Cost Efficiency and K-economy of Commercial Banks in Malaysia

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Abstract: This paper is a pioneer attempt to identify the significance of the K-economy variables as determinants to cost efficiency of commercial banks in Malaysia. Based on the Hausman exogeneity specification test, it was found that all the three K-economy variables, namely, efficient infrastructure, knowledged labour and information and communication technology expenditure were weakly exogenous. This leads us to reject the endogenous growth theory and favour the neo-classical theory. In the neo-classical model, ICT was found to be significant in decreasing cost inefficiency. However, training expenditure and bank size were found to be significant, leading to an increase in cost inefficiency.

Keywords: Cost efficiency, endogenous growth theory, K-economy
JEL classification: D24, C33

1. Introduction

Apart from globalisation and liberalisation, the world economy is also being challenged by the important role of knowledge and the capacity of nations to utilise and generate knowledge. These will in turn create new values in the economy which will further contribute to the economic growth and wealth of a country. This challenge is known as the K-economy and is defined as an economy that is based on knowledge or economy that is directly based on production, distribution and utilisation of knowledge and information (OECD 1996). Amongst the critical factors that contribute to the development of the K-economy, and which also acts as indicators to the strengths and weaknesses of a country, are computer infrastructure, information structure, education and training, research and development (R&D) and technology.

In relation to this, the new growth theory by Romer (1986; 1990) has specified technology or knowledge as an endogenous factor in the production function instead of being considered as an exogenous factor as the neo classical theory has asserted. There are as yet no known studies on the cost efficiency of banks that are correlated to any K-economic indicator or input in Malaysia. Hence, the motive underlying this study is to identify the significant K-economy input that can affect the cost efficiencies of commercial banks in Malaysia, either endogenously or exogenously.

The rest of the paper is organised as follows. Section 2 reviews existing literature on both cost efficiency and some limited K-economic studies. Section 3 presents the model

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specified and data used while Section 4 presents and interprets the empirical findings. Section 5 concludes the article.

2. Literature Review

Studies on bank efficiency have used parametric and non parametric methods. Methods used in the parametric approach were Stochastic Frontier Approach (SFA), Thick Frontier Approach (TFA) and the Distribution-free Approach (DFA). On the other hand, the non parametric researchers used Data Envelopment Analysis (DEA), Malmquist Index, Tornqvist Index and Distance Functions to measure bank efficiency.

SFA has often been used in parametric studies. Berger and Humphrey (1997) reported that of the 60 studies using parametrics, 24 used SFA. Amongst them were Ferrier and Lovell (1990), Greene (1990), Khumbhakar (1996), Battese and Coelli (1992), Bauer and Hancock (1993), Berger (1993), Mester (1996) and Berger and DeYoung (1997). Among the non parametric methods, DEA was most widely used, for example, Sherman and Gold (1985), Rangan *et al.* (1988), Elyasiani and Mehdian (1990), Ferrier and Lovell (1990), English *et al.* (1993), Fixler and Zieschang (1999), and Brockett *et al.* (1997).

In terms of functions used to estimate the production, cost and profit functions in the SFA method, the translog function was most widely used (Mester 1987; Berger *et al.* 1987; Hunter *et al.* 1990; Humphrey 1993; Battese and Coelli 1992; Kaparakis *et al.* 1994; Battese *et al.*1997; Mohd Zaini Abd. Karim 2001; Yildirim and Philippatos 2002; Nikiel and Opiela 2002). Besides the translog function, the fourier flexible function has also became popular, since the 1990s. However, the choice of the function to be used also depends on the sample size of the study; a small sample size cannot be used to estimate the fourier flexible function efficiently.

A few studies have analysed bank efficiency in Malaysia. Mohd Zaini Abd. Karim (2001) investigated the differences in bank efficiency across selected countries in the ASEAN region, including Malaysia. The overall results showed that ASEAN banks enjoyed increasing returns to scale and larger banks tended to have a higher cost efficiency than smaller banks. Mariani Abdul Majid *et al.* (2003) found no evidence of foreign banks being more efficient than local banks. However, this cost inefficiency is related to bank size and provides some evidence for a U-shaped average cost function.

Studies on financial sector efficiency and its relation to the indicators of the K-economy could not be found but there were some studies on financial sector efficiency involving one or part of the K-economy indicators. These were done on the US and other developed countries and revealed mixed empirical results. Studies by Oliner and Sichel (1994), Lichenberg (1995), Stiroh (1998), Lehr and Lichtenberg (1999), and Ten Raa and Wolff (2001) found that information technology (IT) was a significant factor affecting productivity growth. Jorgenson and Stiroh (1999; 2000) found that one sixth of the output growth, that is, 2.4% was due to computer output via capital deepening. However, Bailey and Gordon (1988) and Parsons *et al.* (1993) (reported in Wolff 2002) found otherwise. What was most puzzling was the huge investments in IT that were not contributing to productivity. Why did this IT paradox occur? Frischtak (1992) argued that it could be due to lagged factors such as new technologies needing organisational change and employees' training before the benefits of IT could be realised. In the process, some work was duplicated and redundant. Hence, IT benefits could not be reaped immediately.

The empirical results from previous studies on education and productivity are also mixed. Griliches (1970) found a positive relationship between educational attainment and economic growth (Wolff 2002). However, Wolff (1999) in the US found a negative relationship between skills and productivity except at the managerial and administration levels as some types of occupations were not directly related to output. Wolff (2001) also did not find any significant effect of educational attainment on Gross Domestic Product (GDP) growth of the Organisation for Economic Co-operation and Development (OECD) countries, from 1950 to 1990. In the same study, both on-the-job training and off-the-job training were only significant after a lag of 2 years. This implied that labour needed time to learn new technologies. None of the banking studies related their efficiencies with R&D capacity. This may be due to the problem of data insufficiency in R&D indicators in banks. Therefore, this study may well be the first known attempt to analyse the cost efficiency of banks in Malaysia in relation to K-economy capacity.

3. Model Specification and Data

In this study, cost efficiency scores were first estimated and then correlated to the K-economy variables in the second stage of regression. Cost efficiency was estimated using the translog stochastic cost frontier approach. Cobb-Douglas function was also specified to compare the appropriateness of the functions used. An unbalanced panel data was used as some of the annual reports of the banks were not available. The sample included all existing 23 commercial banks in Malaysia from 1995 to 2003 totalling 173 observations.

In estimating the cost efficiency of banks, it was not always clear as to which balance sheet items should be specified as inputs versus outputs, since they often contained elements of both. Following Fixler (1993), it was found that the appropriate input-output approach was the intermediation approach.[1] This suited the function of the commercial bank as a financial intermediary in channelling funds from depositors to borrowers. For the cost efficiency frontier estimates, this study used the Stochastic Frontier Approach as proposed by Battese and Coelli (1992; 1995). This approach was used as it had been well established and widely used by previous researchers on efficiencies where the translog cost function was the most appropriate function employed in the estimation. Other studies such as those of Berger and Mester (1997), Mitchell and Onvural (1996), and Kraft *et al.* (2002) had used the fourier cost and profit functions which augmented the popular translog specification to include trigonometric terms. These terms allowed the estimation to better fit a broader range of curves. However, this study could not adopt the use of fourier function as the estimation required a larger sample size. Hence the translog function was used.

The models are based on Battese and Coelli's (1992; 1995) Stochastic Frontier Approach which assumed that the firm effects were distributed as normal random truncated variables and were allowed to be changed systematically over time. The Stochastic Cost Frontier function can be written as follows:

$$C_{it} = x_{it}\beta + \left(v_{it} + u_{it}\right), \; i = 1,2,3...N, \; t = 1,2,3...T \qquad (1)$$

where

[1] Prior to this study, asset or liability user cost was calculated to determine the status of the asset or the liability. Deposits were found to be an input and loans as an output to the banks.

= log of total cost of bank i in year t (RM'000)

x_{it} = vector k x 1 input price (w_{it}) and output (y_{it}) of bank i
β = unknown vector parameter
v_{it} = random variable assumed to be normal and not dependent on,
u_{it} = random variable that represents cost inefficiency of the bank also assumed as normal

Input price variable (w = input price vector)
w_1 = price of funds purchased (RM'000)
w_2 = price of deposits (current, savings and time deposits) (RM'000)
w_3 = price of labour (RM'000 per employee)

Quantity of output (y = Output quantity vector)
y_1 = consumer loans (hire purchase, credit cards and related) (RM'000)
y_2 = commercial loans (RM'000)
y_3 = investment securities (RM'000)

The random error, v_{it} accounts for measurement error and other random factors. It is assumed that the v_{it}s are independent and identically distributed (i.i.d.) normal random variables with mean zero and constant variance, independent of the u_{it}s which are assumed to be i.i.d. exponential or half-normal random variables. In the above cost function, u_{it} defines how far the bank is operating above the cost frontier. The cost inefficiency of bank i is defined as the ratio of actual total cost to the stochastic frontier total cost. If u_{it} is zero, the frontier cost function is $C_t{*} = f(y_i w_i \beta)$ and cost efficiency (CE) of bank i can be written as:

$$CE = C_i / C_i{*}$$

$$= f(y_i x_i \beta)\exp(u_{it}) / f(y_i, x_i, \beta) \quad CE = \exp(u_{it}) \tag{2}$$

Hence, cost efficiency is more than or equal to unity. If cost inefficiency is absent from the model, cost efficiency of all the banks will then be unity. This implies that the firms are producing at the frontier cost, given the output values and the input prices. The Cobb-Douglas and translog functions that were estimated using maximum likelihood estimator in the Frontier 4.1 software are as follows:

(a) Cobb-Douglas Cost Function

$$LnC_{it} = \alpha_0 + \sum_{k=1}^{m} \beta_k \ln w_{kit} + \sum_{j=1}^{n} \gamma_j \ln y_{jit} + \ln u_{cit} + \ln v_{cit} \tag{3}$$

(b) Translog cost function

$$LnC_{it} = \alpha_0 + \sum_{k=1}^{m} \beta_k \ln w_{kit} + \tfrac{1}{2} \sum_{k=1}^{m} \sum_{p=1}^{m} \beta_{kp} \ln w_{kit} \ln w_{pit} + \sum_{j=1}^{n} \gamma_j \ln y_{jit}$$
$$+ \tfrac{1}{2} \sum_{j=1}^{n} \sum_{l=1}^{m} \gamma_{jl} \ln y_j \ln y_l + \tfrac{1}{2} \sum_{j=1}^{n} \sum_{k=1}^{m} \eta_{jk} \ln w_{kit} \ln y_{kit} + u_{cit} + \ln v_{cit}. \quad (4)$$

Since panel data is used, firm and time effects will be considered and the log likelihood ratio test will be used to determine the appropriateness of the model. In the Frontier 4.1 software, these options can be selected.

The second part of this paper involves the testing of the endogeneity of the K-economy variables or the appropriateness of K-economy variables being specified for the neo-classical theory or the new growth theory. The neo-classical theory only recognises labour and capital as endogenous factors in the production function and other factors such as knowledge, productivity, education and intellectual capital are regarded as exogenous factors. On the contrary, the new growth theory by Romer (1986; 1990) placed technology or knowledge as endogenous input. The cost efficiency estimates would then be used as the dependent variable. The K-economy variables, considered in this study, which are independent, are efficient infrastructure, knowledged labour and information and communication technology expenditure. R&D expenditure was not included in the model because of the difficulty of obtaining R&D data of the commercial banks. Moreover, the R&D activities in commercial banks only started in early 2001. The locally operating foreign banks were not involved in R&D activities as they were undertaken by their head offices.

In an attempt to determine the exogeneity or endogeneity of the K-economy variables, either the Hausman specification test or Granger Causality test could be used. However, the Granger Causality test involves the testing of various lagged dependent variables. As this study is constrained by a small sample size, the Hausman specification test for exogeneity would be employed to determine the status of the K-economy variables which could also help to rule out any possibility of mis-specification of the model used. This test requires the specification of the K-economy variables in a simultaneous equation system (Gujarati 2003). A two-stage least square method was used to estimate the simultaneous equations that comprised equations (5), (6), (7) and (8). Using *t*-statistics, if the K-economy variables were found to be insignificant at 5 per cent level, they are not endogenous variables. Hence, the model employed would then be the neo-classical model which only requires an estimation of a single equation model (9). Otherwise, the simultaneous equation system would be used, if the K-economy variables were found to be endogenous.

$$LnINF_{it} = a_0 + a_1 \ln KNIT_{it} + a_2 \ln KIT_{it} + a_3 ATM_{it} + a_4 Y_{it} + \ln u_{1it} \quad (5)$$

where

Y_{it} = cost efficiency
INF_{it} = efficient infrastructure = total expenditure on infrastructure
= purchase on premises, building, IT and non-IT capital stock ÷ total asset
KIT_{it} = IT stock expenditure
$KNIT_{it}$ = non IT stock capital expenditure

ATM_{it} = number of ATM machines of the bank
u_{1it} = random error

$$LnL^*_{it} = b_0 + b_1 \ln TER_{it} + b_2 \ln TRAIN_{it} + b_3 Y_{it} + \ln u_{2it} \quad (6)$$

where
L^*_{it} = efficient productivity of labour = total loans/ total number of employees
TER_{it} = number of employees with tertiary education
= % of employees with tertiary education in financial services sector x number of bank employees
$TRAIN_{it}$ = total training expenditure per year = 2.5% x bank employees' salaries

$$LnICT_{it} = c_0 + c_1 \ln KIT_{it} + c_2 \ln ATM_{it} + c_3 \ln TER_{it} + c_4 \ln Y_{it} + u_{3it}..... \quad (7)$$

where
ICT_{it} = ICT utilisation intensity
= number of ATM machines in bank *i* in the commercial bank industry
KIT_{it} = IT Capital = Expenditure on hardware and software of computers
ATM_{it} = number of ATM machines in bank *i*
TER_{it} = number of employees with tertiary education

$$LnY_{it} = d_0 + d_1 \ln INF_{it} + d_2 \ln L^*_{it} + d_3 \ln ICT_{it} + d_4 SIZE_{it} + d_5 \ln L_{it} + d_6 \ln K_{it} + u_{4it} \quad (8)$$

where
$SIZE_{it}$ = total asset
L_{it} = number of labour
K_{it} = total capital

$$LnY_{it} = e_0 + e_1 \ln K_{it} + e_2 \ln L_{it} + e_3 \ln TER_{it} + e_4 \ln TRAIN_{it} + e_5 \ln KNIT + e_6 \ln KIT_{it} + e_7 \ln ATM_{it} + e_8 \ln SIZE_{it} + \ln u_{5it} \quad (9)$$

The Breusch and Pagan Lagrange Multiplier (LM) test was used to determine the existence of both effects (Baltagi 2001). If LM was significant, both effects existed. As panel data was involved, Hausman (H) test was also used to determine the appropriate model which could either be the fixed effect or random effect model. If the H value was significant, the fixed effect model would be appropriate. An unbalanced panel data was used which comprised 14 commercial banks from 1995 to 2003 with a total of 91 observations. Only three foreign banks were included in the sample as most foreign banks did not record their ICT expenditure in their annual reports. Both neo-classical and new growth models would consider the firm and time effect as panel data was used. The ordinary least square (OLS) method was used to estimate the fixed effect model without group effects, and the least square dummy variable (LSDV) method was used to estimate the fixed effect model either with 1-way or 2-way group effects. For the random effect model, the generalised least square (GLS) method was used.

Table 1: Hypothesis test for cost efficiency model

Model/ null hypothesis	Log likelihood	Log likelihood ratio (λ)	Chi-square critical value (5%)	Decision
Cobb Douglas	96.33	171.59**	32.67	Reject H_0. Translog more appropriate
Translog (μ=η=0)	12.92	4.78	43.77	Accept H_0. No firm and time effect
Translog (μ=0)	11.48	2.88	35.17	Accept H_0. No firm effect
Translog(η=0)	11.96	1.92	23.68	Accept H_0. No time effect

** 5 per cent significance level.

4. Empirical Findings

This section presents the results obtained from estimating the Stochastic Cost Frontier using the maximum likelihood estimator Frontier 4.1 and the K-economy variables relationship with cost efficiency using LIMPDEP 8.0.

The maximum likelihood estimator was used to estimate the cost function in this study and the log likelihood ratio test was used to decide which function was more appropriate. Table 1 shows the log likelihood tests for four possible models, that is, the Cobb-Douglas model, and the translog model without effects, with firm effects and time effects.

The results in Table 1 show that the translog function is better than the Cobb-Douglas function as the log likelihood ratio is higher than the chi-square value. This suggests the rejection of the null hypothesis of the Cobb-Douglas function at 5 per cent significance level. For the cost translog function, all tests carried out for no firm effect, time effect or both effects, failed to reject the null hypothesis, suggesting that the best model for the cost translog function is the model without any firm or time effects. The gamma coefficient for the translog cost function without any group effects was found to be significant at 1 per cent level indicating that cost efficiencies of the banks are very much affected by inefficient usage of input.

Based on Table 2, it can be seen that the Hausman exogeneity specification test that employed the simultaneous equation systems confirmed all K-economy variables to be weakly exogenous as cost efficiency does not signficantly affect all the three K-economy variables.[2] This implies that all the K-economy variables should be specified in a single equation system as exogenous variables.

Since panel data was used, the Hausman and Lagrange multiplier tests were carried out to determine the best model. The Hausman test showed that the fixed effect model was appropriate for both the one and two way models as the H value was significant at the 1 per

[2] This result may be different if the number of observation can be increased. The ICT and other K-economy variables may need more time lags in order to realise the benefits.

Table 2: Hausman exogeneity specification test for cost efficiency and K-economy model

Dependent variable	Type of model	Group effect	Coefficient and t-statistic of Y_{it}
L^*_{it}	RE with no group effects	Two way	0.2778 (0.350)
INF_{it}	FE with group effects	Two way	0.8698 (1.060)
ICT_{it}	RE with group effects	Two way	0.2436 (0.167)

Note: Values in parentheses are t-statistics. L^*_{it} , INF_{it} , ICT_{it} are defined in the model specification in Section 3.
RE = Random Effect Model, FE = Fixed Effect Model

Table 3: Hausman and Lagrange multiplier (LM) test

Model	Hausman test	Lagrange multiplier test
One way	53.82 (0.0000)***	26.42 (0.0000)***
Two way	87.91 (0.0000)***	56.03 (0.0000)***

Note: Values in parentheses are p-values. *** 1 per cent significance level.

cent level (Table 3). The LM test also supported one-way and two-way models with group effects. To choose the best model between the one-way and two-way models, the F-statistics test and the likelihood ratio were used. The one-way model was considered as the constrained model and the two-way model was set as the unconstrained model. The results showed that the F-statistic was 12.282 and higher than the F table value of 2.82 ($\alpha = 0.01, 8, 60$). The likelihood ratio also confirmed a higher value of 88.256 compared to the critical value of χ^2 of 21.995 ($\alpha = 0.01, 8$). Hence, the unconstrained model (two-way model) was a better model at 1 per cent significance level.

The adjusted R^2 shows that all the independent variables included in the model could explain 97.84% of the variation in the dependent variable (Table 4). However, the high adjusted R^2 was very much affected by the firm effects. Of the 14 firm effects, 8 were significant at 5 per cent significance level. This implied that the differences in style and management expertise aspects of each bank strongly affected the cost efficiency of commercial banks in Malaysia. Two of the K-economy variables were found to be significant, that is KIT and TRAIN. KIT was negatively related to cost inefficiency and was significant at 1 per cent level. The estimation result showed that a 1 per cent increase in KIT led to a 4.8 per cent decrease in cost inefficiency. This meant that ICT investment of banks was fruitful and had successfully reduced their inefficiency significantly. Mohd Zaini Abdul Karim (2003) also confirmed that ICT investment reduced cost inefficiency even though it was only significant after a lag of one year from the ICT investment. This may have been due to the transition period which saw some duplication of work and disruption of normal work flow because of utilisation of new technology (his study was carried out between 1991 to 1996).

Table 4: Two-way fixed effect for cost inefficiency and K-economy

Independent variable	Model	Bank	Firm effect	Time	Time effect
Intercept	79.290 (0.989)	CS1	65.548 (2.36)**	TS1	-2.429 (0.83)
KIT	-0.048 (-2.970)***	CS2	65.903 (4.51)***	TS2	-5.997 (0.91)
KNIT	-0.002 (-0.080)	CS3	65.689 (0.39)	TS3	22.812 (0.99)
ATM	0.035 (1.222)	CS4	65.10 (11.90)***	TS4	14.008 (1.00)
TER	59.454 (0.978)	CS5	65.815 (1.42)	TS5	8.397 (1.01)
TRAIN	0.100 (2.419)**	CS6	65.443 (5.46)***	TS6	4.769 (1.02)
SIZE	0.019 (2.036)**	CS7	650.629 (0.87)	TS7	14.006 (0.99)
K	-0.055 (-1.037)	CS8	66.769 (7.75)***	TS8	19.842 (0.98)
L	-59.467 (-0.978)	CS9	66.132 (5.15)***		
Adj. R^2	0.9784	CS10	65.694 (0.42)		
Log likelihood	143.6608	CS11	65.621 (0.43)		

Note: Value in parentheses are *t*-statistic values. Abbreviations for all the independent variables are defined in the model specification in Section 3.
***1 per cent significance level; ** 5 per cent significance level.

Training expenditure (TRAIN) was found to be significantly positive to cost inefficiency at the 5 per cent significance level. The estimation showed that a 1 per cent increase in TRAIN led to a 10 per cent increase in cost inefficiency. This implies that the training conducted had not made employees more efficient in executing their tasks and was thus unable to reduce costs. Knowledged employees or those with tertiary education also caused an increase, though it was insignificant in affecting cost inefficiency.

Apart from TRAIN and KIT, bank size (SIZE) was also found to be significant, affecting cost inefficiency at the 5 per cent significance level. This implies that as the bank grew bigger, it was unable to reap economies of scale, resulting in increased cost inefficiency. In the case of Malaysia, this may have been due to the transition period of the merger process. The banks were in the process of consolidation and there were related costs such as compensation payment to the employees who were given the option of the Voluntary Separation Scheme (VSS). Hence, the initial stage of an increase in size of banks may have incurred costs, and thus increased cost ineffiency. Fadzlan and Muhd Zulkhilbri (2005) also confirmed that size led to increased technical inefficiency during this transition period. Other variables such as the number of ATM machines that represented efficient infrastructure were insignificant but affected positively cost inefficiency. Non ICT stocks (KNIT), number of labour (L) and total capital (K) were also found to be insignificant.

5. Conclusions and Recommendations

This study has given rise to four main findings. First, although constrained by the limited amount of observations, it found that all three K-economy variables were weakly exogenous and not (weakly) endogenous. Based on this empirical result, it implies that K-economy components of the commercial banks have not reached a sufficient stage to reap the knowledge spillover as Romer (1990) had expected. Second, in the neo-classical model, training expenditure was found to be a significant factor in increasing cost inefficiency. Hence, commercial banks should review the relevant training needed to upgrade the knowledge and skills of their employees in order to be able to further decrease cost inefficiency. Thirdly, ICT expenditure was also found to be significant in reducing cost inefficiency of banks. Last but not least, bank size contributed to an increase in cost inefficiency during the transition period of the consolidation process of banks. However, the size factor could be a very important factor in future banking cost efficiencies as increasing SIZE, after the consolidation process has settled, would help banks achieve economies of scale and thus enjoy improvements in cost efficiency.

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