvement in fixed asset, current asset and paid up capital, respectively while 42, 3, and 9 SMEs need 100 per cent target improvement on these three mentioned inputs, respectively. For the two outputs, around 90 per cent of the SMEs do not require any target improvement, that is, 0 per cent. Also, 8.2 per cent of the SMEs show a negative target improvement, a technical result that is difficult to interpret. Generally, the target improvement analysis implies that SMEs in NCER are content with oversupply of financial resources (input) relative to their financial performance (output).

6. Concluding Remarks

This paper investigates relative operating efficiency in utilisation of financial resources for SMEs in Malaysia using Data Envelopment Analysis (DEA). Our focus was on SMEs located in the Northern Corridor Economic Region (NCER), covering the four states of Kedah, Penang, Perak, and Perlis with a population of 16,988 SMEs in the financial year 2007. We compiled and screened the population to exclude those with incomplete information

Table 10. Frequency of various target improvement levels and average improvement values for the inefficient SMEs

Panel A: Frequency of various target improvement levels

Target improvement	Input						Output			
	Fixed assets	%	Current assets	%	Paid-up capital	%	Revenue	%	Profit	%
100%	42	4.0	3	0.3	9	0.9	0	0.0	0	0.0
≥ 80% but < 100%	803	76.7	868	82.9	883	84.3	55	5.3	25	2.4
≥ 60% but < 80%	70	6.7	106	10.1	94	9.0	9	0.9	2	0.2
≥ 40% but < 60%	21	2.0	30	2.9	25	2.4	13	1.2	5	0.5
≥ 20% but < 40%	7	0.7	14	1.3	11	1.1	14	1.3	3	0.3
≥ 0% but < 20%	3	0.3	6	0.6	5	0.5	14	1.3	9	0.9
= 0%	101	9.6	20	1.9	20	1.9	941	89.9	917	87.6
< 0%	0	0.0	0	0.0	0	0.0	1	0.1	86	8.2
	1047	100.0	1047	100.0	1047	100.0	1047	100.0	1047	100.0

Panel B: Average improvement values

Target improvement	Input			Output	
	Fixed assets	Current assets	Paid-up capital	Revenue	Profit
Average	82.34%	87.15%	88.13%	125.90%	-367.32%

on state code, post code and business code, and that left us with 15,771 SMEs. As Perlis only had 198 SMEs, we excluded it from our analysis. For the remaining three states, we excluded investment firms and sampled only 100 SMEs from four different levels of company size, proxied by total asset. We obtained 1200 SMEs in total but due to constraints in DEA programming, we excluded 153 SMEs with zero revenue and negative profit, and were finally left with 1047 SMEs for DEA analysis. The inputs applied were fixed asset, current asset and paid up capital while the two outputs used were revenue and profit before tax. These inputs/outputs were basically free from multicollinearity problems and hence we could safely apply DEA.

Basically, the efficiency scores of SMEs in NCER are positively skewed. For the total sample analysis, less than 2 per cent of the sample (20 SMEs) managed to achieve the status of 100 per cent efficient and they were mostly from the sector of *Wholesale and Retail Trade and Restaurant and Hotels*, followed by *Financing Insurance, Real Estate, Investment and Business Services*, and *Manufacturing*. This is consistent with the sector representative in the pool of total screened population, which involved 15,771 SMEs. Although Penang had more numbers of efficient SMEs than Perak in individual-state analysis, in the pooled analysis of all SMEs in the total sample, Kedah and Perak seemed to dominate the list of efficient SMEs. From the peer identification analysis, the efficient SMEs in Perak were found to be relatively better compared to the rest. In the analysis on input/output contribution, the key variable in the DEA benchmarking process was identified as current asset. Also, for the inefficient SMEs, the target improvement analysis suggests that they should focus on how to minimise all the three financial inputs.

This study delivered three important findings. First, the efficiency of channelling financial resources is not based on company size; this is true at least in the NCER region. This finding is reflected in various different analyses on the efficient and inefficient SMEs. Second, the SMEs in NCER need to focus on efficient utilisation of financial resources, instead of revenue or profit generating. Generally, they can gain efficiency by reducing wastage in financial resources. Finally, the distribution of financial efficiency is not balanced across the three states in NCER. For the first and third points, our findings are very much consistent with the Korean case reported in Yang (2006).

Surprisingly, Penang as the second leading economic state after the capital state Kuala Lumpur, is not showing any dominance in financial efficiency rating of SMEs in NCER. But this study only focused on one financial year, 2007. To enable a strong and robust policy recommendation, we need to compare time series behaviour of financial efficient scores. Future studies should extend a comparison of SMEs in other states, especially those in Kuala Lumpur and Johor as well; or to benchmark our SMEs to SMEs in other emerging markets as undertaken by Tan and Batra (2003).

References

- Aigner, D., C.A.K. Lovell and P. Schmidt. 1977. Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics* 6: 21-37.
- Ali, A.I. and R. Nakosteen. 2005. Ranking industry performance in the US. *Socio-Economic Planning Sciences* 39: 11-24.

- Battese, G. and G. Corra. 1977. Estimation of a production frontier model: with application to the pastoral zone of Eastern Australia. *Australian Journal of Agricultural Economics* 21: 169-179.
- Berger, A.N. 1993. Distribution-free estimates of efficiency in the US banking industry and tests of the standard distributional assumptions. *Journal of Productivity Analysis* 4: 261-292.
- Berger, A.N. and D.B. Humphrey. 1991. The dominance of inefficiencies over scale and product mix economies in banking. *Journal of Monetary Economics* 28: 117-148.
- Burns, P. 2001. *Entrepreneurship and Small Business*. Palgrave: Macmillan..
- Charnes, A., W.W. Cooper and E. Rhodes. 1978. Measuring efficiency of decision making units. *European Journal of Operational Research* 3: 429-444.
- Cooper, W.W., L.M. Seiford, E. Thanassoulis and S.H. Zanakis. 2004. DEA and its uses in different countries. *European Journal of Operational Research* 154: 337-344.
- Deprins, D.S.L. and H. Tulkens. 1984. Measuring Labour Efficiency in Post Offices. In *The Performance of Public Enterprises*, ed. M. Marchand, P. Pestieau and H. Tulkens. Amsterdam: North-Holland.
- Meeusen, W. and J. van den Broeck. 1977. Efficiency estimation from Cobb-Douglas production functions with composed error. *International Economic Review* 18: 435-444.
- Moha, A. 1999. *Small and Medium Enterprises in Malaysia: Policy Issues and Challenges*. Ashgate: Vermont.
- Saleh, A.S. and N.O. Ndubisi. 2006. An evaluation of SME development in Malaysia. *International Review of Business Research Papers* 2(1): 1-14.
- Seiford, L.M. and R.M. Thrall. 1990. Recent developments in DEA: the mathematical programming approach to frontier analysis. *Journal of Econometrics* 46: 7-38.
- SMIDEC. 2004. *SMIDEC Annual Report: SME Performance 2003*. SMIDEC: Kuala Lumpur.
- Tan H.B. and C.W. Hooy. 2007. The development of East Asia countries towards a knowledge-based economy: a DEA analysis. *Journal of the Asia Pacific Economy* 12(1): 17-33.
- Tan H.B., C.W. Hooy, M.N. Sardar Islam and A. Manzoni. 2008. Relative efficiency measures for the knowledge economies in the Asia Pacific region. *Journal of Modelling in Management* 3(2): 111-124.
- Tan, H. and G. Batra. 2003. SME Technical Efficiency and its Correlates: Cross-National Evidence and Policy Implications. World Bank Institute Working Paper.
- Taskin, F. and O. Zaim. 2001. The role of international trade on environmental efficiency: a DEA approach. *Economic Modelling* 18: 1-17.
- Wang, S.D. 2003. The implications of e-financing: implications for SMEs. *Bulletin on Asia-Pacific Perspective 2003-2004*. United Nations.
- Yang, J.C. .2006. The efficiency of SMEs in the global market: measuring the Korean performance. *Journal of Policy Modeling* 28: 861-876.