Total Factor Productivity of Thai Banks

in 2007-2010

An Application of DEA and Malmquist Index

Dang-Thanh Ngo[1] and Linh Thi Phuong Nguyen[2]

Abstract

This research employs the Data Envelopment Analysis (DEA) and Malmquist index approaches to evaluate the efficiency and Total Factor Productivity (TFP) changes of Thai banking system in the period of 2007-2010 using panel data of 27 major banks in Thailand. This paper shows that the global crisis had a late effect on Thai banks as the TFP only dropped in 2010. While the local banks maintained their stable, foreign banks were more fluctuating – some improved their TFPs, some did not and become worst performers in the system. The reason behind it may relate to the fact that Thai banking system is currently running at decreasing returns to scale situation, which proposes that Thai banks are wasting resources in over-expansion. Hence, continuing to develop and restructuring the banking system is an emergence task for Thailand in the near future.

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[1] University of Economics and Business (Vietnam National University, Vietnam),
email: ndthanhf@yahoo.com
[2] Asia-Pacific International University (Thailand), email: phuonglinhmc@gmail.com

1 Introduction

Over the past years, Thai banks have been competed intensely in many aspects. Thailand banking industry has witnessed many ups and downs in different periods and continues to grow and becomes one of the most vital sectors in Thailand. In 2010, according to the Bank of Thailand (BOT), Thai banking industry achieved net profit 123 billion bahts and contributed a substantial amount to the GDP. The amount of deposits and loans providing to the economy were 8,762 and 7,489 billion bahts respectively in 2010 and have been represented the nation's money stock (BOT, 2010).

Since the competition of Thai banking industry has been increasing, efficiency of Thai banks become a crucial issue to study. Evaluating their efficiency will bring useful information for managers, investors, depositors and owners in decisions making. The efficiency of a bank is defined bases on the relation between inputs and outputs of that bank, which encouraging banks to maximizing their outputs and/or minimizing their inputs. Because of high competition in the market, there is a pressure for Thai banks to improve their efficiency.

There are several ways to measure the efficiency of banks. Traditionally one can use return on assets (ROA), return on equity (ROE) or cost to income ratio, among others. In recent years, Data Envelopment Analysis (DEA) has been used by many economists, experts, and researchers to analyze the relative efficiency of banks, hospitals, universities, and manufacturing firms. As the efficiency of a bank can change every year, however, it is also important to analyze the Total Factor Productivity (TFP) changes of Thai banks over time. Hence, in this paper, we will apply DEA and Malmquist index technique to evaluate the efficiency of Thai banking industry and its changes through the 2007-2010 period.
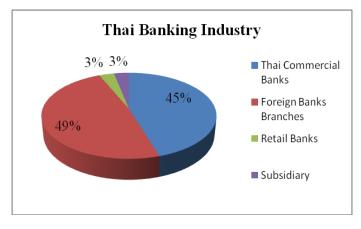
The rest of the paper is constructed as follows. Section 2 provides some background information on the Thai banking system. Section 3 reviews the related literatures. Section 4 explains the data and technical methodologies which are used in the research. Section 5 presents the empirical results and discussions while Section 6 concludes.

2 Overview of Thai banking system

Thai financial system has been established for many years. It plays an important role in the economy of Thailand. The main organizations with responsibility for policymaking and supervision of the financial system are the Ministry of Finance (MOF) and the BOT. The BOT was established in 1939 and was first called Thai National Banking Bureau. It changed to Bank of Thailand in 1942. BOT is responsible for printing and issuing banknotes, formulating monetary policies, supervising and examining financial institutions, managing the

country's foreign exchange rates and supporting the establishment of payment system. Thai baking system is regulated by Financial Institution Act B.E 2551 which was issued in 2008. It defines the commercial banks and describes the types of businesses the banks may operate. This law includes regulations on formation, operation, supervision, maintenances of capital funds and assets, investment, restrictions on granting credits of financial institutions (BOT, 2008).

The Thai financial sector comprises of various institutions. The most significant financial institutions in the Thai money market are the local commercial banks. Currently, Thai banking system consists of 14 Thai commercial banks, 15 foreign banks branches, 1 retail bank and 1 subsidiary (Figure 1). In 2010, total assets held by financial institutions in Thailand stood at THB 11.75 trillion (BOT, 2010). According to Emerging Markets Direct (EMD, 2010), the commercial banks represented 77.25% of the banking industry, with Bangkok Bank remaining the key dominant player in term of total assets. Krung Thai, Kasikorn and Siam Commercial Banks are also large banks in the industry.

Source: BOT (2012)

Figure 1: Brief on Thai Banking Industry (2012)

The main services that commercial banks provide are mobilizing savings in form of deposit and provision of loans. In recent years, Thai commercial banks have been competing severely to enlarge their market shares by improving the quality of services and facilities through increasing the numbers of ATM, giving attractive promotions, providing electronic banking services and diversifying banking services that are offered.
While local banks are dominated in the market, foreign banks operating locally account for only 10% of the total assets of the banking system, and foreign

funding accounts for only 3.5% of the total liabilities of the banking system (BOT, 2010). Almost all of these banks operate in Bangkok and other major cities. These foreign bank branches aim the business to multinational corporations which have a very strong creditability or organizations of the same nationality. For example, Procter & Gamble Trading (Thailand) Ltd may choose to do business with American Banks such as the Bank of America, Citibank, or JP Morgan Chase Bank.

Thus, these foreign banks tend to gain control of a niche market of foreigners in terms of nationalities for their businesses. As mentioned in the overview section, the comparison of size and scale of domestic and overseas banks in Thailand reveals that domestic banks still maintain the majority of banking businesses.

Thai financial system has gone through different periods. In the early 1990s, starting with financial liberalization, Thailand accepted the International Monetary Fund's Articles of Agreement and deregulated some measures in the financial system[3]. In 1992, the Stock Exchange Commission was established to control and supervised the stock exchange market in Thailand. In order to boost the growth of the Thai economy, in 1993, the Thai government has established the Bangkok International Banking Facility (BIBF) which is an offshore financial market. The purpose of BIBF was to facilitate the flow of foreign capital into Thailand and increase domestic investment need (Collignon, Pisani-Ferry, & Park, 1999). It encouraged local Thai companies borrow a large amount of money from foreign countries. Since the interest rate was lower than Thai currency, most of these loans were in US dollars.

In addition, during 1987-1995, Thailand experienced a great economic growth of almost 10% per year (ADB, 2011). With low cost labor force, it attracted foreign direct investment to build plants in order to export products to other developed countries. Thailand became confident about its economic status, so the government had excessive official spending and also encouraged local commercial banks and finance companies to lend money for real estate and others (Lai, 2000). This led to the sharp increase in the non-performing loans (NPLs) in banking industry.

In 1996, Thailand economic activity slowed down and followed by the decline in export. This reduction in export caused Thailand to stop pegging Thai baht to US dollar and started to devaluate the currency in order to promote export. As local companies needed to earn Thai baht to repay the loans in dollars, this created larger and heavier debts for these companies. For these reasons, Thailand was suffering in economic crisis in 1997. Foreign investors lost their confidence in Thai economy so they withdrew their investments. Moreover, Thai baht was depreciated from 25 baht/ US dollar to 47 baht/US dollar in 1997 (ADB, 2011).

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[3] International Monetary Fund (2011). Article of agreements of International Monetary Fund, retrieved on 1st May, 2012 from http://www.imf.org/external/pubs/ft/aa/index.htm

Many companies with high debts had to declare bankrupts and caused thousands of people become unemployment. Consequently, Thailand government had to use foreign reserve to protect Thai baht from speculation, also sought aid from the International Monetary Fund and lowered interest rate to make the currency more attractive.

After the financial crisis in 1997, commercial banks were greatly affected by non-performing loans and needed to tighten their lending policies. The government and the financial sector realized the need for better information, and credit reporting agencies were established (Kunvipusilkul, 2009). The period of 1999 to 2006 was the time that Thailand recovered from the crisis. Economic growth rate was about 5% per year during this period (ADB, 2011).

In 2007 and 2008, Thailand faced the global economic crisis. Although this crisis influenced on many countries, including both advanced and developing ones, it had little impact on Thailand (BOT, 2010). The Bank of Thailand had experienced the Asian financial crisis in 1997, so it increased supervision and created policies for risk management of banks, and control foreign capital inflows. In addition, Thailand had low reliance on foreign sources of funding as well as its low exposure to foreign assets since foreign banks which operate locally account for only 10% of the total assets of the banking system. Currently, Bank of Thailand is still trying to reduce the non-performing loans (NPLs) and implementing strict monetary policies on the overall economy.

3 Literature reviews

Traditionally, one simple way to measure the efficiency of an economic institution is using the ratio between an output and an input. However, if we got more than one inputs and/or outputs, the ratio model is enlarged into multiple case and is called X-efficiency (Berger, Hunter, & Timme, 1993) or productive (technical) efficiency (Färe, Grosskopf, & Lovell, 1994; Siems & Barr, 1998), among others.

In the literatures, various approaches have been used to measure the efficiency, in which two popular ones are parametric and nonparametric approaches. As output of banks is considered to have multi-dimensional characteristics and it is also difficult to estimate the cost, revenue or profit functions for banking activities, however, the nonparametric approach is more suitable in this case (Bhattacharyya, Lovell, & Sahay, 1997). The Data Envelopment Analysis (DEA) methodology, which belongs to the nonparametric approach, collects data from observed banks and envelopes it into a form of the optimal frontier for the whole sample, and then evaluates each institution by comparing its current level with the optimal one. Discussion on DEA have been inspired by the work of Farrel (1957), Charnes, Cooper and Rhodes (1978), Färe, Grosskopf and Lovell (1994), and so on.

In term of time trend analysis, researchers often use the distance function (Shephard, 1970) to measure the total factor productivity (TFP) changes. After being introduced by Caves, Christensen, and Diewert (1982), the Malmquist productivity index technique became popular among studies in the banking industry, including Fare, Grosskopf, Lindgren, & Roos (1992), Berg, Forsund, & Jansen (1992), A.N Berger & Mester (1997), Tortosa-Ausina, Grifell-Tatje, & C. Armero (2008), etc.

Regarding Thai banking industry and its efficiency, Leightner & Lovell (1998) investigated on the impact of financial liberalization on the performance of Thai banks. In their research, they did a study on 31 commercial and foreign banks in Thailand in the period of 1989 to 1994. Their research revealed that when the profit-oriented objectives of banks themselves were used, there was a growth in total factor productivity of banks in Thailand. However, when the economic-growth producing objectives of the regulator, Bank of Thailand, were used, total factor productivity declined for Thai banks and increased for foreign banks.

In 2008, Chansarn (2008) conducted a study on the efficiency of 13 Thai commercial banks from 2003 to 2006 using Data Envelopment Analysis technique. This research investigated the performance of Thai commercial banks in both operation and intermediation approaches. This research had shown that Thai commercial banks were more efficient in operation approach than intermediation approach during 2003 to 2006. Moreover, while large, medium and small banks were all efficient in operation approach, this research also discovered that small banks were most efficient in intermediation approach.

Later, Phochathan, Krasachat, Pompech, & Sanguanwongwan (2009) also applied the same method in measuring the efficiency of eight Thai major commercial banks. However, in their research, they measured the efficiency in two periods, before the economic crisis (1993-1996) and after the economic crisis (1997-2006). In addition, they also used Malmquist index of Thai banking industry for the whole period of 1993-2006. Their research has shown that the mean value of technical and scale efficiency scores before the economic crisis period are higher than those after the economic crisis period. In addition, the results also indicated that Thai commercial banks had a rising productivity level at a decreasing rate. Moreover, they also pointed out that the return on assets and non-performing loans have affected the productivity growth of the banking industry in Thailand.

Similarly, Chunhachinda & Li (2010) investigated on the efficiency of Thai commercial banks before and after economic crisis of 1997 using a combination of parametric and non-parametric frontier approaches. They, consistently with Phochathan et al. (2009), also found that the average profit and cost efficiency levels of the post-crisis period were lower than those of the pre-crisis period.

In the effort of measuring the technical efficiency of Thai banks using a 2-stages DEA model, Sufian & Habibullah (2010) indicated that scale inefficiency dominated pure technical inefficiency in determining the Thailand banking

sector's technical efficiency. The results from regression analysis of this study also suggested that banks with higher loans intensity and better capitalized tend to have higher efficiency levels. The results indicate that the domestic banks had higher technical efficiency compared to foreign bank.

Apart from the studies above, there is no research on the total factor productivity of Thai banking industry during and after the global crisis 2007. Therefore, this paper can contribute to the literatures by examining the efficiency of Thai banking industry during 2007 to 2010 using DEA and Malmquist index approaches.

4 Data and methodologies

4.1. Data collection

In this research, we collected data from annual reports which are available on the official websites of 27 major banks in Thailand from 2007 to 2010. These 27 banks represented more than 77% of Thai banking industry (BOT, 2010), therefore, researching this sample somehow equals to researching the whole Thai banking industry.

Table 1: List of Thai banks included in the research

No.	Name of Banks	Category	Code
1	Bangkok Bank Public Company Limited	Local commercial	BKB
2	Krung Thai Bank Public Company Limited	Local commercial	KTB
3	The Siam Commercial Bank Public Company Limited	Local commercial	SCB
4	Kasikornbank Public Company Limited	Local commercial	KKB
5	TMB Bank Public Company Limited	Local commercial	TMB
6	Bank Of Ayudhya Public Company Limited	Local commercial	BOA
7	Kiatnakin Bank Public Company Limited	Local commercial	KNB
8	Thanachart Capital Public Company Limited	Local commercial	TCC

No.	Name of Banks	Category	Code
9	CIMB Thai Bank Public Company Limited	Local commercial	CIMB
10	Islamic Bank Of Thailand	Specialized financial institution	ISB
11	Export-Import Bank Of Thailand	Specialized financial institution	EIB
12	Bank For Agriculture And Agricultural Cooperatives	Specialized financial institution	BAAC
13	Small And Medium Enterprised Development Bank Of Thailand	Specialized financial institution	SMEDB
14	The Government Housing Bank	Specialized financial institution	GHB
15	The Government Saving Bank	Specialized financial institution	GSB
16	Tisco Financial Group Public Company Limited	Local commercial	TISCO
17	Land And House Bank Public Company	Local commercial	LHB
18	Industrial And Commercial Bank Of China (Thailand) Public Company Ltd.	Local commercial	ICBC
19	Citibank (Us)	Foreign	CB
20	HongKong and Shanghai Banking Corporation	Foreign	HSBC
21	Credit Agricole Corporate And Investment Bank	Foreign	CALYON
22	Deutsche Bank	Foreign	DB
23	Oversea Chinese Banking Corporation Ltd.	Foreign	OCB
24	RHB Bank Berhad	Foreign	RHB
25	JP Morgan Chase Bank	Foreign	JPMC
26	Standard Chattered Bank (Thai) Public Company Ltd.	Local commercial	SC
27	United Oversea Bank (Thai)	Local commercial	UOB

Note: Codes are defined by authors

In order to measure how efficient Thai banks are, we used Interest expenses ($x1$), Non-interest expenses ($x2$), Interest and dividend income ($y1$), and Non-

interest income (y2) as inputs and outputs of the model (all measures in Thai baht). These variables were chosen according to the production or operation approach of DEA model, following Chansarn (2008), Avkiran (2010), and Paradi, Rouatt, & Zhu (2011), among others. The descriptive statistics of data are shown in Table 2.

Table 2: Descriptive statistics of Thai banking industry (2007-2010)

Variables	Interest & Dividend Income	Non-Interest Income	Interest Expense	None-Interest Expense
Mean	20,143,733,508.4	6,063,924,993.3	6,572,760,943.9	10,650,712,970.1
Standard Error	2,194,339,106.7	917,106,710.9	730,823,098.1	1,327,975,392.8
Minimum	74,321,764.0	-4,118,774,166.0	7,818,849.0	1,105,129.0
Maximum	80,621,685,532.0	57,946,043,913.0	33,237,596,994.0	72,047,437,028.0
Sum	2,175,523,218,904.5	654,903,899,278.8	709,858,181,945.1	1,150,277,000,771.3

Once the necessary data were collected, the DEAP 2.1 software (Coelli, 1996) was used to measure the efficiency of 27 banks in Thailand.

4.2. Methodologies

This paper applies both DEA and Malmquist index methodologies for analyzing the efficiency and productivity changes of Thai banks in the 2007-2010 periods. It firstly uses DEA to calculate the (relative) efficiency scores of each bank in each year, and then uses Malmquist indexing method to measure the productivity changes through the years.

DEA is used widely nowadays and has become an important tool in evaluating the performance of manufacturing firms as well as service organizations. It is a non-parametric methodology which uses linear programming methods to optimize the use of inputs or outputs of every bank in the data set. If the aim is to minimize inputs while outputs are constrained, we have an output-oriented DEA model; else if it is to maximize outputs while inputs are constrained, we have an input-oriented DEA model. In this case, banks that are already at their optimization levels will form an (optimal) piece-wise surface (or frontier) for the whole set, and then efficiency of a certain bank now can be measured by

comparing its current level to the frontier. Practically, we can measure the efficiency of a certain j_0-th bank using the equation proposed by Charnes, Cooper and Rhodes (1978) under the assumption that there is no difference in scale among Thai banks[4].

$$\min \sum_k v_k x_{kj_0} \tag{1}$$

subject to

$$\sum_m u_m y_{mj_0} = 1$$

$$-\sum_m u_m y_{mj} + \sum_k v_k x_{kj} \geq 0$$

$$1 \leq j \leq n$$

$$0 \leq u_m, \ v_k \leq 1$$

Where:
u_m: weight of *m-th* output variable
v_k: weight of *k-th* input variable
x_{kj}: k-th input of *j-th* bank
y_{mj}: m-th output of *j-th* bank
n: number of banks

Even though the Malmquist index technique was introduced in the 1980s by Caves et al. (1982), it was only became applicable for the DEA method after the foundation of Fare et al. (1992). In their research, the non-parametric efficiency theory of Farrell (1957) was combined with the Malmquist index of Caves et al. (1982) into a DEA Malmquist index of productivity changes which is now commonly used in evaluating TFP changes in the banking industry.

After each efficiency score is defined for each year using DEA method, one can follow Fare et al. (1992) to calculate the (geometric) distance m_0 or TFP change between two indices of the year *t* and *t+1* applying equation (2). Thus, if m_0 greater than one then it means there is an improvement in TFP, otherwise the TFP has been decreasing.

$$m_o(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{d_o^t(x^{t+1}, y^{t+1})}{d_o^t(x^t, y^t)} \times \frac{d_o^{t+1}(x^{t+1}, y^{t+1})}{d_o^{t+1}(x^t, y^t)} \right]^{\frac{1}{2}} \tag{2}$$

where (x^t, y^t) and (x^{t+1}, y^{t+1}) are production points at time *t* and *t+1*, respectively. While m_0 (TFPCH) can be decomposed into efficiency changes (EFCH) and technological changes (TECHCH), one can also apply the variable return to scale
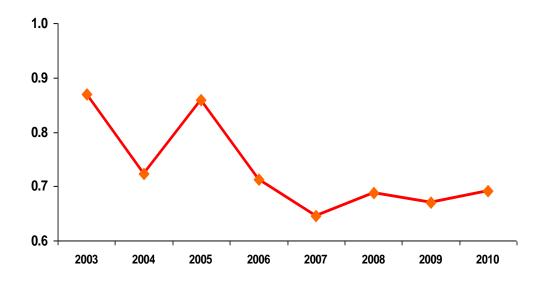
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[4] We have chosen the input-oriented DEA model because it is easier for Thai banks to control the expenses than competing with each others to increase the incomes.

condition (Banker, Charnes, & Cooper, 1984) to analyze the pure efficiency (PECH) and scale efficiency changes (SECH) following these equations:

$$\text{TFPCH} = \text{EFCH} \times \text{TECHCH} \tag{3}$$
$$\text{EFCH} = \text{PECH} \times \text{SECH} \tag{4}$$

5 Results and discussions

In the first place, the technical efficiency scores of each bank are calculated using equation (1) for each year in the period of 2007-2010. These scores, on average, are fluctuating during the time, started from 0.646 in 2007, increased to 0.688 in 2008, dropped to 0.670 in 2009, and then rose again in 2010 to 0.691. Combining these results with what Chansarn (2008) had found, we can derive at the development of Thai banks' efficiency in the past 8 years.

Source: Chansarn (2008) and authors' calculation

Figure 2: Technical efficiency of Thai banking industry (2003-2010)

Using equation (2), (3) and (4), the software DEAP 2.1 shows that, in overall, and the productivity of Thai banks is on the increasing trend. For the whole 2007-2010 period, most of the efficiency changes are slightly greater than one, meaning that every year these banks can only gain small improvements, less than five percent of the previous years (see Table 3). It is different from previous studies on the effect of the crisis 1997, where the post-crisis efficiency scores were lower than pre-crisis ones. This suggests that effect of the recent 2007 global crisis had not as strong as in the regional crisis 1997.

Of all the component indexes, only the scale efficiency change (SECH) is smaller than one indicating that Thai banks are starting to fall into the decreasing returns to scale situation (as average value of SECH is 0.998, very close to one). It suggests that the productivity (not efficiency) of Thai banking industry will continue to drop in the next few years before they can solve the returns to scale issue.

Table 3:Changes in TFP components of Thai banking industry

	EFCH	TECHCH	PECH	SECH	TFPCH
2007	1.000	1.000	1.000	1.000	1.000
2008	1.073	1.000	0.954	1.124	1.072
2009	0.959	1.180	1.059	0.906	1.131
2010	1.057	0.871	0.985	1.073	0.921
Average	1.028	1.009	0.998	1.030	1.038

If the year 2007 is taken into account with base efficiency scores equal to one, the TFP changes of Thai banks can be expressed as in Figure 3. We can see that the TFP only started to decrease in 2010, meaning the damage of the recent global financial crisis on Thai banking industry (if any) is having its late effect.

Once we looking at bank level, it is clear that some foreign banks (such as SC, ISB, JPMC, etc.) are improving their TFPs while others losing their productivities (including RHB, ICBC, DB, and so on). It also means that Thai local banks are more stable (Table 4). Within the Top 5 banks with highest TFP changes, except for SC got its TFP improvement due to technological development, the other four (ISB, JPMC, TMB, and SMEDB) are taking advantage of (technical) efficiency increasing. It suggests that Thai banks still have opportunity to improve their TFPs through technological development.
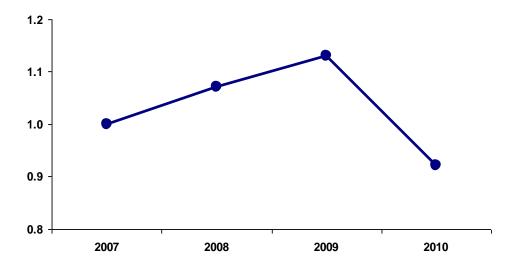
Figure 3: TFP changes of Thai banking industry (2007-2010)

Table 4: (Average) TFP changes of Thai banks (2007-2010)

Rank	Bank code	EFCH	TECHCH	PECH	SECH	TFPCH
1	SC	1.186	1.238	1.036	1.145	1.469
2	ISB	1.270	1.046	1.243	1.021	1.328
3	JPMC	1.285	0.961	1.230	1.044	1.235
4	TMB	1.222	0.973	1.010	1.209	1.189
5	SMEDB	1.079	1.065	1.054	1.024	1.149
6	BOA	1.160	0.988	1.072	1.082	1.146
7	SCB	1.141	1.003	1.000	1.141	1.145
8	KKB	1.171	0.974	1.000	1.171	1.141
9	EIB	0.952	1.193	0.955	0.997	1.136
10	BKB	1.141	0.993	1.000	1.141	1.133
11	TISCO	1.064	1.057	1.026	1.036	1.124
12	LHB	0.981	1.111	0.966	1.015	1.089
13	KNB	0.998	1.084	0.931	1.072	1.081
14	CIMB	1.075	0.988	1.023	1.050	1.061
15	OCB	0.961	1.074	1.031	0.932	1.031

Rank	Bank code	EFCH	TECHCH	PECH	SECH	TFPCH
16	HSBC	0.951	1.073	0.929	1.024	1.020
17	BAAC	0.997	1.015	1.000	0.997	1.013
18	CB	1.116	0.901	1.000	1.116	1.005
19	GHB	0.846	1.186	1.000	0.846	1.003
20	KTB	1.034	0.963	1.000	1.034	0.995
21	GSB	0.871	1.118	1.000	0.871	0.974
22	UOB	1.173	0.796	1.098	1.068	0.934
23	CALYON	0.879	1.012	0.907	0.969	0.890
24	DB	0.795	1.076	0.776	1.024	0.855
25	TCC	0.852	0.925	0.909	0.937	0.788
26	ICBC	0.938	0.785	0.867	1.082	0.736
27	RHB	0.874	0.811	1.000	0.874	0.709

6 Conclusions

Examining the efficiency and productivity changes of Thai banking industry is an important task. It provides information on the quality of Thai banks, including both local and foreign ones. By employing the Data Envelopment Analysis and Malmquist index approaches in evaluating 27 major banks in Thailand, this paper derived at some important conclusions which can contribute to the literatures and also practical decision makers.

This paper shows that the global crisis had a late effect on Thai banks as the TFP only dropped in 2010. While the local banks maintained their stability, foreign banks were more fluctuating – some improved their TFPs, some did not and become worst performers in the system. The reason behind it may relate to the fact that Thai banking system is starting to fall into decreasing returns to scale situation, which proposes that productivity of Thai banks are expected to continuously dropping in the next few years. Continuing to develop and restructuring the banking system, therefore, is an emergence task for Thailand in the near future.

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