สำนักงานวิทยทรัพยากร จุฬาลงกรณ์มหาวิทยาลัย

CHAPTER IV

COST EFFICIENCY IN THE BANKING INDUSTRY IN THAILAND

4.1. Introduction

Globalization, a process driven by economic forces, has brought the increasing division of production into separate stages carried out in different locations. It is becoming increasingly effective in integrating goods and services markets at the global level. What has provided the attractive force for this process is a liberalization of capital inflow. The globalization of market economies may conceivably require the following factors to exist: people, goods, foreign exchange, and information. Globalization leads to transactions in financial products through the relaxation of capital movements and integration of financial markets, thus enhancing the competition among the financial institutions, especially commercial banks. In order to allocate resources effectively, they should have to perform efficiently to keep their costs competitive.

4.2. Literature concerned with the effects of efficiency

G.E. Battese and T.J. Coelli (1995) defined a stochastic frontier production function for panel data on firms, in which the non-negative technical inefficiency effects were assumed to be a function of firm-specific variables and time. The inefficiency effects were assumed to be independently distributed as truncations of normal distributions with constant variance, but with means which were a linear function of observable variables. This panel data model is an extension of recently proposed models for inefficiency effects in stochastic frontiers for cross-sectional data.

Simon H. Kwan and Robert A. Eisenbeis (1996) measured the inefficiency of individual banking firms in the United States by using the stochastic efficient frontier methodology. In this method, a banking firm's observed total cost was modeled to deviate from the cost-efficient frontier due to random noise and possibly X-inefficiency.

To specify the cost function, they employed total operating costs (including interest costs) and input prices. Five measures of banking outputs were included: book value of investment securities, book value of real estate loans, book value of commercial and industrial loans, book value of consumer loans, and off-balance sheet commitments and contingencies which included loan commitments, letters of credit (both commercial and standby), futures and forward contracts, and notional value of outstanding interest rate swaps. Three input prices were utilized: the unit price of capital measured as total occupancy expenses divided by fixed plant and equipment, the unit cost of funds defined as total interest expenses divided by total deposits, borrowed funds, and subordinated notes and debentures, and the unit price of labor, defined as total wages and salaries divided by the number of full-time equivalent employees.

Jacob A. Bikker (1999) applied the stochastic cost frontier approach to the European banking industry in an attempt to measure its efficiency in 9 European countries. Bank cost efficiency analysis was based on the assumption that the technology of an individual bank could be described by a production function, which linked banking outputs to available input factors. Loans, savings accounts and demand deposits were distinguished as production factors. The number of branches had been included in the multi-product cost function, as an indicator of additional service of a bank to its clients. Most bank services were related to traditional balance sheet items, such as loans and deposits, but to an increasing extent, banks provided other services such as trade in securities, asset management and investment funds.

Wonsik Sul (1998) intended to test empirically whether universal hanks could surpass specialized banks in performance. As a result, diversification into universal banks guaranteed a higher performance on the average than specialization. The change in performance determining structure according to strategy taking of universal banks or specialized hanks could be observed. Resources such as size, stability and liquidity were shown as important factors which influenced procedure to diversification and improvement of performance. Specialized banks were comparatively small-size and had competitive advantage with cost efficiency maintaining lower equity-assets ratio.

Jonathan Hao, William Curt Hunter, Won Keun Yang (1999) examined the productive efficiency of a sample of private Korean banks over period of 1985 -1995. The goal of the analysis was to identify the key determinants of Korean bank efficiency (inefficiency) following the program of deregulation initiated by the government in the early 1980s and augmented in the early 1990s. Instead of comparing the operating performance of the sample banks with a set of superior-operated banks by using financial ratio, they used production theory and econometric procedures to extract information on managerial efficiency. Using the stochastic frontier cost function approach, efficiency scores were determined for each bank in the sample. A second stage efficiency regression was then estimated to identify the key determinants of operating efficiency. To calculate each bank's efficiency index, they fitted a stochastic frontier cost function to characterize the efficient frontier for the sample banks by using the variables: total loans and securities, demand deposits, and fee income, the prices of inputs, used in the production of bank assets i.e. the wage rate, interest for borrowed funds, and the price of physical capital.. The cost function also included the variable equity capital for each bank, to adjust for increased costs of funds due to financial risk. The results showed that banks with higher rates of asset growth, fewer employees per million won of assets, larger amounts of core deposits, and lower expense ratios were more efficient. In addition, banks which branched nationwide were found to be more efficient. The financial deregulation of 1991 was found to have had little or no significant effect on the level of sample bank efficiency.

Tim Coelli, Sergio Perelman and Elliot Romano (1999) measured the efficiency of international airlines. They measured technical efficiency from stochastic frontier production functions which had been adjusted to account for environmental influences such as network conditions, geographical factors, etc. Two alternative approaches to this problem had been proposed in the efficiency measurement literature. The first one was that the environmental factors influenced the shape of the technology while the other assumes that they directly influenced the degree of technical inefficiency. The results of the two approaches provided similar rankings of airlines but suggested differing degrees of technical inefficiency. Both had concluded that

Asia/Oceanic airlines were technically more efficient than European and North American airlines but that the differences were essentially due to more favorable environmental conditions. In addition, Asian companies had major improvements in managerial efficiency (technical efficiency with environmental factors netted out).

George E. Battese, Almas Heshmati, Lennart Hjalmarsson (2000) analyzed the impact of the deregulation of the Swedish banking industry in the mid-1980s, and the consequent banking crisis, on productive efficiency and productivity growth in the industry. They studied an unbalanced panel of Swedish banks over the period of 1984 – 1995. A translog stochastic frontier model was adopted to estimate the labor-use requirements in terms of the variables, loans, deposits, guarantees, number of branches, and total inventories, together with the year of observation. The inefficiency effects in the labor-use frontier were modeled in terms of the number of branches, total inventories, the type of bank and year of observation. The technical inefficiencies of labor use of Swedish banks were found to be significant.

Richard Kneller and Philip Andrew Stevens (2003) investigated whether differences in absorptive capacity help to explain cross-country differences in the level of productivity. They utilized stochastic frontier analysis to investigate two potential sources of this inefficiency: differences in human capital and R&D for nine industries in twelve OECD countries over the period of 1973 -1992. They examined the effect of human capital and of research and development (R&D) as determinants of absorptive capacity. Inefficiency in production indeed existed and depended upon the level of human capital of the country's workforce. Differences in the level of absorptive capacity helped explain deviations from this frontier through differences in inefficiency. The use of R&D and human capital as determinants of absorptive capacity allows for the possibility that one or both have a dual effect on production: a direct effect and an effect through inefficiency.

J.W.B. Bos and LW. Kolari (2003) employed stochastic frontier cost and profit models to estimate economies of scale as well as X-efficiency (the economic efficiency of any single firm minus scale and scope efficiency effect) for multi-billion dollar European and U.S. banks over the period of 1995-1999. The general concept of

efficiency referred to the difference between observed and optimal values of inputs, outputs, and input/output mixes and measured how efficiently a firm produces outputs from its inputs. They defined profit before tax (PBT) as outputs, input prices and control variable, which reflected differences in risk-taking behavior of banks. Further, they included linear and quadratic trend terms. For the specific choice of variables the optimal profit level for bank was a function of the number of outputs, input prices, and the control variable. Empirical results with respect to separate analyses of large European and U.S. banks were similar with decreasing (increasing) cost (profit) returns to scale. The large banks in Europe and the U.S. had cost and profit functions that were similar to increasing returns to scale and decreasing (increasing) scope economies for the cost (profit) model. Although profitability in absolute terms was equal, large U.S. banks tended to exhibit higher average profit efficiency than European banks on average. In addition, banks in the U.S. were more profit efficient than banks in most individual European countries. Potential efficiency gains were possible via geographic expansion of large European and U.S. banks.

Fatma Cebenoyan (2003) analyzed differential earnings/price behavior by using stochastic frontier methodology to measure firm performance. The study model employed the basic input-output production function relationship with some modifications to the variables. The study evaluated firms' relative ability to utilize their resources and linked this ability to the value-relevance of earnings. The variables included sales revenue as an output and a vector of operational inputs generating the revenue and denoted an inefficiency factor that affected the firm's comparative performance level, and the random error that incorporated a measurement error and/or luck that affected the firm's performance. Results provided strong evidence that the efficiency measure explained some of the differences in value-relevance of earnings. The results were robust to functional forms, portfolio choices, timing differences, as well as to the inclusion of other explanatory variables such as risk, profitability, size and R&D. Also, the results indicated a significant relationship between the firms' relative operational efficiency and earnings persistence.

Claudia Girardone, Philip Molyneux and Edward P. M. Gardener (2004) investigated the main determinants of Italian banks' cost efficiency over the period of 1993-1996, by employing a Fourier-flexible stochastic cost frontier in order to measure X-efficiencies and economies of scale. Quality and risks of bank outputs were explicitly accounted for in the cost function and their impact on cost efficiency levels. Mean X-inefficiencies range tended to decrease over time for all bank sizes. Economies of scale appeared present and significant and the inclusion of risk and output quality variables in the cost function seemed to reduce the significance of the scale economy estimates. A profitability test was undertaken which allowed for the identification of banks that were both cost and profit efficient. The most efficient and profitable institutions were more able to control all aspects of costs, especially labor costs. The analysis also showed that there was no clear relationship between asset size and bank efficiency.

Juiien Reynaud and Rofakoli Rokeim (2005) studied the role of efficiency in banking crises in Indonesia and Turkey. Building on these elements, banking crises could be divided into two categories: microeconomic and macroeconomic. The study focused on the microeconomic level, which referred to bad banking. Banking crises were linked to weak bank operations such as poor lending practices, excessive risk taking, deficient governance, lacking of internal controls, focusing on market share rather than profitability, and currency and maturity mismatches in the banks themselves or among their borrowers. These conditions may be worsened when bank ownership is very narrow. Bad banking also referred to bad lending, connected lending, insider operations, and outright fraud may go hand in hand with impunity. State banks may be rim as quasi-fiscal agencies based on political criteria with disregard for commercial principles, undermining their solvency and the soundness of other better-run banks. Bad banking could only persist in the absence of proper regulation and supervision, and of adequate market discipline. Supervisors may also lack authority and the sufficient skilled staff.

Andy Cosh, Xiaolan Fu and Alan Hughes (2005) explored the impact of management characteristics and patterns of collaboration on a firm's innovation performance in transforming innovation resources into commercially successful outputs.

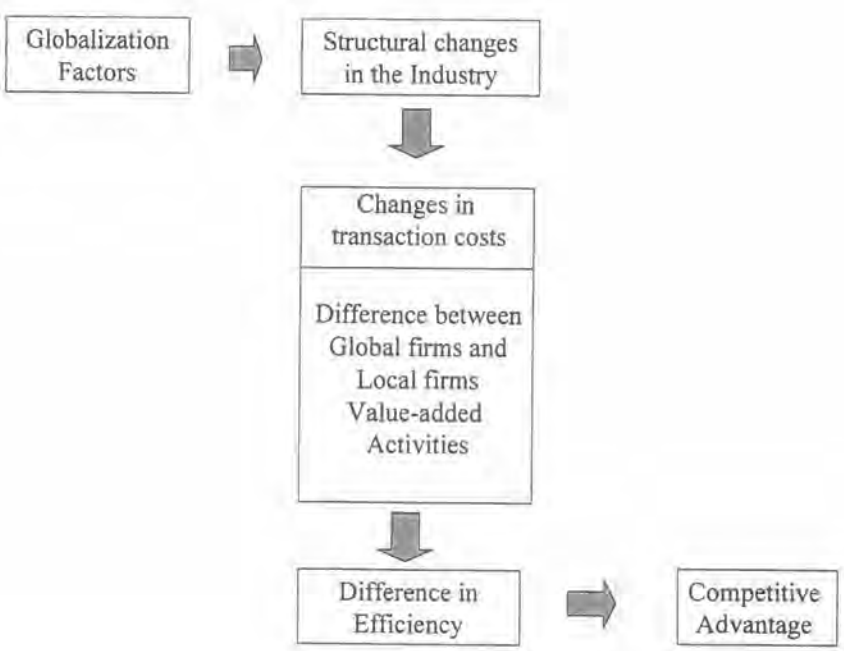
They used a recent firm level survey database for 465 innovative British small and medium enterprises (SMEs) over the period of 1998-2001. Both Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) were employed to benchmark a firm's innovative efficiency against best practice. Quality and the variety of innovations were taken into account. The innovative efficiency of SMEs was significantly affected by their management characteristics and collaboration behavior. Collaboration, organizational flexibility, formality in management systems and incentive schemes were found to contribute significantly to a firm's innovative efficiency. Managerial share ownership also showed some positive effects. The innovative efficiency in high-tech SMEs was significantly enhanced by collaboration, formal management structure and training; and that in medium- and low-tech SMEs was significantly associated with managerial ownership, incentive schemes and organizational flexibility.

Pek Chen Goh(2005) measured the intellectual capital performance of commercial banks in Malaysia over the period of 2001 - 2003, using efficiency coefficient called VAIC" developed by Ante Pulic to calculate human capital, structural capital and capital employed efficiencies. The findind was that all banks had relatively higher human capital efficiency than structural and capital efficiencies. Domestic banks were generally less efficient compared to foreign banks. There were significant differences between rankings of bank according to efficiency and traditional accounting measures. In view of the findings that seven out of ten domestic banks did not show improvement in efficiency following the consolidation exercise requires an urgent attention and remedial actions.

To measure the efficiency of individual firms in the industry, the model of efficiency was constructed in such a way that it reflected the cost-efficient frontier. Exogenous globalization factors led to changes in the industry structure which resulted in the difference in cost positions and difference in position advantages. The underlying factors from the above sections could be formulated into possible relations of variables as follows: external uncertainty i.e. advances in information technology and liberalization of economic exchange of factors of production such as capital, raw materials, human resources, including knowledge, structural changes in the industry involving

opportunistic behavior, internal uncertainty such as value added chain of activities, international experience, socio-cultural distance and the scale of foreign business community in the host country, transaction-specific assets i.e. investments in physical assets, human assets and organizational capital such as social complexity, causal ambiguity and network externalities, free-riding potential such as international goodwill and recognition and value of a brand name, cost drivers including search and information costs, bargaining and decision costs and policing and enforcement costs, governance, structure and structural advantages such as firm-specific (or ownership-specific) advantages, country-specific (or location) advantages and internalization advantages.

Figure 3 Efficiency and competitive advantage



4.3. Literature concerned with Intellectual Capital

Pulic (1998) proposed the Value Added Intellectual Coefficient (VAIC™) to provide information about the value creation efficiency of tangible and intangible assets

within a company. VAIC ^{TM} is an analytical procedure designed to enable management, shareholders and other relevant stakeholders to effectively monitor and evaluate the efficiency of VA by a firm's total resources and each major resource component. Instead of valuing the intellectual capital of a firm, the VAIC method mainly measures the efficiency of firms' three types of inputs: physical and financial capital, human capital, and structural capital, namely the Capital Employed Efficiency (CEE) — indicator of VA efficiency of capital employed, the Human Capital Efficiency (HCE) — indicator of VA efficiency of human capital, and the Structural Capital Efficiency (SCE) — indicator of VA efficiency of structural capital. The sum of the three measures is the value of VAIC. The higher VAIC value results in better companies' value creation potential.

The subordinate concept of VAIC^{TM}, Intellectual Capital Efficiency (ICE), describes the efficiency of Intellectual Capital (IC) within a company. VAIC^{TM} indicates the total efficiency of value creation from all resources employed and ICE reflects the efficiency of value created by the IC employed. The better a company's resources have been utilized the higher the company's value creation efficiency will be. (See e.g. Pulic, 2000) The method is based on two resources: capital employed (CE) and intellectual capital (IC). Both resources play a significant role in the value adding of a company and are considered as investments. Capital employed consists of equity, the accumulation of profit-adjusting entries and liabilities with interest. IC consists of human and structural capital (defined this way in the context of VAIC^{TM}). Intellectual capital efficiency (ICE) is calculated by summing together the human capital efficiency HCE and the structural capital efficiency (SCE). The following equation explains the relationship algebraically:

$VAIC^{TM}_{i} = CEE_{i} + HCE_{i} + SCE_{i}$ where

$VAIC^{TM}$ = VA intellectual coefficient for firm i;

CEE_{i} = VA_{i}/CE_{i} VA capital employed efficiency for firm i;

HCE_{i} = VA_{i}/HC_{i}; human capital efficiency for firm i;

SCE_{i} = SC_{i}/VA_{i}; structural capital efficiency VA for firm i;

ICE_{i} = $HCE_{i} + SCE_{i}$ Intellectual capital efficiency for firm i;

VA_i = Output – Input (Total Sales (Revenue) – cost of brought in materials, components and services or operating profits + Employee costs+ Depreciation + Amortization

CE_i = book value of the net assets for firm i

HC_i = total salary and wages for firm i;

SC_i = VA_i - HC_i structural capital for firm i.

4.4. Literatures concerned with the Thai Banking Industry

Prakit Narongtanupon (2000) examined the efficiency of commercial banks in Thailand during the 1989 and 1998 using the Stochastic Frontier Approach as one of his three essays in his dissertation. His findings were consistent with the dominance of the Global Advantage Hypothesis, which supports superior efficiency by foreign banks relative to host-country banks. In addition, the average efficiency levels of both Thai-owned and foreign-owned banks in Thailand deteriorated after the eruption of its 1997 economic crisis. However, foreign-owned banks appeared to cope better with the economic downturn. The variation in the bank's efficiency significantly correlated with both macro-economic variables and bank's specific characteristics.

Saovanee Chantapong (2001) examined the impact of the crisis and the financial sector restructuring introduced after 1997 financial crisis in Thailand on Thai banking Industry. The Study is based on a new micro-level dataset covering a 6-year span from 1995 - 2000 of bank level panel data on financial statements and it examined whether domestic and foreign banks performed differently under the same unfavorable economic environment. It was found that the domestic banks experienced larger negative impacts from the financial crisis than foreign banks and foreign banks performance rebounded faster than that of domestic banks. It could be inferred that stronger and efficient banks could survive under adverse situations and weaker players were forced to exit. Positively, efficiency and professionalism in Thai banking industry could be a stimulus for domestic banks to adjust themselves and to improve financial system infrastructure.

Molnar, M. (2003) investigated the changing relationship between banks and their business customers in Thailand after 1997. The changes were manifest in declining bank lending growth and could be attributed to three major driving forces: cyclical factors, the fallout from the 1997 Asian crisis and structural factors affecting both the supply of and demand for bank credit. These forces resulted in reduced corporate loan demand, non-performing loans (NPLs) and the banks' cautious decision in lending money. These factors along with other factors such as increasing competition from multinationals and capital markets had squeezed bank profits. In response to declining lending growth and declining profits, banks have been changing their strategies. They have been diversifying their customer base and scope of activities. Individuals and small and medium-size enterprises are among the fastest growing customer segments of the banks. Banks are also expanding the scope of their activities such as entering securities business.

Consolidation is another strategy to restore profitability and stay afloat in the global competition arena. Mergers and acquisitions have resulted in further concentration of the banking sector in Thailand. These problems of debt load and over-capacity in many real sectors are inducing shifts in corporate strategies that are affecting their demand for loans and other products from banks, Faced with more stringent bank lending conditions, and seeking to reduce their debt loads, larger firms have been turning to capital markets as part of an effort to diversify their sources of funding. The development of the corporate bond market, facilitated by the establishment of pricing benchmarks, has been spectacular. The Thai firms had diversified their sources of financing over the period of 1997-2000, which was reflected in the rise of the share of debt securities and trade financing. The share of loans, short-term or long-term, on the other hand, had declined.

According to Mckinsey's research on Thai productivity (2002) in response to the regional financial crisis that began in 1997, the Thai government had introduced a number of liberalization measures aimed at reviving the banking sector. Foreign banks were permitted to own a majority stake in selected local banks for a period of 10 years. Consequently, the so-called 'hybrid' banks had emerged in which foreign banks hold

more than 50% equity stakes. The creation of hybrid banks represented the most visible increase in foreign participation in the Thai banking sector since the onset of the financial crisis.

Hidenobu Okuda and Suvadee Rungsomboon (2004) investigated the impact of foreign bank entry on Thai domestic banks by using panel data on 17 domestic commercial banks from 1990 to 2002. The paper examined different factors affecting bank performance, including changes in the foreign ownership of banks, financial regulations, and market structure. They found that an increase in foreign banks' presence led to a rise in overhead expenses, a decline in profits, and an increase in the interest spreads of domestic banks. In the short run, increased competition from foreign banks negatively affected domestic banks. However, in the long run, domestic banks' performance should improve.

Saovanee Chantapong (2005) studied the performance of domestic and foreign banks in Thailand in terms of profitability and other characteristics after the East Asian financial crisis. The study was based on a micro bank-level panel data on financial statements by pooling cross-section time-series data with the major balance sheet and income statement ratios for domestic and foreign banks in Thailand between 1995 and 2000. All banks were found to have reduced their credit exposure during the crisis years and to have gradually improved their profitability during the post-crisis years. The results indicated that foreign bank profitability was higher than the average profitability of the domestic banks although importantly, in the post-crisis period, the gap between foreign and domestic profitability became closer. This showed some positive results of the financial restructuring program.

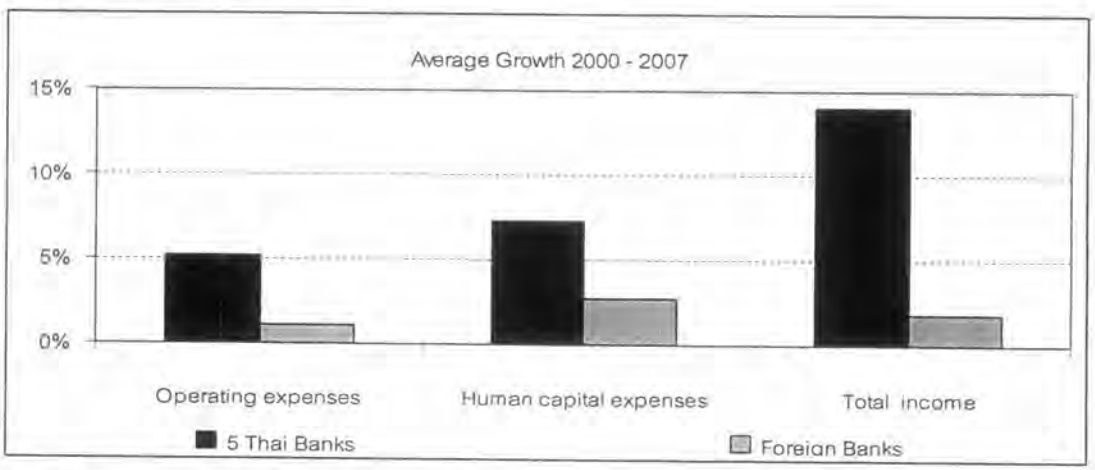
Saovanee Chantapong (2005) estimated and compared cost efficiency of domestic and foreign banks in Thailand by using bank-panel data between 1995 and 2003. It also examined the effect of foreign bank entry on banking efficiency in Thailand since the significant acquisitions by foreign banks after the 1997 financial crisis. The widely used translog functional form specification was statistically tested by pooled regressions. The estimated results suggested that the unit costs of production of domestic and foreign banks were indistinguishable, although the two types of banks

focused on different areas of the banking business. The findings suggested that based on bank operating efficiency, if foreign banks represented the best-practice banks in the industry, to a large extent, domestic banks in Thailand had caught up to the best-practice standards through out 1995-2003, significantly after the 1997 financial crisis. This may be due to greater foreign participation through acquisitions, which increased the competitive pressure in the banking industry, and also to financial restructuring of domestic banks, which increased the cost efficiency of domestic banks.

Koji Kubo (2006) analyzed the influence of the East Asian crisis and the subsequent reforms on the oligopolistic nature of the Thai banking industry. Since the crisis, there had been substantial changes in competitive environment, including a decline in the family ownership of banks as well as the arrival of new entrants. How did these changes affect a banking industry in which the six largest local banks accounted for over 70 percent of market share? The estimated Lerner index from Bresnahan's conjectural variation model indicates the possibility of a decline in the degree of competition.

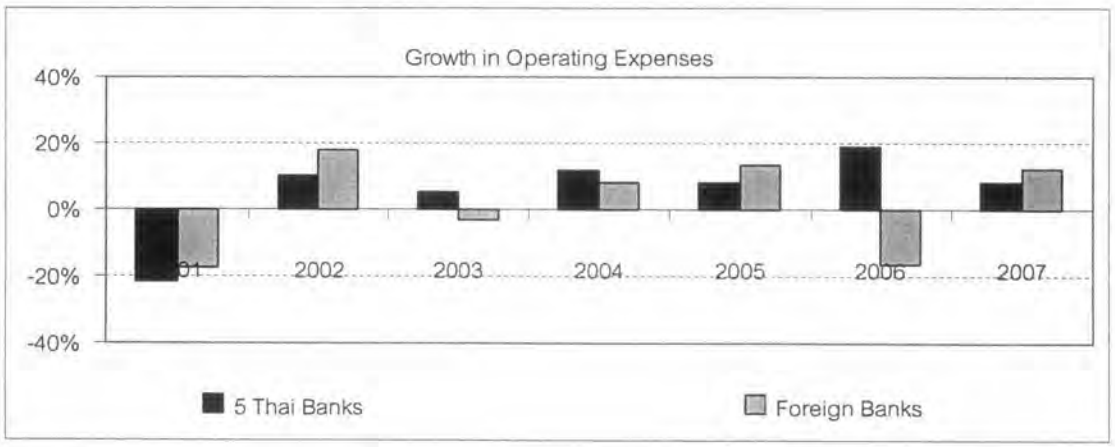
After the eruption of its 1997 economic crisis, foreign banks performed superior efficiency relative to domestic banks. The average efficiency levels of both domestic and foreign banks in Thailand deteriorated. The domestic banks experienced larger negative impacts from the financial crisis than foreign banks and foreign banks performance rebounded faster than that of domestic banks.

Figure 4 Average growth 2000 - 2007



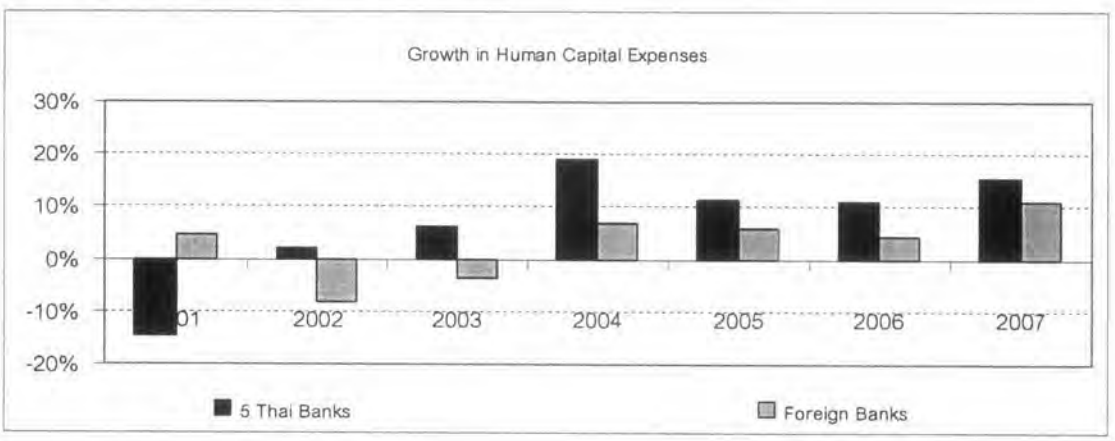
Source: own calculation

Figure 5 Growth in operating expenses



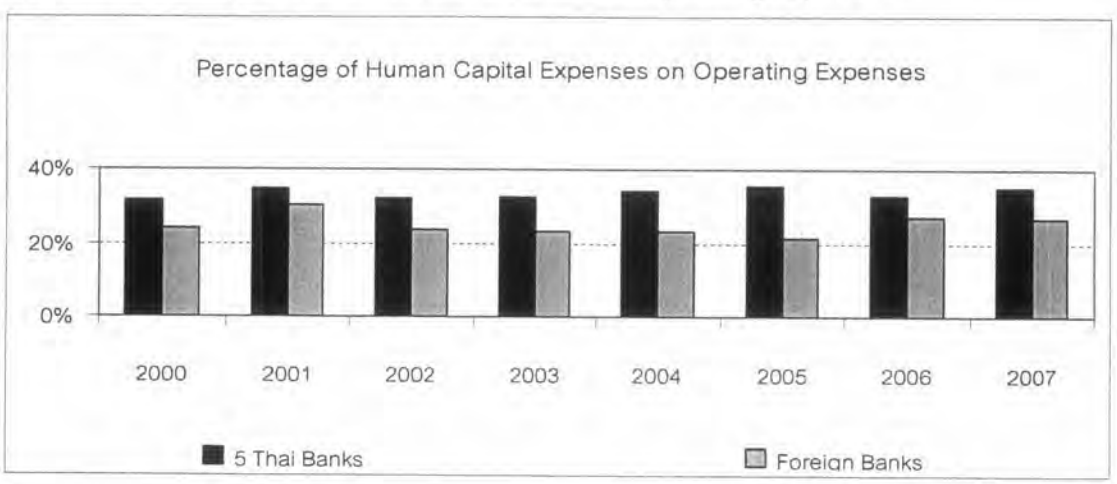
Source: own calculation

Figure 6 Growth in human capital expenses



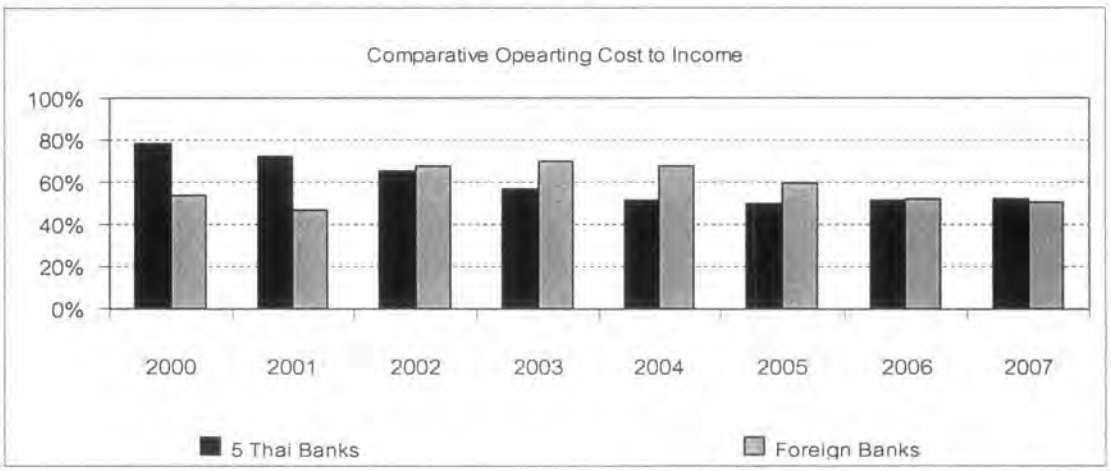
Source: own calculation

Figure 7 Percentage of Human capital expenses on operating expenses



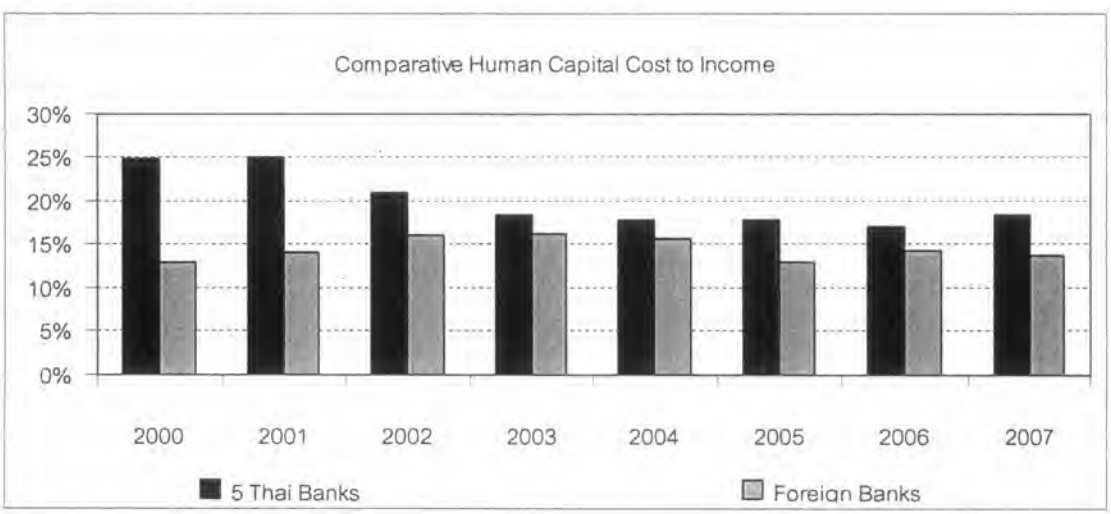
Source: own calculation

Figure 8 Comparative operating costs to income



Source: own calculation

Figure 9 Comparative human capital costs to income



Source: own calculation

All banks were found to have reduced their credit exposure during the crisis years. They have gradually improved their profitability during the post-crisis period. The results indicate that foreign bank profitability is higher than the average profitability of the domestic banks. From figure 4 to 9, the banking industry has concentrated on cost management. Thai banks had an average 5% growth in operating expenses and 7% growth in human expenses, which are lower than growth in total income at 14%. At the same time, foreign banks had an average growth in total income at 2% and kept the average growth of operating expenses at 1% but allowed the growth of human capital

expenses at an average 2%. Moreover, the ratio of human capital cost to total cost for Thai banks has been increased from 32% in 2000 to 37% in 2007 whereas that of foreign banks has been kept at the lower level from 24% in 2000 to 27% in 2007.

In terms of cost efficiency, related to globalization and measured by the improvement on the ratio of cost to income, Thai banks had improved their cost competitiveness by reducing the ratio from 78% in 2000 to 52%. For foreign banks, the cost to income ratio had been reduced from 54% in 2000 to 51% in 2007. In terms of human capital expenses, the ratio of human capital expenses to total income for Thai banks had been reduced from 25% in 2000 to 19% in 2007 whereas foreign banks had little improvement in the ratio from 14% in 2000 to 13% in 2007.

In summary, the banking industry has continued to grow their profitability by accelerating growth in their income but controlling their operating costs. They have kept the cost efficiency ratio down. However, they have kept investing in human capital. The group of Thai banks had dynamically improved their cost competitiveness over time, reflecting from the reduction on the cost to income ratio. This would enhance their competitiveness against those from the foreign countries.

4.5. Statement of Problem

The Banking industry was severely hit by the economic crisis during 1997–1999. Its financial performance has been turned into profit since 2001. All banks were found to have reduced their credit exposure during the crisis years. The group of Thai banks and the group of foreign-owned banks have gradually improved, which have interesting points to study on how efficiency plays a role in different financial performances.

4.6. Research Objective

To measure the efficiency of individual firms in the industry, the model of efficiency is constructed in such a way that it reflects the cost-efficient frontier. To examine differences in efficiency among Thai local firms and Foreign-owned firms,

which operate their business activities in Thailand, the research will study the effects of *Ownership* and *Intellectual Capital* on the cost performance of the firms. Ownership and Dynamic movement of the industry, which are the exogenous ones, lead to changes in the industry structure and ~~then~~ results in the difference in cost positions and difference in position advantages.

4.7. Research Methodology

In order to obtain inefficiency indexes of sample banks, a stochastic frontier approach, which becomes a common approach in bank efficiency research, will be employed. The stochastic frontier (SFA) model is used as it allows for measurement error, which is an important feature in light of the fact that measuring bank production can be difficult due to data availability and the choice of a set of inputs and outputs. In addition it generates firm-specific efficiency estimates, which can be used to test for differences in efficiency among banks According to Battese and Coelli (1995), the analysis of the stochastic frontier production function for panel data is defined by equation (1),

$$Y_{it} = exp(x_{it}\beta + V_{it} - U_{it})$$

Or

$$Y_{it} = X_{it}\beta + (V_{it} - U_{it}) \qquad (1)$$

Where Y_{it} = the (logged) output obtained by the i-th firm in the t-th time period;

X_{it} = a (1 x k) vector of (transformation of the) known input quantities associated with the i-th firm in the t-th time period of observation;

β = a (k x 1) vector of unknown parameters to be estimated; and

V_{it} = assumed to be iid N (0, σ_v^2) random errors, and independently distributed of the U_{it}'s;

U_{it} = non-negative random variables, associated with technical inefficiency of production , which are assumed to be independently distributed as truncations at zero of the normal distribution with mean, $z_{it}\sigma$ and varianceσ_u^2

z_{it} = a (1 x m) vector of firm—specific variables which may vary over time;

σ = an (m x 1) vector of unknown coefficients of the firm—specific inefficiency variables.

Equation (1) specifies the stochastic frontier production function (e.g., of Cobb—Douglas or transcendental—logarithmic form) in terms of the original production values. However, the technical inefficiency effects, the U_{it} 's, are assumed to be a function of a set of explanatory variables, the zit's and an unknown vector of coefficients, σ. The explanatory variables in the inefficiency model may include some input variables in the stochastic frontier, provided the inefficiency effects are stochastic.

The technical inefficiency effect, U_{it} in the stochastic frontier model (1) could be specified in equation (2),

$$U_{it} = z_{it}\sigma + W_{it} \qquad (2)$$

where the random variable, W_{it}, is defined by the truncation of the normal distribution with zero mean and variance, σ^2, such that the point of truncation is $-z_{it}\sigma$, i.e., $W_{it} \geq -z_{it}\sigma$. These assumptions are consistent with U_{it}, being a non-negative truncation of the N $(z_{it}\sigma, \sigma^2)$-distribution. The assumption that the U_{it} s and the V_{it}s are independently distributed for all t = 1,2,..., T, and i =1,2,...,N, is a simplifying, but restrictive, condition.

The method of maximum likelihood is used for simultaneous estimation of the parameters of the stochastic frontier and the model for the technical inefficiency effects. The likelihood function is expressed in terms of the variance parameters, $\sigma^2_s = \sigma^2_s + \sigma^2$ and $\gamma \Xi\sigma^2 / \sigma^2_s$. The technical efficiency of production for the i-th firm at the t-th observation is defined by equation (3),

$$TE_{it} = exp(-U_{it}) = exp(- z_{it}\sigma W_{it}) \quad (3)$$

The prediction of the technical efficiencies is based on its conditional expectation, given the model assumptions.

4.7.1. Model Estimation

With regards to the literature review on efficiency, which names several factors, the stochastic frontier function to be estimated for the bank cost efficiency is

$$\ln C_{it} = \beta_0 + \beta_1 \ln INC_{it} + \beta_2 \ln LFD_{it} + \beta_5 \ln OPS_{it} + \beta_3 \ln WAG_{it} + V_{it} + U_{it} \quad (4)$$

Economic inefficiency effects due to Global economic integration:

$$U_{it} = \sigma_0 + \sigma_1 VAIC_{it} + \sigma_2 OWN_{it} + W_{it} \quad (5)$$

where *ln* is the natural logarithm (i.e. logarithm to the base e);

C_{it} = Total administrative cost of bank unit i at time period t except for salaries and employee benefits

INC_{it} = Total income from net interest income and income from bank products excluding loans i.e. fees and commissions

LFD_{it} = Loanable funds including deposits, due to financial institutions and money market, liabilities payable on demand, securities sold under repurchase agreements and borrowings

OPS_{it} = All Assets used in operating banks' transactions i.e. loans and all other assets

WAG_{it} = Price of Labor i.e. salaries and employee benefits

$VAIC_{it}$ = Valued added intellectual coefficient for firm i;

$GROUP_{it}$ = Dummy variables for Thai and Foreign-owned banks, 0= Foreign Banks, 1=Thai Banks including Kasikorn Bank, Siam Commercial Bank, Bangkok Bank, Bank of Ayudhaya and Krung Thai Bank

The stochastic frontier production function in (4) can be viewed as a linearized version of the logarithm of the Cobb-Douglas production of function. The inefficiency frontier model i.e. the equations (4) and (5) accounts for both technical change and time-varying inefficiency effects.

4.7.2. Data

The study of Thai banking industry will include an investigation of an evolutionary 8-year path of the industry from 2000 until 2007, which is the period of events, leading to changes in banks' competitiveness. The data used in the model consists of quarterly bank-level data which is acquired from the published statistics by the Bank of Thailand, which classify the data on foreign banks' branches. The data for selected Thai banks, including Kasikorn Bank, Siam Commercial Bank, Bangkok Bank, Bank of Ayudhaya and Krung Thai Bank, comes from the Stock Exchange of Thailand. Kasikorn Bank, Siam Commercial Bank and Bangkok Bank are in the same group, in which Bangkok Bank has the largest asset size and Krung Thai Bank is the state enterprise bank. The variables are selected from the banks' balance sheet and income statements. However, the treatment of data has been done by omitting the data in quarter 4, 2001, quarter 2, 2003 and quarter 4, 2005 which cannot be transformed into logarithm value.

4.8. Empirical Results

The maximum-likelihood estimates of the parameters of the model are obtained using a computer program, FRONTIER 4.1 (Coelli, 1996). These estimates, together with the estimated standard errors of the maximum-likelihood estimators, are given to three significant digits, are as follows:

	$\ln C_{it}$ =	-3.101968 +	1.6544 ** $\ln INC_{it}$ +	0.0652 $\ln LFD_{it}$
SE		*(16.3607)*	*(0.0665)*	*(0.0627)*
t-ratio		*(-0.1895)*	*(24.8771)*	*(-1.0404)*

	+ 0.0048$\ln OPS_{it}$	-0.7726 ** $\ln WAG_{it}$
SE	*(0.0933)*	*(0.0669)*
t-ratio	*(0.0514)*	*(-11.5472)*

Economic inefficiency effects:

	U_{it} =	1.9910	-0.2354 ** $VAIC_{it}$	- 0.0894* *$GROUP_{it}$
SE		*(16.340128)*	*(0.010)*	*(0.0369)*
t-ratio		*(0.1218)*	*(-23.2948)*	*(-2.4201)*

log likelihood function = 131.9663

LR test of the one-sided error = 242.5596

with number of restrictions = 4

N = 174

** ... significant at the 5% critical level

The signs of the coefficients of the stochastic frontier are mostly positive except the negative sign for Price of Labor. The estimated coefficients for income from bank products including loans and fees and commissions and Price of Labor are significant at 5% critical level. From the equation, it is implied that the banks will increase the

operating costs excluding salaries and employee benefits when they grow their incomes but controlling salaries and benefits. This is in line with the banks controlling total operating costs, which including both administrative costs and salaries and employee benefits so that they can monitor their cost efficiency ratio such as cost to income ratio. In addition, the more income from loan and fees the banks have, the more costs related to those activities incurred. For the inefficiency model (*U*), the estimated coefficients are of particular interest, in that there are significant effects of ownership of the banks on the cost efficiency model at 5% critical level. Both of the Valued added intellectual coefficient and *ownership* are negative, which indicate that different ownerships have the impact on the cost efficiency. Thai banks have better position in administrative cost efficiency. In addition, the dynamic competition of industry results in better cost efficiency.

4.9. The measurement of productivity change

To measure technical change and technical efficiency change, a Malmquist index is used to estimate Total Factor Productivity (TFP) following respective periods of deregulation embarked from 2000 to 2007. The Malmquist index specified can be used to determine levels of change in productivity and technical efficiency between time periods.

The Malmquist index discussed above is calculated as follows;

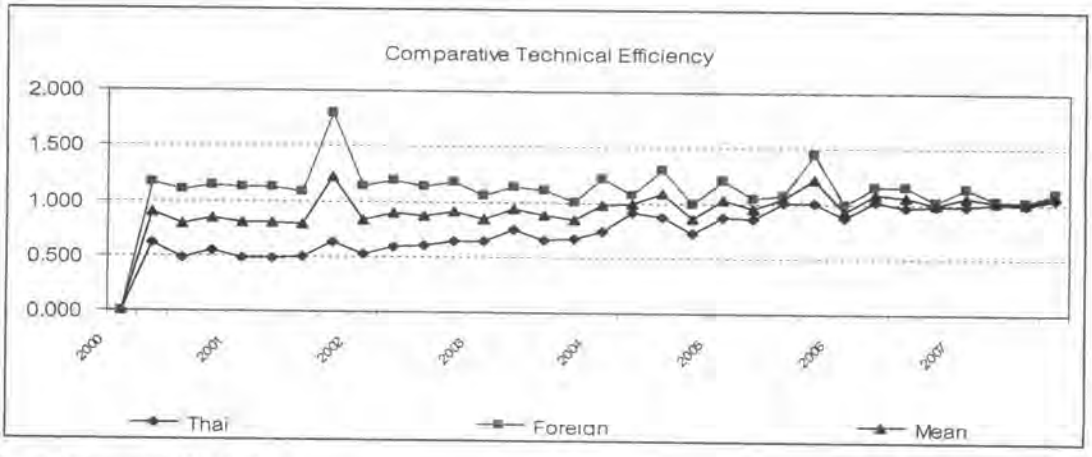
$$m_0\ (y_{t+1}, x_{t+1}, y_t, x_t) = \left(\frac{d^t_0\ (y_{t+1}, x_{t+1t})}{d^t_0\ (y_t, x_t)} \quad X \quad \frac{d^{t+1}_0\ (y_{t+1}, x_{t+1})}{d^t_0\ (y_t, x_t)} \right)^{1/2}$$

When a panel of data is available, moreover, changes in productivity growth over the period under consideration can also be calculated using the Malmquist productivity change index. The Malmquist index provides a measure of changes in total factor productivity (TFP) from year to year. Three aspects of the efficiency of commercial banks will be considered: technical efficiency, i.e. the efficiency with which

inputs are converted into outputs; scale efficiency, i.e. how close a bank is to its most efficient scale size; and productivity growth, i.e. the change in output which is not a consequence of growth in input quantities. The values are concentrated around 1, which implies no change. A TFP value greater than 1 implies an improvement or indicate positive TFP growth from period t to period t+1, while a value less than 1 implies a decrease in productivity. TFP is comprised of two parts—efficiency changes and technical change. The efficiency change relates to how the firms performed relative to the production frontier, i.e. whether firms are getting closer to the production frontier over time. An efficiency change greater than 1 implies that the firms are operating closer to the frontier than in the previous time period, however if the figure is less than 1, the bank in question is operating further from the frontier. In addition, the technical change is one which measures changes in technology i.e. whether the production frontier is moving outwards over time. For the scale efficiency, if it is equal to 1 then the firm is already at its optimum scale size in period t.

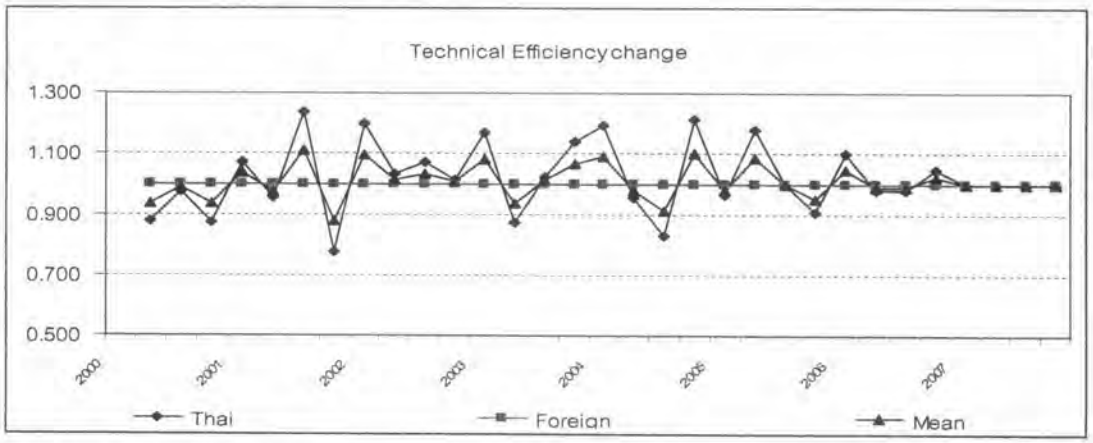
In line with the formula in the Malmquist index, the quarterly data of Thai banks and foreign banks are used to calculate the productivity change. The outputs from the banks are loans y_1 and investment in securities y_2, whereas input quantities are Premises and Equipment x_1, Number of employees x_2, and deposit and borrowing x_3. The results, calculated by the Data Envelopment Analysis (Computer) Program DEAP (Ver. 2.1), developed by Coelli, are as the following graphs and a table:

Figure 10 Comparative technical effciency



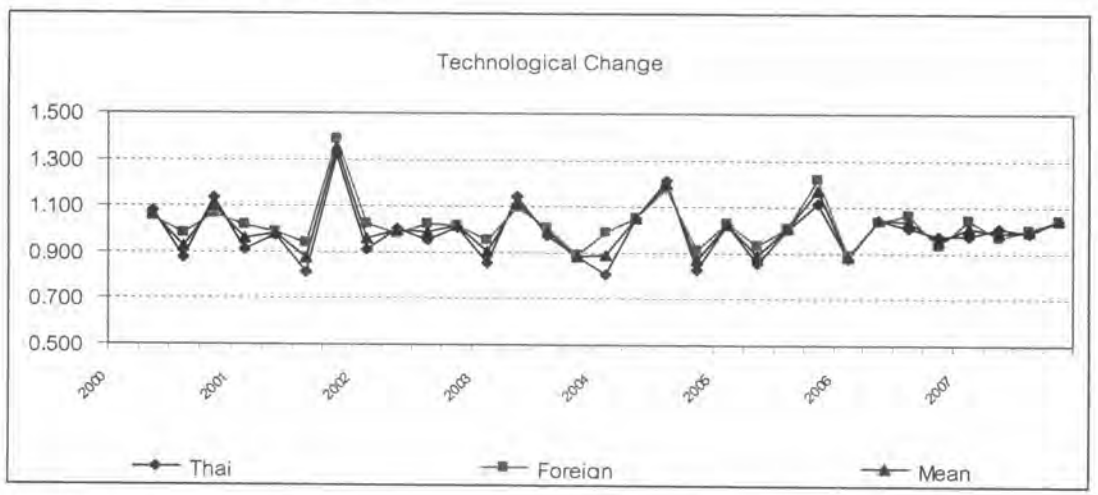
Source: own calculation

Figure 11 Technical efficiency change



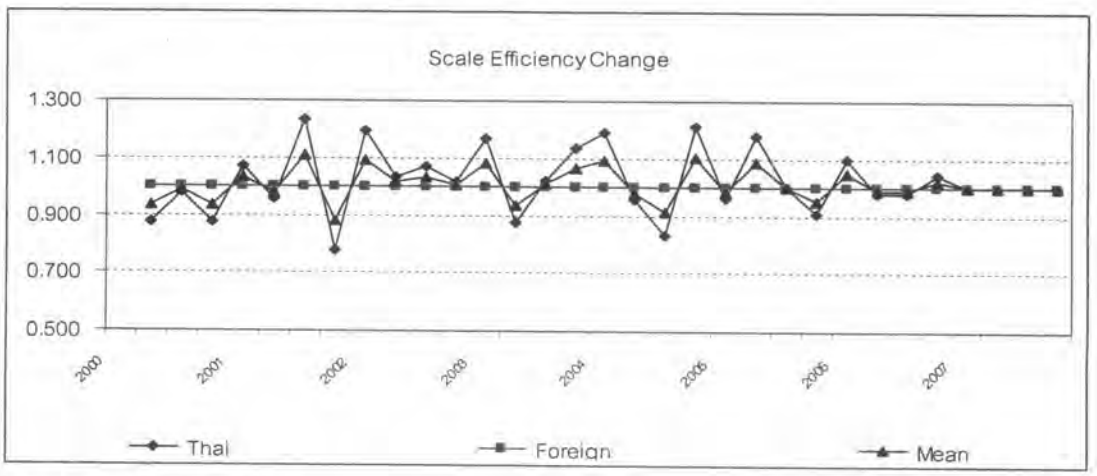
Source: own calculation

Figure 12 Technological change



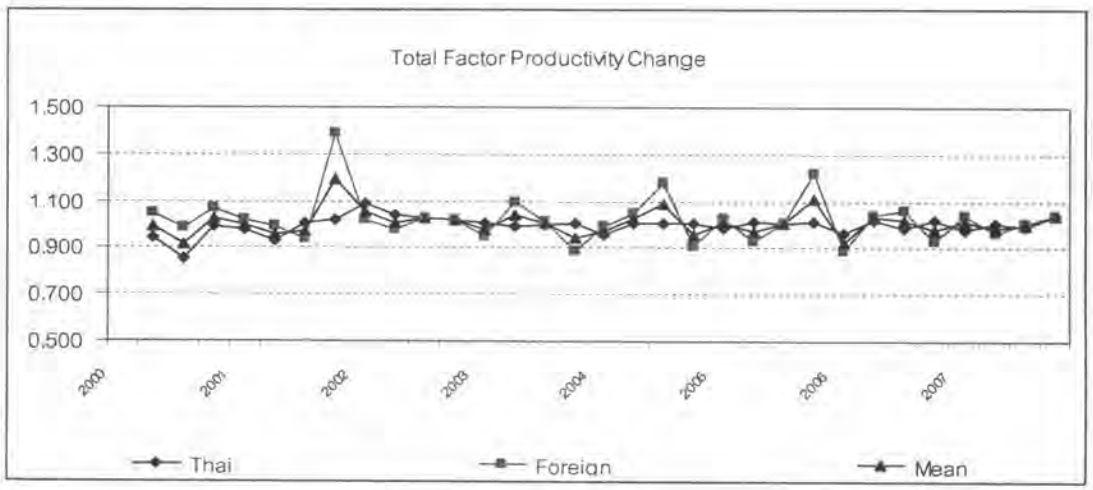
Source: own calculation

Figure 13 Scale efficiency change



Source: own calculation

Figure 14 Total factor productivity change



Source: own calculation

From figure 10 to 14, when comparing technical efficiency, technical efficiency for Thai banks had changed from the level of 0.605 in quarter 2, 2000 to 1.05 in quarter 4, 2007. From the same period, the foreign banks had changed the technical efficiency from 0.893 to 1.072 quarter of 2007. This would reflect a drastic change in competitive position for Thai banks by improving their technical efficiency. Moreover, the technical efficiency change displayed a similar converged pattern. Both Thai banks and foreign banks come close together in technical efficiency change. Thai banks improve their efficiency whereas foreign banks keep constant on their technical efficiency. For the technological change, both Thai and foreign banks are almost similar in moving the production frontier outwards over time. In terms of scale effieciency, foreign banks had scale efficiency close to 1.00 over the period of 2000 to 2007. However, Thai banks had improve their scale to the optimum level over the same periods. In conclusion, changes in productivity over the period of study were little improved. Comparatively, foreign banks performed the productivity change better than Thai banks by getting close to level of 1.00, of which their mean value is 1.02.

Table 3 Malmquist index summary of firm mean

Firm	Technical efficiency change	Technological change	Pure technical change	Scale efficiency change	Total factor productivity change
Thai banks	1.014	0.984	1.000	1.014	0.997
Foreign banks	1.000	1.020	1.000	1.000	1.020
Mean	1.007	1.002	1.000	1.007	1.009

From Table 3, this provided further insights into productivity changes. The first component, measures the change in technical efficiency over periods i.e. whether or not the unit is getting closer to its efficiency frontier over time. It is shown that mean of Thai banks' technical efficiency change was at 1.014 whereas that of foreign banks was at 1.00. This reflected Thai banks' efforts on improving their competitive position, which they ran behind foreign banks in early 2000. However, when measuring the change in technology over the two time periods, i.e. whether or not the frontier is shifting out over time, foreign banks did perform the change valued at 1.020 better than Thai banks, which had value at 0.984. In terms of scale efficiency, both Thai banks and foreign banks ran at scale but Thai banks were in a better position by having mean of scale valued at 1.014 compared to foreign banks' value at 1.00. In summary, with regards to mean of overall the cost efficiency and productivity, foreign banks can perform the total productivity change at 1.020, which was more productive than Thai banks,of which their value was at 0.997, since Thai banks had to spend time in early 2000 to improve their productivity.

4.9. Conclusion

With regards to the examination on the differences in efficiency among Thai local firms and Foreign-owned firms that operate their business activities in Thailand, it was

found that Thai banks ran behind foreign banks in early 2000. However, with the dynamic of the industry, they improved their performance dramatically by controlling their operating costs.

The research studied the effects of globalization factors on the performance of these firms Globalization had made them more productive and keep improving themselves. The empirical results, from the cost efficiency model and the Malmquist index, had shown that Thai banks improved all of the performance ratios so that they were almost at the same level as foreign banks. This would reflect they would gain cost advantage when competing against foreign competitors in the same segment.

An application of the model for panel data is presented using data from 2 groups of commercial banks in Thailand by quarterly over an eight-year period. The result implies that the model for the technical inefficiency effects, involving a constant term and ownership, is a significant component in the stochastic frontier cost function. In terms of intellectual capital index, VAIC and globalization factors, the ownership shows significant factors in the cost efficiency model. In addition, Thai banks could gain more competitive advantage. This application has a limitation in that the data for foreign banks employed in the model is a consolidated one. So, the model is not able to specify the performance of each particular commercial bank due to the limitation on the published data by the government agency. However, the model specification permits the estimation of both technical change and time-varying technical inefficiency, given that inefficiency effects are stochastic and have a known distribution. It would be better if the model can incorporate the more specific data for the model of stochastic frontiers and if the technical inefficiency effects can be effectively associated with the analysis of panel data.