ASIAN ACADEMY *of* MANAGEMENT JOURNAL *of* ACCOUNTING *and* FINANCE

AAMJAF, Vol. 3, No. 1, 37–57, 2007

WHAT EXPLAINS DIFFERENCES IN THE EFFICIENCY OF NON-COMMERCIAL BANK FINANCIAL INTERMEDIARIES? EMPIRICAL EVIDENCE FROM MALAYSIA

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ABSTRACT

This paper investigates the performance of Malaysian Non-Commercial Bank Financial Institutions (NCBFIs) during the period of 2000 to 2004. The efficiency estimates of individual NCBFIs are evaluated using the non-parametric Data Envelopment Analysis (DEA) method. The method allows us to distinguish individual NCBFIs technical efficiency (TE) along with its mutually exhaustive components of pure technical efficiency (PTE), and scale efficiency (SE) components. Additionally we have performed a series of parametric and non-parametric tests to examine whether the merchant banks and finance companies were drawn from the same population. The findings suggest that during the period of study, scale inefficiency dominates pure technical inefficiency in the Malaysian NCBFI sector. We found that the merchant banks have exhibited higher technical efficiency relative to its finance companies peers. The results from the parametric and non-parametric tests do not reject the null hypothesis of the merchant banks and finance companies sharing the same production technology, implying that it is appropriate to construct a common frontier.

Keywords: Non-Commercial Bank Financial Institutions (NCBFIs), Data Envelopment Analysis (DEA), Malaysia

INTRODUCTION

Non-Commercial Bank Financial Institutions (NCBFIs) play an important dual role in a financial system. Traditionally NCBFIs comprise of a mixed bag of

institutions that includes all financial institutions, which are not classified as commercial banks. They complement the role of commercial banks, filling in financial intermediation gaps by offering a range of products and services that they offered. Nevertheless, they also compete with commercial banks, forcing the latter to be more efficient and responsive to their customers needs. Most NCBFIs are also actively involved in the securities markets and in the mobilization and allocation of long-term financial resources. The state of development of NCBFIs is usually a good indicator to the state of development of a country's financial system as a whole.

The importance to investigate the efficiency and productivity of Malaysian NCBFIs could be best justified by the fact that in Malaysia, the NCBFIs play important roles in complementing the facilities offered by the commercial banks and are the key players in the development of the capital markets in Malaysia. The existence of Banking Financial Institutions (BFIs) and NCBFIs, supported by efficient money and capital markets, keeps the financial sector complete, while enhancing the overall growth of the economy. Although Malaysia is moving towards a full market-based economy, its capital markets are still at its infancy. As a sophisticated and well-developed capital markets are considered as the hallmark for a market-based economy worldwide, study of this nature is particularly important as the health and development of the capital market rely largely on the performance of the NCBFIs. Hence, efficient and productive NCBFIs are expected to enhance the Malaysian capital markets in its pursuit to move towards a full market-based economy.

The main motivation for this study is the Malaysia's Financial Sector Master Plan (FSMP), a long-term development plan charting the future direction of the financial services industry in Malaysia to achieve a more competitive, resilient and efficient financial system (see BNM Financial Sector Master Plan, 2001). Among the measures outlined in the plan is further liberalization of the banking sector, ahead of the opening of the financial sector to foreign competitions in 2007. The findings of this study will highlight the effectiveness of microeconomic reforms introduced by the Malaysian government to enhance the competitiveness of the Malaysian financial services industry, which among others includes the most recent consolidation in the sector involving the commercial banks and their finance companies subsidiaries. The findings of the study could be used as an avenue for future research in the area as well as to provide useful insights to policymakers who may be interested to know the impact of the rationalization exercise on the efficiency of the acquiring institutions.

The study will also be the first to investigate the sources of productivity of NBFI in a developing economy. Despite the significance of the NBFI sector

towards economic developments, studies that attempt to investigate this issue are relatively scarce. Over the years, while there have been extensive literature examining the productivity and efficiency of banking industries in various countries, empirical works on NCBFIs productivity and efficiency are still in its infancy. To the best of our knowledge, there has been no microeconomic study performed in this area of research with respect to the NCBFIs.

Since its introduction by Charnes, Cooper, and Rhodes (1978), researchers have welcomed Data Envelopment Analysis (DEA) as a methodology for performance evaluation (Gregoriou & Zhu, 2005). DEA has many advantages over traditional parametric techniques such as regression techniques. While regression analysis approximates the efficiency of banks under investigation relative to the average performance, DEA in contrast, focuses on the yearly observations of individual banks and optimises the performance measure of each bank. Constructing a separate frontier for each of the years under study is a critical issue in a dynamic business environment because a financial institution may be the most efficient in one year but may not be in the following year. In the Malaysian context, it becomes more important, as there is an ongoing liberalization in the banking sector over the estimation period. A separate frontier will highlight any significant changes taking place in the sector that are induced by Bank Negara Malaysia's (BNM) supervisory policies.

By applying the non-parametric DEA methodology, we attempt to investigate the efficiency of Malaysian non-commercial bank financial institutions during the period of 2000 to 2004. The preferred non-parametric DEA methodology has allowed us to distinguish between three different types of efficiency, such as technical, pure technical and scale efficiencies. Additionally we have performed a series of parametric and non-parametric tests to examine whether the merchant banks and finance companies were drawn from the same population.

During the period of study, the empirical findings suggest that, the Malaysian merchant banks have exhibited mean overall or technical efficiency of 69.6% while the finance companies have exhibited lower mean technical efficiency of 44.7%. Overall, the results suggest that scale inefficiency dominates pure technical inefficiency effects in determining Malaysian NCBFIs overall or technical inefficiency.

BRIEF OVERVIEW OF THE MALAYSIAN FINANCIAL SYSTEM

The Malaysian financial system can broadly be divided into the banking system and the non-commercial bank financial intermediaries. These two banking

institutions are different with respect to their activities. For a well functioning financial market along with the BFIs, NCBFIs have an important role to uplift the economic activity. These two financial sectors can simultaneously build up and strengthen the financial system of the country. The banking system is the largest component, accounting for approximately 70% of the total assets of the financial system. The banking system can be further divided into three main groups, namely the commercial banks, finance companies and the merchant banks.

The commercial banks are the main players in the banking system. They are the largest and most significant providers of funds in the banking system. As at end of 2004, there were 10 domestically incorporated and 13 locally incorporated foreign commercial banks in Malaysia. Legally, Malaysian commercial banks enjoy the widest scope of permissible activities and are able to engage in a full range of banking services. Traditionally, Malaysian commercial banks main functions include retail-banking services, trade financing facilities, treasury services, cross border payment services and custody services. Apart from the more traditional activities, Malaysian commercial banks are also allowed to engage in foreign exchange activities, i.e. to buy, sell, and lend foreign currencies and the only financial institutions allowed to provide current account facilities.

Finance companies formed the second largest group of deposit taking institutions in Malaysia. There were 10 domestically incorporated finance companies in Malaysia as at end of 2004. Traditionally, finance companies specialize in consumption credit, comprising mainly of hire purchase financing, leasing, housing loans, block discounting, and secured personal loans. The finance companies are allowed to accept savings and fixed deposits from the public, but are prohibited from providing current account facilities. They are also not allowed to engage in foreign exchange transactions compared to their commercial banks counterparts. During the later part of the last decade, the finance companies began to expand its traditional role in retail financing to include wholesale banking as well.

Merchant banks emerged in the Malaysian banking scene in the 1970s, marking an important milestone in the development of the financial system alongside the corporate development of the country. As the country's small businesses prospered and grew into large corporations, the banking needs of the nation became larger and more sophisticated, requiring more bulk financing and complex banking services.

Merchant banks filled the need for such services by complementing the facilities offered by commercial banks, which were at times more focused on providing short-term credit for working capital and trade financing. They play a role in the short-term money market and capital raising activities such as

financing, syndicating, corporate financing, providing management advisory services, arranging for the issue and listing of shares as well as managing investment portfolio. As at end of 2004, there were 10 merchant banks in Malaysia and all were domestically controlled institutions.

Table 1
Assets of the Financial System, 1960–2004

Year	Commercial banks		Finance companies		Merchant banks	
	RM million	As a ratio of GDP	RM million	As a ratio of GDP	RM million	As a ratio of GDP
1960	1,231.9	0.21	n.a.	n.a.	n.a.	n.a.
1970	4,460.2	0.38	531.0	0.05	19.6*	0.002
1980	32,186.1	0.63	5,635.4	0.13	2,228.7	0.05
1990	129,284.9	1.23	39,448.0	0.50	11,063.2	0.14
1995	295,460.0	1.77	91,892.0	0.55	27,062.0	0.16
1996	360,126.8	1.98	119,768.8	0.65	34,072.8	0.19
1997	480,248.1	2.46	152,386.8	0.77	44,300.0	0.23
1998	453,492.0	2.52	123,596.9	0.68	39,227.8	0.22
1999	482,738.3	2.50	116,438.0	0.60	39,184.0	0.20
2000	512,714.7	2.44	109,409.8	0.52	36,876.0	0.18
2001	529,735.5	2.51	121,811.1	0.58	41,025.2	0.19
2002	563,254.1	2.56	130,520.0	0.59	41,415.5	0.19
2003	629,975.3	2.71	141,911.0	0.61	44,103.6	0.19
2004	761,254.8	3.05	68,421.1	0.27	42,691.0	0.17

Source: Bank Negara Malaysia

Note: * as at end of 1971

The Malaysian financial system's assets and liabilities continued to be highly concentrated at the commercial banking sector with total assets and liabilities amounting to RM761,254.8 billion or 3.05 times the national GDP as at end of 2004. Prior to the Asian financial crisis in 1997/1998, the finance companies' assets and liabilities were seen increasing from only RM531 million or 0.05 times of the national GDP in 1970 to reach RM152.4 billion or 0.77 times in 1997. The ratio however has gradually declined to RM123.6 billion or 0.60 times in 1998 to RM109,409.8 billion or 0.52 times GDP in 2000, before increasing again in year 2001, to reach a post crisis high of RM141,911.0 billion or 0.61 times of the national GDP in 2003.

Due to further consolidation in the Malaysian financial sector, the finance companies assets as a ratio of the national GDP declined again to reach 0.27 times in 2004. As for the merchant banks, a similar trend is observed where its assets and liabilities as a ratio of the national GDP have been increasing since

1971 to reach a peak of RM44.3 billion or 0.23 times GDP in 1997, i.e. before the Asian financial crisis. During the post crisis period, the merchant banks' assets and liabilities continued to remain stable at 0.17 to 0.22 times of the national GDP. A combination of both the finance companies and merchant banks total assets reveal that, the non-commercial bank financial sector command approximately 22.8% of the banking system's total assets and liabilities.[1]

RELATED STUDIES

In the past few years, DEA have frequently been applied to banking industry studies. Berger and Humphrey (1997) made a wide survey of efficiency studies of financial institutions from 21 different countries around the world. They identified 130 studies that estimate frontiers of efficiency for different type of institutions and used different methodologies. Despite these differences, the studies reviewed have exhibited surprisingly similar results: X-inefficiencies tend to be large and amount to approximately 20% of the total costs of the banking industry. Additionally, X-inefficiency was in most cases more important than scale and scope inefficiencies. There is not, however, a clear understanding of the reasons for the differences observed in those studies. Berger and Mester (1997) explored the sources of the differences in measured efficiency issue in more detail. Their findings indicate that the use of different methods, functional forms and variables usually make very little difference in the ranking of individual firms or the average industry efficiency.

Despite substantial studies performed on the developed economies banking industry with regard to the efficiency and productivity of financial institutions, there were only a handful of studies performed on the Malaysian financial industry partly due to the lack of available data sources and the small sample of institutions. As pointed out by Kwan (2003), the lack of research on the efficiency of Asian banks was due to the lack of publicly available data for non-publicly traded Asian financial institutions.

Among the notable microeconomic research performed on Malaysian banks' efficiency was by Katib and Mathews (2000), which studied the characteristics of the management structure and technical efficiency of the banking industry in Malaysia by DEA from 1989 to 1995. They found that on the average, Malaysian banks do not efficiently combine their inputs. They suggest that over the period of observation, average technical efficiency of Malaysian banks range from 68% to 80%. They also suggest that most of the Malaysian

[1] The figure is at end of 2003, prior to the consolidation of finance companies into their respective commercial banking parents.

commercial banks do not operate at constant returns to scale and that the technical inefficiency of Malaysian banks were attributed to scale inefficiency.

Okuda and Hashimoto (2004) conducted a research on the production technology of Malaysian domestic commercial banks with Stochastic Cost Functions approach adjusted to non-performing loans from the year 1991 to 1997. They found that fixed costs were higher for the large banks compared to its small and medium sized peers. Despite that, they found economies of scale do exist for the large banks while economies of scale were not evident for the small and medium sized banks.

These studies have arrived at similarities and differences. Katib and Mathews (2000) concluded that most commercial banks in Malaysia do not operate at constant returns to scale with technical efficiency ranged from 68% to 80%. They also found that technical inefficiency is mainly due to scale inefficiency adding that scale inefficiency is relatively large in the Malaysian commercial banks. Supporting to the view, Okuda and Hashimoto (2004) have also concluded that the estimated total elasticity of scale is greater than unity and that economies of scale were not observed. Okuda and Hashimoto (2004) also found that there was a tendency that the operational cost of Malaysian commercial banks increases over time and negative technological progress was observed. Correspondingly, Katib and Mathews (2000) suggests the deterioration of technical efficiency of Malaysian commercial banks during 1989 and 1994.

With regard to the efficiency of banks in different forms, Okuda and Hashimoto (2004) arrived at a different conclusion to that of Katib and Mathews (2000). Okuda and Hashimoto (2004) found that small sized banks are more cost efficient than the large size counterparts, while Katib and Mathews (2000) suggests that the best practice is provided by the medium sized banks. They found that banks of smaller size have constant or increasing returns to scale, which implies that they are too small to realize scale merit. On the other hand, scale inefficiency exists in large banks implying that they are too large to operate business efficiently.

Okuda and Hashimoto (2004) suggest that the management of Malaysian domestic banks was not efficient in spite of the progress in financial liberalization that was pursued during the 1990s, which sees the banking sector grew rapidly. They also suggested that there are possibilities that the Malaysian banking sector was under various forms of government influence until 1980s and that banks are required to provide loans for specific policy purposes. Furthermore, the government was a major stockholder in many banks, which may impede independent management to pursuit managerial efficiency.

METHODOLOGY

A non-parametric DEA is employed with variable return to scale assumption to measure input-oriented technical efficiency of the Malaysian NBFI. DEA involves constructing a non-parametric production frontier based on the actual input-output observations in the sample relative to which efficiency of each firm in the sample is measured (Coelli, 1996). Let us give a short description of the DEA.[2] Assume that there is data on K inputs and M outputs for each N bank. For ith bank, these are represented by the vectors x_i and y_i respectively. Let us call the $K \times N$ input matrix – X and the $M \times N$ output matrix – Y. To measure the efficiency for each bank we calculate a ratio of all inputs, such as $(u'y_i/v'x_i)$ where u is an $M \times 1$ vector of output weights and v is a $K \times 1$ vector of input weights. To select optimal weights we specify the following mathematical programming problem:

$$\begin{aligned} &\min_{u,v} (u'y_i/v'x_i), \\ &u'y_i/v'x_i \leq 1, \qquad j = 1, 2, \ldots, N, \\ &u,v \geq 0. \end{aligned} \tag{1}$$

The above formulation has a problem of infinite solutions and therefore we impose the constraint $v'x_i = 1$, which leads to:

$$\begin{aligned} &\min_{\mu,\varphi} (\mu'y_i), \\ &\varphi'x_i = 1, \\ &\mu'y_i - \varphi'x_j \leq 0 \quad j = 1, 2, \ldots, N, \\ &\mu,\varphi \geq 0. \end{aligned} \tag{2}$$

Where we change notation from u and v to μ and φ, respectively, in order to reflect transformations. Using the duality in linear programming, an equivalent envelopment form of this problem can be derived:

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

[2] Good reference books on efficiency measures are Avkiran (2002), Cooper, Seiford, and Tone (2000) and Thanassoulis (2001).

$$y_i + Y\lambda \geq 0\,,$$

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

$$\lambda \geq 0\,. \qquad (3)$$

Where θ is a scalar representing the value of the efficiency score for the *i*th decision-making unit which will range between 0 and 1. λ is a vector of *N* $\lambda \geq 0$ $\times$ 1 constants. The linear programming has to be solved *N* times, once for each decision-making unit in the sample. In order to calculate efficiency under the assumption of variable returns to scale, the convexity constraint ($N1'\lambda = 1$) will be added to ensure that an inefficient firm is only compared against firms of similar size, and therefore provides the basis for measuring economies of scale within the DEA concept. The convexity constraint determines how closely the production frontier envelops the observed input-output combinations and is not imposed in the constant returns to scale case. The variable returns to scale technique therefore forms a convex hull which envelops the data more tightly than the constant returns to scale, and thus provides efficiency scores that are greater than or equal to those obtained from the constant returns to scale model.

Amongst the strengths of the DEA is that, DEA is less data demanding as it works fine with small sample size (Canhoto & Dermine, 2003). The small sample size is among other reasons, which leads us to DEA as the tool of choice for evaluating Malaysian NCBFIs X-efficiency. Furthermore, DEA does not require a preconceived structure or specific functional form to be imposed on the data in identifying and determining the efficient frontier, error, and inefficiency structures of the DMUs[3] (Bauer, Berger, Ferrier, & Humphrey, 1998; Evanoff & Israelvich, 1991; Grifell-Tatje & Lovell, 1997). Hababou (2006) adds that it is better to adopt the DEA technique when it has been shown that a commonly agreed functional form relating inputs to outputs is difficult to prove or find. Such specific functional form is truly difficult to show for financial services entities. Avkiran (1999) acknowledges the edge of the DEA by stating that this technique allows the researchers to choose any kind of input and output of managerial interest, regardless of different measurement units. There is no need for standardization.

Three useful features of DEA are first, each DMU is assigned a single efficiency score, hence allowing ranking amongst the DMUs in the sample. Second, it highlights the areas of improvement for each single DMU. For example, since a DMU is compared to a set of efficient DMUs with similar input-

[3] Avkiran (1999) and Hababou (2006) provide a relatively thorough discussion of the merits and limits of the DEA.

output configurations, the DMU in question is able to identify whether it has used input excessively or its output has been under-produced. Finally, there is possibility of making inferences on the DMUs general profile. We should be aware that the technique used here is a comparison between the production performances of each DMU to a set of efficient DMUs. The set of efficient DMUs is called the reference set. The owners of the DMUs may be interested to know which DMU frequently appears in this set. A DMU that appears more than others in this set is called the global leader. Clearly, this information gives huge benefits to the DMU owner, especially in positioning its entity in the market.

The main weakness of DEA is that it assumes data are free from measurement errors. Furthermore, since efficiency is measured in a relative way, its analysis is confined to the sample set used. This means that an efficient DMU found in the analysis cannot be compared with other DMUs outside of the sample. The reason is simple. Each sample, separated, let us say, by year, represents a single frontier, which is constructed on the assumption of the same technology.

DEA can be use to derive measures of scale efficiency by using the variable returns to scale (VRS), or the BCC model, alongside the constant returns to scale (CRS), or the CCR model. Coelli, Prasada-Rao and Battese (1998) noted that the BCC model has been the most commonly used since the beginning of the 1990s. A DEA model can be constructed either to minimize inputs or to maximize outputs. An input orientation aims at reducing the input amounts as much as possible while keeping at least the present output levels, while an output orientation aims at maximizing output levels without increasing use of inputs (Cooper, Seiford & Tone, 2000). The focus on costs in banking and the fact that outputs are inclined to be demand determined means that input-oriented models are most commonly used (Kumbhakar & Lozano-Vivas, 2005).

As we are looking at relative efficiency, it is important that the DMUs to be sufficiently similar, so that comparisons are meaningful. This is particularly the case with DEA, where Dyson, Allen, Carmanho, Podinovski, Sarrico, and Shale (2001) have developed what they describe as a series of homogeneity assumptions. The first of these is that the DMUs the performance of which is being compared should be undertaking similar activities and producing comparable products and services so that a common set of outputs can be defined. The second homogeneity assumption is that a similar range of resources is available to all DMUs and they are operating in a similar environment.

Data Sample, Inputs-Outputs Definition, and the Choice of Variables

For the empirical analysis, all Malaysian NCBFIs would be incorporated in the study. The annual balance sheets and income statements used to construct the

variables for the empirical analysis are sourced from published balance sheet information in annual reports of each individual NBFI. Due to the unavailability of data resulting from mergers and acquisitions, the final sample comprised of an unbalanced panel sample of 92 NBFI year observations.

The definition and measurement of inputs and outputs in the banking function remains a contentious issue among researchers. To determine what constitutes inputs and outputs of banks, one should first decide on the nature of banking technology. In the banking theory literature, there are two main approaches competing with each other in this regard: the production and intermediation approaches (Sealey & Lindley, 1977).

Under the production approach, pioneered by Benston (1965), a financial institution is defined as a producer of services for account holders, that is, they perform transactions on deposit accounts and process documents such as loans. Hence, according to this approach, the number of accounts or its related transactions is the best measures for output, while the number of employees and physical capital is considered as inputs. Previous studies that adopted this approach are among others Ferrier and Lovell (1990), Fried, Lovell, and Eeckaut (1993) and Sherman and Gold (1985).

The intermediation approach on the other hand assumes that financial firms act as an intermediary between savers and borrowers and posits total loans and securities as outputs, whereas deposits along with labor and physical capital are defined as inputs. Previous banking efficiency studies research that adopted this approach are among others Bhattacharya, Lovell, and Sahay (1997), Charnes, Cooper, Huang, and Sun (1990) and Sathye (2001).

For the purpose of this study, a variation of the intermediation approach or asset approach originally developed by Sealey and Lindley (1977) will be adopted in the definition of inputs and outputs used.[4] According to Berger and Humphrey (1997), the production approach might be more suitable for branch efficiency studies, as at most times bank branches process customer documents and bank funding, while investment decisions are mostly not under the control of branches.

The aim in the choice of variables for this study is to provide a parsimonious model and to avoid the use of unnecessary variables that may

[4] Humphrey (1985) presents an extended discussion of the alternative approaches over what a bank produces.

reduce the degree of freedom.[5] All variables are measured in millions of Ringgit Malaysia (RM). Accordingly, total deposits ($x1$), which include deposits from customers and other banks and fixed assets ($x2$), are used as an input vectors to produce total loans ($y1$), which include loans to customers and other banks and investments ($y2$), which include investment securities held for trading, investment securities available for sale (AFS) and investment securities held to maturity.

Table 2 presents the summary statistics of the input and output variables used to construct the efficiency frontier. During the period of study, it is apparent that the finance companies were almost three times larger (in terms of asset size), and command higher market share in terms of loans and deposits relative to its merchant banks peers. On the other hand, although the merchant banks were smaller, they seem to have produced higher amount of investments. The differences are further confirmed by a series of parametric (t-test) and non-parametric (Kruskal-Wallis and Mann-Whitney (Wilcoxon Rank-Sum) tests), which suggest that the differences in the mean are significant for all variables at the 1% level of significance[6].

RESULTS

In this section, we will discuss the technical efficiency change (TE) of the Malaysian NBFI sector, measured by the DEA method and its decomposition into pure technical efficiency (PTE) and scale efficiency (SE) components. In the event of the existence of scale inefficiency, we will attempt to provide evidence on the nature of returns to scale of the Malaysian NBFI.

Table 2

[5] For a detailed discussion on the optimal number of inputs and outputs in DEA, see Avkiran (2002).

6 Investment is not significant in the case of Mann-Whitney (Wilcoxon Rank-Sum) and Kruskal-Wallis tests at any conventional levels. To conserve space, we do not report the results here but are available from the authors upon request.

Efficiency of the Malaysian NBFI Sector

Table 3 presents the mean efficiency scores of Malaysian NCBFIs for the years 2000 (Panel A), 2001 (Panel B), 2002 (Panel C), 2003 (Panel D), 2004 (Panel E), merchant banks (Panel F) and finance companies (Panel G). The results from DEA Model A seems to suggest that Malaysian NCBFIs mean technical efficiency has been on a declining trend during the earlier part of the studies, before increasing again during the latter years. The decomposition of overall efficiency into its pure technical and scale efficiency components suggest that while scale inefficiency dominates pure technical inefficiency of the finance companies during all years, the merchant banks on the other hand have exhibited higher scale efficiency during 2000 and 2002. Overall, the results imply that during the period of study, the Malaysian NCBFIs have been operating at the wrong scale of operations.

During the period of study, the results seem to suggest that the merchant banks (Panel F) have exhibited mean technical efficiency of 69.6%, suggesting mean input waste of 30.4%. In other words, the merchant banks could have produced the same amount of outputs by only using 69.6% of the amount of inputs it uses. From Table 3 (Panel F) it is also clear that scale inefficiency dominates pure technical inefficiency of the merchant banks. On the other hand, our results from Table 3 (Panel G) suggest that the finance companies have exhibited lower mean technical efficiency of 44.7% compared to its merchant banks counterparts. Likewise, our results also suggest that the finance companies inefficiency were mainly due to scale rather than pure technical albeit at a higher degree of 44.8% (merchant banks – 23.0%). The finance companies also seem to have exhibited lower pure technical efficiency of 82.0% (merchant banks – 89.7%). Overall, the results suggest that, compared to their finance companies counterparts, the merchant banks were relatively managerially efficient in controlling their operating costs and have been operating at a relatively more optimal scale of operations.

Our findings are interesting in that, although the merchant banks were small relative to its finance companies counterparts, and have relatively limited operations, they seem to have exhibited higher efficiency levels compared to its finance companies peers. The findings support the divisibility theory, which holds that there will be no such operational advantage accruing to large NCBFIs, if the technology is divisible, that is, small scale NCBFIs can produce financial services at costs per unit output comparable to those of large NCBFIs, suggesting no or possibly negative association between size and performance. This was made possible as advances in technology reduced the size and cost of automated equipment, thus significantly enhance small banks' ability to purchase expensive technology, implying more divisibility in technology in the banking industry (Kolari & Zardkoohi, 1987).

Table 3
Summary Statistics of Efficiency Measures

Efficiency measures	Mean		Minimum		Maximum		Std. Dev.	
	MB	FC	MB	FC	MB	FC	MB	FC
Panel A: 2000								
Technical efficiency	0.908	0.538	0.443	0.350	1.000	1.000	0.193	0.216
Pure technical efficiency	0.925	0.811	0.527	0.466	1.000	1.000	0.167	0.197
Scale efficiency	0.974	0.679	0.841	0.399	1.000	1.000	0.056	0.228
Panel B: 2001								
Technical efficiency	0.745	0.389	0.342	0.266	1.000	0.693	0.271	0.142
Pure technical efficiency	0.897	0.807	0.547	0.491	1.000	1.000	0.180	0.219
Scale efficiency	0.822	0.489	0.372	0.342	1.000	0.693	0.218	0.124
Panel C: 2002								
Technical efficiency	0.750	0.248	0.216	0.058	1.000	0.589	0.327	0.149
Pure technical efficiency	0.851	0.828	0.266	0.530	1.000	1.000	0.266	0.186
Scale efficiency	0.861	0.300	0.438	0.092	1.000	0.589	0.222	0.155
Panel D: 2003								
Technical efficiency	0.506	0.490	0.188	0.243	1.000	0.769	0.320	0.140
Pure technical efficiency	0.894	0.822	0.429	0.440	1.000	1.000	0.201	0.199
Scale efficiency	0.562	0.599	0.188	0.446	1.000	0.769	0.298	0.104
Panel E: 2004								
Technical efficiency	0.582	0.625	0.331	0.296	1.000	0.974	0.209	0.188
Pure technical efficiency	0.924	0.835	0.685	0.428	1.000	1.000	0.133	0.209
Scale efficiency	0.636	0.758	0.386	0.540	1.000	0.974	0.226	0.169
Panel F: Merchant Banks All Years								
Technical efficiency	0.696		0.188		1.000		0.295	
Pure technical efficiency	0.897		0.266		1.000		0.190	
Scale efficiency	0.770		0.188		1.000		0.258	
Panel G: Finance Companies All Years								
Technical efficiency	0.447		0.058		1.000		0.205	
Pure technical efficiency	0.820		0.428		1.000		0.193	
Scale efficiency	0.552		0.092		1.000		0.220	

Notes: The table presents mean, minimum, maximum, and standard deviation of Malaysian NCBFIs technical efficiency (TE), and its mutually exhaustive pure technical efficiency (PTE) and scale efficiency (SE) components derived from DEA. Panel A, B, C, D, and E shows the mean, minimum, maximum and standard deviation of TE, PTE, and SE of the merchant banks and finance companies for the years 2000, 2001, 2002, 2003, and 2004, respectively. Panel F and G presents the merchant banks and finance companies mean, minimum, maximum and standard deviation of TE, PTE and SE scores, respectively. The TE, PTE, and SE scores are bounded between a minimum of 0 and a maximum of 1. MB denotes merchant banks. FC denotes finance companies.

Table 4
Composition of Production Frontiers

Bank	Type	2000	2001	2002	2003	2004	Count
Affin Merchant Bank	MB	IRS	DRS	DRS	DRS	DRS	0
Affin-ACF Finance	FC	DRS	DRS	DRS	DRS	DRS	0
Alliance Finance	FC		DRS	DRS	DRS	DRS	0
Alliance Merchant Bank	MB		DRS	DRS	DRS	DRS	0
Arab-Malaysian Finance	FC	CRS	DRS	DRS	DRS	DRS	1
Arab-Malaysian Merchant Bank	MB	CRS	DRS	DRS	DRS	DRS	1
Aseambankers	MB	CRS	DRS	CRS	DRS	DRS	1
Bumiputra Commerce Finance	FC	DRS	DRS	DRS	DRS	DRS	0
Commerce International Merchant Bankers	MB	CRS	CRS	DRS	DRS	DRS	2
EON Finance	FC	DRS	DRS	DRS	DRS		0
Hong Leong Finance	FC	DRS	DRS	DRS	DRS	DRS	0
Malaysian International Merchant Bankers	MB	IRS	CRS	CRS			2
Mayban Finance	FC	DRS	DRS	DRS	DRS	DRS	0
Public Finance	FC	DRS	DRS	DRS	DRS		0
Public Merchant Bank	MB		CRS	CRS	DRS	DRS	2
RHB Delta Finance	FC		DRS	DRS	DRS	DRS	0
RHB Sakura Merchant Bankers	MB	CRS	CRS	CRS	DRS	DRS	3
Southern Finance	FC	DRS	DRS	DRS	DRS	DRS	0
Southern Investment Bank	MB	CRS	IRS	DRS	CRS	IRS	2
Utama Merchant Bank	MB	IRS	DRS	CRS	CRS	CRS	3
Number of NBFI	n	6	4	5	2	1	

Notes: CRS – Constant Returns to Scale; DRS – Decreasing Returns to Scale; IRS – Increasing Returns to Scale. The NCBFIs corresponds to the shaded regions have not been efficient in any year in the sample period (2000–2004) compared to the other NCBFIs in the sample; MB – Merchant Bank; FC – Finance Company.

Since the dominant source of the total technical X-(in)efficiency in the Malaysian NBFI sector seems to be scale related, it is worth investigating the composition of the efficiency frontier. Table 4 shows NCBFIs that lie on the efficiency frontier under DEA Model A. The composition of the efficiency frontier for DEA Model A suggests the number of 100% efficient NCBFIs (operating at constant returns to scale (CRS)), varies between one to six NCBFIs. During the period of study, the merchant banks seem to have dominated the efficiency frontier for DEA Model A. It is also clear from the results that two merchant banks namely, RHB Sakura Merchant Bankers and Utama Merchant Bank have appeared the most times on the efficiency frontier, a total of eight merchant banks have appeared at least once on the efficiency frontier, while only two merchant banks have failed to make it to the frontier. On the other hand, the results seem to suggest that only one finance company has managed to make it to the frontier, while nine finance companies have never made it to the efficiency frontier throughout the period of study.

Univariate Test Results

After examining the DEA results, the issue of interest now is whether the two samples are drawn from the same population, i.e. whether the merchant banks and finance companies possess the same technology. The null hypothesis tested is that the merchant banks and finance companies are drawn from the same population or environment and have identical technologies. We tested the null hypothesis that merchant banks and finance companies are drawn from the same population and have identical technologies by using a series of parametric (ANOVA and *t*-test) and non-parametric (Kolmogorov-Smirnov, Mann-Whitney (Wilcoxon Rank-Sum) and Kruskall-Wallis) univariate tests. The results are presented in Table 5.

Based on most of the results, we failed to reject the null hypothesis at the 5% levels of significance that the merchant banks and finance companies are drawn from the same population and have identical technologies, particularly during the latter part of the studies. This implies that, there is no significant difference between the merchant banks and finance companies technologies (frontiers) and that it is appropriate to construct a combined frontier. The findings corroborate with the findings by among others, Sathye (2001) and Isik and Hassan (2002).

CONCLUSIONS

The paper attempts to investigate the efficiency of Malaysian NCBFIs during the period of 2000 to 2004. The preferred non-parametric DEA methodology has allowed us to distinguish between three different types of efficiency, namely, technical, pure technical and scale efficiencies. Additionally we have performed a series of parametric and non-parametric tests to examine whether the merchant banks and finance companies were drawn from the same population.

During the period of study, our results suggest that, the Malaysian merchant banks have exhibited mean overall or technical efficiency of 69.6% while the finance companies have exhibited lower mean technical efficiency of 44.7%. In other words, during the period of study, the merchant banks could have produced the same amount of outputs by only using 69.6% of the inputs that it currently employed. Similarly, the finance companies could have reduced 55.3% of the amount of inputs it employed currently without affecting the amount of outputs that it currently produces. Overall, our results suggest that scale inefficiency dominates pure technical inefficiency effects in determining Malaysian NCBFIs technical inefficiency. The findings suggest that during the period of study, the merchant banks have dominated the efficiency frontier under

Table 5

Summary of Parametric and Non-Parametric Tests for the Null Hypothesis that Merchant Bank (mb) and Finance Companies (fc) Possessed Identical Technologies (Frontiers)

	Test groups			
	Parametric test		Non-parametric test	
Individual tests	Analysis of variance (ANOVA) test	*t*-test	Kolmogorov-Smirnov [K-S] test	Mann-Whitney [Wilcoxon Rank-Sum] test
Hypotheses	$Mean_{mb} = Mean_{fc}$		$Distribution_{mb} = Distribution_{fc}$	$Median_{mb} = Median_{fc}$
Test statistics	*F* (Prb > *F*)	*t* (Prb > *t*)	K-S (Prb > K-S)	*z* (Prb > *z*)
Technical efficiency				
2000	15.606	–3.950	1.572	8.500
2001	0.634	–3.678	1.342	11.500
2002	19.470	–4.412	1.565	11.000
2003	0.021	–0.147	0.991	37.000
2004	0.198	0.445	0.657	32.500
Pure technical efficiency				
2000	1.107	–1.052	0.857	22.000
2001	0.040	–0.996	0.671	35.000
2002	0.053	–0.230	0.671	40.000
2003	0.614	–0.783	0.822	37.000
2004	1.149	–1.072	0.572	28.000
Scale efficiency				
2000	14.699	–3.834	1.601	7.500
2001	17.639	–4.200	1.565	12.000
2002	42.959	–6.554	2.012	2.000
2003	0.140	0.374	1.016	32.000
2004	1.564	1.250	0.915	24.000

Notes: Test methodology follows among others, Aly, Grabowski, Pasurka, and Rangan (1990), Elyasiani and Mehdian (1992) and Isik and Hassan (2002). Parametric (ANOVA and t-test) and Non-Parametric (Kolmogorov-Smirnov and Mann-Whitney) tests, test the null hypothesis that the merchant banks and finance companies are drawn from the same efficiency population (environment).
The numbers in parentheses are the *p*-values associated with the relative test.
*** indicates significant at 0.05 level.

both models. The merchant banks have also appeared to be the global leader by appearing the most times on the frontier. The results are interesting as although the merchant banks were smaller in terms of size, have smaller market share relative to its finance companies peers, they seem to have followed the best practice during the period of study. Further, despite being smaller, the results imply that although size is important for firms to be able to catch up to the

frontier, however, it is not a dominant factor for firms to be able to catch up to the frontier in terms of innovations and technological advancements. The findings thus support for the divisibility theory, which suggest that there will be no or possibly negative association between size and firms ability to catch up to the frontier as technology is becoming cheaper.

It should be acknowledged that the scope of this paper is limited and several interesting questions are not answered. It is suggested for further analysis on the efficiency of the Malaysian NBFI sector to investigate changes in cost, allocative and technical efficiencies over time. In addition, the paper modeled Malaysian NCBFIs according to the intermediation function. Given that NCBFIs are multi-output firms, considering the production function along with the intermediation function at the same time could be another extension of the paper. Finally, the non-parametric frontier analysis used in this paper could also be combined with the stochastic frontier analysis method of estimating the frontier. This should testify to the robustness of the results against alternative estimation methods.

REFERENCES

Altunbas, Y., Liu, M-H., Molyneux, P., & Seth, R. (2000). Efficiency and risk in Japanese Banking. *Journal of Banking and Finance, 24*(10), 1605–1628.

Aly, H. Y., Grabowski, R., Pasurka, C., & Rangan, N. (1990). Technical, scale and allocative efficiencies in U.S. banking: An empirical investigation. *Review of Economics and Statistics, 72*(2), 211–218.

Avkiran, N. K. (1999). An application reference for data envelopment analysis in branch banking: Helping the novice researcher. *International Journal of Bank Marketing, 17*(5), 206–220.

_____. (2002). *Productivity analysis in the service sector with data envelopment analysis*. Camira: N.K. Avkiran.

Bank Negara Malaysia. (2001). *Financial sector masterplan: Building a secure future*. Kuala Lumpur: Bank Negara Malaysia Press.

_____. (2004). *Annual report.* Kuala Lumpur: Bank Negara Press.

Bauer, P. W., Berger, A. N., Ferrier, G. D., & Humphrey, D. B. (1998). Consistency conditions for regulatory analysis of financial institutions: A comparison of frontier efficiency methods. *Journal of Economics and Business, 50*(2), 85–114.

Benston, G. J. (1965). Branch banking and economies of scale. *Journal of Finance, 20*(2), 312–331.

Berger, A. N., & Humphrey, D. B. (1997). Efficiency of financial institutions: international survey and directions for future research. *European Journal of Operational Research, 98*(2), 175–212.

Berger, A. N., & Mester, L. J. (1997). Inside the black box: What explains differences in the efficiencies of financial institutions. *Journal of Banking and Finance, 21*(7), 895–947.

Bhattacharya, A., Lovell, C. A. K., & Sahay, P. (1997). The impact of liberalization on the productive efficiency of Indian commercial banks. *European Journal of Operational Research, 98*(2), 332–345.

Canhoto, A., & Dermine, J. (2003). A note on banking efficiency in Portugal: New vs. old banks. *Journal of Banking and Finance, 27,* 2087–2098.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research, 2*(6), 429–444.

Charnes, A., Cooper, W. W., Huang, Z. M., & Sun, D. B. (1990). Polyhedral cone – Ratio DEA models with an illustrative application to large commercial banks. *Journal of Econometrics, 46*(1–2), 73–91.

Coelli, T. (1996). *A guide to DEAP version 2.1.* (CEPA Working Paper 8/96). Armidale University of New England.

Coelli, T., Prasada-Rao, D. S., & Battese, G. E. (1998). *An introduction to efficiency and productivity analysis.* Boston: Kluwer Academic Publishers.

Cooper, W. W., Seiford, L. M., & Tone, K. (2000). *Data Envelopment Analysis.* Boston: Kluwer Academic Publishers.

Drake, L., & Hall, M. J. B. (2003). Efficiency in Japanese banking: An empirical analysis. *Journal of Banking and Finance*, 27(3): 891–917.

Dyson, R. G., Allen, R., Camanho, A. S., Podinovski, V. V., Sarrico, C. S., & Shale, E. A. (2001). Pitfalls and protocols in DEA. *European Journal of Operational Research, 132*(2), 245–259.

Elyasiani, E., & Mehdian, S. (1992). Productive efficiency performance of minority and non-minority owned banks: A non-parametric approach. *Journal of Banking and Finance, 16*(5), 933–948.

Evanoff. D. D., & Israelvich, P. R. (1991). Productive efficiency in banking. In *Economic perspectives* (11–32). Chicago: Federal Reserve Bank of Chicago.

Ferrier, G., & Lovell, C. A. K. (1990). Measuring cost efficiency in banking: Econometric and linear programming evidence. *Journal of Econometrics, 46*(1–2), 229–245.

Fried, H. O., Lovell, C. A. K., & Eeckaut, P. V. (1993). Evaluating the performance of U.S. Credit Unions. *Journal of Banking and Finance, 17*(2–3), 251–265.

Gregoriou, G. N., & Zhu, J. (2005). *Evaluating hedge funds and CTA performance: Data Envelopment Analysis approach*. New York: John Wiley.

Grifell-Tatje, E., & Lovell, C. A. K. (1997). The sources of productivity change in Spanish banking. *European Journal of Operational Research, 98*(2), 364–380.

Hababou, M. (2006). *Tutorial in DEA*. http://members.tripod.com/moezh/DEAtutorial/DEAtutorial.html. Retrieved March 20, 2006.

Humphrey, D. B. (1985). Cost and scale economies in bank intermediation. In Aspinwall, R., & Eisenbeis, R. (Eds.). *Handbook for banking strategy*. New York: John Wiley and Sons.

Isik, I., & Hassan, M. K. (2002). Technical, scale and allocative efficiencies of Turkish banking industry. *Journal of Banking and Finance, 26*(4), 719–766.

Katib, M. N., & Mathews, K. (2000). A non-parametric approach to efficiency measurement in the Malaysian banking sector. *The Singapore Economic Review, 44*(2), 89–114.

Kolari, J., & Zardkoohi, A. (1987). *Bank costs, structure and performance*. USA: Lexington Books.

Kumbhakar, S. C., & Lozano-Vivas, A. (2005). Deregulation and productivity: The case of Spanish banks. *Journal of Regulatory Economics, 27*(3), 331–351.

Kwan, S. H. (2003). Operating performance of banks among Asian economies: An international and time series comparison. *Journal of Banking and Finance, 27*(3), 471–489.

Okuda, H., & Hashimoto, H. (2004). Estimating cost functions of Malaysian commercial banks: The differential effects of size, location and ownership. *Asian Economic Journal, 18*(3), 233–259.

Sathye, M. (2001). X-efficiency in Australian banking: An empirical investigation. *Journal of Banking and Finance, 25*(3), 613–630.

Sealey, C., & Lindley, J. T. (1977). Inputs, outputs and a theory of production and cost at depository financial institutions. *Journal of Finance, 32*(4), 1251–1266.

Sherman, H. D., & Gold, F. (1985). Bank branch operating efficiency: Evaluation with Data Envelopment Analysis. *Journal of Banking and Finance, 9*(2), 297–315.

Thanassoulis, E. (2001). *Introduction to the theory and application of Data Envelopment Analysis.* Boston: Kluwer Academic Publishers.