Bangor University

DOCTOR OF PHILOSOPHY

Financial liberalisation in Thailand

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Award date:
2001

Awarding institution:
Bangor University

FINANCIAL LIBERALISATION IN THAILAND

A THESIS SUBMITTED TO THE UNIVERSITY OF
WALES IN FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

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JUNE 2001

ACKNOWLEDGEMENTS

First, I would like to express my gratitude to my supervisor, Professor E.P.M. Gardener, for his willingness to supervise this study. I benefited greatly from his enlightened comments and extremely grateful for his patience, inspiration and warm encouragement. I would like to thank my joint supervisor Mrs. Z.M. Brown for her invaluable constructive comments on research plans underlying this study. Special thanks go to Professor P. Molyneux, who provide many learned remarks in the course of research committee.

I would never have been able to engage in this study, had it not been for the full financial support and encouragement of Mr. Surapong Pethputong, whom I dedicate this thesis to. My sincere appreciation is for his help to collect data given his tight business schedules.

I wish to acknowledge the remarkable assistance of the Bank of Thailand's Governor, M.R. Chatu Mongol Sonagul, who provided additional information on foreign banks in Thailand. I am grateful to Tim Coelli and William Greene for their help on statistical programs. Acknowledgements are also due to Jon Williams, Emily Smith, and other IEF members for all the help they have given me throughout the years.

Special thanks are due to Chinorost Booncherm, Chansawang Ngampongsai, Amina & Amani Al-Zaidan, Santi Narasukasem, Boontarika Srithai, Sirinun Aemprapa, Sodsai Chookoet and the Burton family, who supply whatever is needed from Thailand. I also wish to thank all the friends in Kyoko's badminton club for every glorious Friday evening. My final words are for my best companion, Justin Blackwell, who always offers me reassurance. His courtesy has made my stay in Bangor memorable. Let this thesis add to the long list of pleasure we happily share.

Thida Intarachote
April 2001

ABSTRACT

Financial liberalisation is the process of financial development that reduces the extent of government control over the financial industry. It is argued that a liberalised financial system is a fundamental prerequisite for more efficient allocation of savings and investment, which in turn leads to greater economic growth. Financial liberalisation includes the freeing up of interest rate controls, exchange and capital controls, entry of foreign banks, and the deregulation of banking sector. The latter process, which comprises the deregulation of bank structure and conduct rules and the concomitant re-regulation of bank prudential supervision, is generally targetted to improve the efficiency and productivity of banks. On the other hand, financial liberalisation and basic deregulation have also (been) precursors to many banking and financial crises.

This study examines the effects of deregulation on the Thai banking sector during 1990-97 using a two-stage approach. In the first-stage analysis, the relative efficiencies and productivity of each bank in each year are measured using DEA techniques. In the second-stage, regression techniques are used to evaluate the impact of financial deregulation on efficiency and productivity, controlling for bank-specific attributes.

The main findings regarding bank efficiency are that on average banks operating in Thailand hardly improved their technical, allocative and cost efficiencies, except in 1996 and 1997. Most banks were better at optimising their input mix than minimising their usage and costs of inputs. There was a clear association between size and cost efficiency for the domestic Thai banks, and on average their cost efficiencies were greater than those of the foreign bank branches, all other things being equal. However, the majority of the banks on the best-practice efficient frontier were foreign, and the smallest Thai banks were the least efficient of all the banks studied.

The average productivity of foreign banks increased over the period studied, and this was mainly due to outward shifts of the production frontier each year (technological progress) rather than improvements in relative efficiency. The average productivity of domestic banks did not change over time, as technological progress was offset by moves away from the best-practice frontier.

Overall, the evidence for the postulated beneficial effects of deregulation is somewhat mixed. Improvements in total factor productivity were driven by the huge expansion in lending made possible by the liberalisation, but these increases in productivity were mainly achieved by the foreign bank branches whose operations were supported by substantial amounts of financial capital from their parents. Productive efficiency of the domestic banks did improve over the period of study, but these improvements were greatest for the large and medium size banks, thus widening the gap between the most inefficient group of small Thai banks and the rest of the banking sector.

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LIST OF ACRONYMS

ADB	Asian Development Bank
AE	Allocative Efficiency
BDC	Bond Dealers' Club
BDTD	Bank Deposits to Total Deposits ratio
B/E	Bill of Exchange
BIBF	Bangkok International Banking Facilities
BIS	Bank for International Settlements
BOT	Bank of Thailand
BSDC	Bangkok Stock Dealing Centre
CBA	Commercial Banking Act
CD	Certificate of Deposit
CE	Cost Efficiency
CR	Concentration Ratio
CRS	Constant Returns to Scale
CV	Coefficient of Variation
DEA	Data Envelopment Analysis
DEAP	Data Envelopment Analysis Program
DFA	Distribution Free Approach
DMUs	Decision Making Units
EC	European Commission
EFFCH	Technical Efficiency Change
EM	Equity Multiplier
EQTA	Equity to Total Assets ratio
EU	European Union
FB	Foreign Banks
FF	Fourier Flexible Functional Form
FIR	Financial Interrelation Ratio
FSIs (FS)	Finance and Specialised Institutions
GDP	Gross Domestic Product
GNP	Gross National Product
IMF	International Monetary Fund
LLRTL	Loan Loss Reserves to Total Loans ratio
LOGTA	Natural log of total assets
LP	Linear Programming
MLR	Minimum Lending Rate
MOR	Minimum Overdraft Rate
MGI	Malmquist Growth Index
MPI	Malmquist Productivity Index
MPSS	Maximum Productive Scale Size
NDRS	Non-decreasing Returns to Scale
NIRS	Non-increasing Returns to Scale

OECF	Japan's Overseas Economics Cooperation Funds
OLS	Ordinary Least Square
PECH	Pure Technical Efficiency Change
RI	Risk Index
ROA	Returns on Assets
ROE	Returns on Equity
SECH	Scale Efficiency Change
SEC	Securities and Exchange Commission of Thailand
SET	Stock Exchange of Thailand
SFA	Stochastic Frontier Approach
SFR	Stochastic Frontier Regression
SMP	Single Market Program
STDEV	Standard Deviation
SUR	Seemingly Unrelated Regression
SWM	Shareholder Wealth Maximisation
TCTA	Total Costs to Total Assets ratio
TD	Time Dummy
TE	Technical Efficiency
TECHCH	Technological Change
TFA	Thick Frontier Approach
TFP	Total Factor Productivity
TFPCH	Total Factor Productivity Change
TLTA	Total Loans to Total Assets ratio
TH	Thai Banks
TRIS	Thai Rating and Information Services
VRS	Variable Returns to Scale

THAI BANKS

BBL	Bangkok Bank Public Company Limited
KTB	Krung Thai Bank Public Company Limited
TFB	Thai Farmer Bank Public Company Limited
SCB	The Siam Commercial Bank Public Company Limited
AYD	Bank of Ayudhya Public Company Limited
TMB	The Thai Military Bank Public Company Limited
FBC	First Bangkok City Bank Public Company Limited
SCIB	Siam City Bank Public Company Limited
BMB	Bangkok Metropolitan Bank Public Company Limited
BBC	The Bangkok Bank of Commerce Public Company Limited
BOA	Bank of Asia Public Company Limited
TDB	The Thai Danu Bank Public Company Limited
NKB	Nakornthon Bank Public Company Limited
UBB	The Union Bank of Bangkok Public Company Limited
LTB	The Laem Thong Bank Public Company Limited

FOREIGN BANKS

TOKYO	The Bank of Tokyo-Mitsubishi Limited
SAKURA	The Sakura Bank Limited
CITIBANK	Citibank N.A.
DEUTSCHE	Deutsche Bank AG.
STCB	Standard Chartered Bank
INDOSUEZ	Credit Agricole Indosuez
HSBC	The Hongkong and Shanghai Banking Corporation Limited
CHASE	The Chase Manhattan Bank N.A.
AMERICA	Bank of America N.T. & S.A.
ABN	ABN-AMRO Bank N.V.
BHARAT	Bharat Overseas Bank Limited
ICBC	The International Commercial Bank of China
SIME	Sime Bank Berhad
OCBC	Oversea-Chinese Banking Corporation Limited
DKB	The Dai-Ichi Kangyo Bank Limited
DRESDNER	Dresdner Bank AG.
BNP	Banque Nationale de Paris
SUMITOMO	The Sumitomo Bank Limited
IBJ	The Industrial Bank of Japan
BOC	The Bank of China

Specialised Financial Institutions

BAAC	Bank for Agriculture and Agricultural Cooperatives
GHB	Government Housing Bank
GSB	Government Savings Bank
IFCT	Industrial Finance Corporation of Thailand
EXIM	Export-Import Bank of Thailand

Chapter 1 Introduction

1.1 Background

Thailand has operated under a liberalised financial system since 1990. Financial liberalisation is accompanied by financial sector deregulation, defined as a process of structural change which reduces the government's direct control over the financial industry. In banking, deregulation invariably implies the "freeing up" of bank structure and conduct rules. At the same time, bank prudential (supervision) rules are invariably strengthened within this kind of deregulation. Table 1.1 differentiates these different kinds of banking regulation.

Table 1.1 Classification of the methods of banking regulation

Regulations influencing the structure	Regulations influencing the conduct	Regulations influencing prudential concerns
– Functional separation of institutions	– Regulations of banks' deposit and lending rates	– Deposit insurance
– Entry restrictions	– Regulations of fees and commissions	– Discount window (lender-of-the-last resort)
– Discriminatory rules against foreign banks (and investors)	– Credit quotas	– Minimum capital requirements
– Liberalisation of capital movement	– Branching limitation	– Solvency ratios
	– Reserve requirements	– Ownership restrictions
	– Money laundering	– Restrictions on asset concentration (large exposures)
		– Information disclosure requirements

Note: The Thai banking system has no system of deposit insurance.
Source: European Commission, 1997.

Financial liberalisation theory argues that a more liberalised and deregulated financial system is necessary in order to facilitate an efficient allocation of resources which is crucial to the growth of the national economy (see, for example, Mckinnon (1973) and Shaw (1973)). This is because it is hypothesised that a deregulated financial system can improve the efficiency of financial institutions and, thereby, help to enhance the efficiency of those economic sectors who use financial services. Deregulation of banking structure and conduct rules increases competitive pressures, which enhances the need for banks to measure their own efficiency, benchmark it against their competitors and attempt to improve it through their own policies. At the same time, the reinforcement of bank supervision, especially capital adequacy, increases the need for banks to allocate more efficiently their internal capital resources.

Since the early 1990s, the efficiency of financial institutions, especially productive efficiency, has become an important part of the banking and respective industrial economics literature. Greater productive efficiency implies that individual banks can adapt better to a different operating environment via their improved ability to combine and utilise inputs. This development could lead, for example, to improved financial products and services, a higher shareholder value, a higher volume of funds intermediated, and more economic growth if funds are channeled into more productive investments. Since the banking sector has a pivotal role in the economic development process in Thailand, it is useful and, indeed, necessary to investigate and analyse the effects of financial deregulation on banking efficiency.

1.2 Aims of the study

Financial deregulation is fundamentally aimed at increasing the efficiency of the banking and the financial system. However, as Berger and Humphrey (1997) point out, the results of financial deregulation have been mixed. Some argue that banks experience improved efficiency and productivity after deregulation (Berg, Forsund and Jansen, 1992; Zaim, 1995; Bhattacharyya, Lovell, and Sahay, 1997; Leightner and Lovell, 1998). In contrast, others argue that banking efficiency in the US and bank productivity of savings banks in Spain, for example, appeared to be comparatively unchanged by financial deregulation (Bauer, Berger and Humphrey, 1993; Elyasiani and Mehdian, 1995; Grifell-Tatjé and Lovell, 1996; Humprey and Pulley, 1997). In some cases, deregulation even appears to have led to a reduction in measured efficiency (Grabowski, Rangan, and Rezvanian, 1994). In short, the empirical evidence is mixed at best and apparently contradictory at worst.

The present study aims to investigate the effects of financial deregulation on efficiency and productivity in Thailand. There are two important reasons for undertaking this research. First, very little empirical work has so far been undertaken to investigate the efficiency of the Thai banking system and, therefore, undertaking such an investigation may yield useful insights that could be of interest to academics, bankers and policymakers. Secondly, the ongoing financial deregulation in Thailand and the existing literature draw attention to the fact that measurement of bank efficiency and productivity changes may be useful for evaluating the impact of financial deregulation. In particular, this study endeavours to answer the following questions:

The main research question explored is as follows:

- Has the 1990-97 deregulation improved efficiency and productivity of banks in Thailand?

This can be broken down into the following, related sub-questions.

- What are the theoretical links between financial deregulation and efficiency and the productivity of banks?
- Is there empirical evidence to support the view that financial deregulation improves efficiency and productivity of banks?
- Are there efficiency and productivity differences for Thai banks, foreign banks and the FSIs (finance and specialised institutions)?
- Are efficiency and productivity changes related to bank size?
- Does financial deregulation explain the variation of bank efficiency and productivity?

1.3 Methodology

This study adopts a two-stage approach in order to investigate the effects of the 1990-97 financial deregulation in Thailand. First, productive efficiency and productivity of banks is examined by calculating technical, allocative and cost efficiencies for each DMU (decision making unit) using the data envelopment analysis (DEA) technique. In the second stage, we use regression analyses to help explain how financial deregulation affects the measured efficiency and productivity. This approach is broadly similar to methods used in studies by, for example, Aly *et al.* (1990), Elyasiani *et al.* (1994), Grifell-Tatjé and Lovell (1996), Bhattacharyya *et al.* (1997), Donni and Fecher (1997), Worthington (1999) and Glass and Mckillop (2000).

1.4 Data

This study uses banks' balance sheet and income statement data of 379 DMUs from 15 Thai banks, 20 foreign bank branches, 5 specialised institutions and 27 finance companies between 1990 and 1997; other non-bank financial institutions are excluded from this study because of data unavailability. Data were obtained from the Bank of Thailand, Bangkok Bank, the Thai Securities and Exchange Commission, and the London-based International Bank Credit Analysis Ltd's Bankscope database.

1.5 The structure of the study

The outline of this study is as follows:

Chapter 1 Introduction

Chapter 2 Thai financial institutions

The major characteristics of the banking and financial system in Thailand are analysed. The structures of the banking and financial systems are investigated, comprising the money market, securities market, the Bank of Thailand, commercial banks, specialised financial institutions, and non-bank financial institutions. The analysis of the financial structure seeks to establish the role, nature and relative importance of banks within the Thai financial and economic system.

Chapter 3 Financial liberalisation and deregulation in Thailand

This chapter analyses the theoretical and policy perspectives of financial liberalisation, including the rationale, the preconditions, sequencing speed, and comparative experience. The primary emphasis is on analysing the reasons why financial liberalisation is desirable and the forms that it may take, including the deregulation of the banking sector. This chapter also explores the impact of the 1990-97 financial deregulation on the structure of commercial banks.

Chapter 4 Productive efficiency and productivity in the banking sector

The importance of productive efficiency in the banking sector is examined. This Chapter reviews the recent approaches used to measure efficiency and productivity of banking firms, the consistency conditions of the estimations and the empirical evidence on the effects of financial deregulation. The aim is to identify the most feasible and coherent approach to estimate efficiency and productivity, and the impact of financial deregulation on banks in Thailand.

Chapter 5 Exploratory data analysis of the Thai banking system

This chapter analyses the risks and returns of Thai and foreign banks and the FSIs during 1990-97 period. The return measures are return on equity (ROE), return on assets (ROA) and the equity multiplier. The risk measures include variability of ROE and ROA, risk index, capital adequacy, liquidity and credit risks. We also investigate financial ratios of bank efficiency in order to provide additional information on the risks and returns of a bank.

Chapter 6 Data and methodology

Bank inputs and outputs are examined in order to calculate the productive efficiency and productivity of banks. The two-stage approach to examine the effects of financial deregulation is discussed, including the first-stage DEA analysis and the second-stage regression analyses. This chapter also defines the environmental variables that may be used to explain the effects of financial deregulation.

Chapter 7 Productive efficiency in Thai banking: empirical results

Technical, allocative and cost efficiencies of Thai and foreign banks and the FSIs between 1990 and 1997 are analysed. The sources of cost efficiency, allocative disefficiency and the input slacks are examined. The characteristics of best-practice banks and their returns to scale characteristics are discussed. The consistency of relative efficiencies is examined and finally, the results from the second-stage regression analysis are examined.

Chapter 8 Productivity change in Thai banking

The Malmquist total factor productivity (TFP) change index and its components for Thai and foreign banks between 1990 and 1997 are analysed. We examine the sources of productivity change and explore whether there are differences for Thai and foreign banks. The relationship between bank size and productivity indices and the consistency of the Malmquist index are examined. The results are compared with Leightner and Lovell (1998)'s Malmquist growth index. Finally, the results from the second-stage regression analysis are examined.

Chapter 9 Conclusion and limitations

The main conclusions of the study are summarised and the limitations of the research are identified and discussed.

Chapter 2 Thai Financial Institutions

Introduction

Tobin (1984) *inter alia* emphasises that it is important to understand the institutional and related policy context of financial institutions before analysing their economic performance. This chapter analyses the structure and development of financial institutions in Thailand during 1990 to 1996. Fry (1997) notes a stylised fact about financial systems in developing economies: they are dominated by commercial banks, and Thailand is no exception.

The primary purpose of this chapter is two-fold. First, to analyse the broad economic environment (and how it has developed) in which the banks operate, covering the characteristics of the economy, monetary policy and the path of financial development. Second, to introduce and examine the banking and financial institutions that comprise and distinguish the Thai financial system. This survey is needed in order to understand the nature of the economy as an important strategic driver of banks and banking, and to identify the scope and nature of related changes. This chapter, then, provides the necessary background to an analysis and discussion of financial liberalisation and respective bank' efficiency change in Thailand.

The chapter is organised as follows: section 2 outlines the characteristics of the Thai economy and general economic policy during 1990 to 1996. Section 3 discusses the monetary system and monetary policy of the Thai authorities. Section 4 considers the development of the Thai financial system and the role of financial institutions within it. Section 5 explores the importance of commercial banks in the process of economic development and discusses the cause and effect of the 1997 financial crisis; section 6 concludes the chapter.

2.1 Thai economy and general economic policy

In recent years, Thailand has made major progress toward achieving sustained economic growth with continued price stability. The country's remarkable success (up to the 1997 crisis at least) is attributable to the stabilisation and reform strategy the authorities adopted from late 1989. This section provides a background analysis covering the structure of the economy and macroeconomic performance during 1990-96.

Thailand is a middle-income country of about 60 million population with annual per capita income estimated at USD2937 (in 1996). During 1990-96, GDP growth was largely determined by four main sectors: manufacturing, wholesale and retail trade, services and the agricultural sector, which together accounted for about 69 percent of total GDP (see Table 2.1). This feature resulted from the import-substitution policy of industries, like construction material and petroleum products, as well as the export promotion of various types of products.

Table 2.1 Structure of Thai economy, 1990-96

As % of GDP	1990	1991	1992	1993	1994	1995	1996	Average 1990-96
Agricultural	12.7	15.1	12.3	10.6	10.7	10.8	10.7	11.8
Mining and quarrying	1.6	1.7	1.5	1.4	1.3	1.3	1.3	1.4
Manufacturing	27.2	26.7	27.6	28.1	27.9	28.5	28.6	27.8
Construction	6.2	5.5	6.7	6.8	7.4	7.3	7.4	6.8
Electricity and water supply	2.2	2.3	2.3	2.4	2.3	2.3	2.4	2.3
Transport and communication	7.2	7.4	7.2	7.5	7.4	7.4	7.4	7.4
Wholesales and retail trade	17.6	16.7	16.7	16.8	16.7	16.5	16.5	16.8
Banking, insurance and real estate	5.5	4.6	6.5	7.3	7.7	7.8	7.9	6.8
Ownership of dwellings	3.0	3.2	2.8	2.6	2.5	2.4	2.2	2.7
Public defence	3.5	3.5	3.7	3.7	3.6	3.5	3.4	3.6
Services	13.3	13.3	12.7	12.8	12.5	12.2	12.2	12.7
Total	100	100	100	100	100	100	100	100.0

Sources: Bank of Thailand, *Quarterly Bulletin*, December 1994-1997.

From Table 2.1, it is evident that banking, insurance and real estate have become more important in the Thai economy, improving their overall share of GDP from 5 percent in 1990 to 8 percent in 1996. The sector contributing least to GDP growth during this period was mining and quarrying, owing to the closing of some mines as a result of unfavourable export prices and a restrictive export policy aimed at reducing the domestic shortage of raw materials.

Table 2.2 Macroeconomic performance, 1990-96

At the end of	1990	1991	1992	1993	1994	1995	1996	Average 1990-96
GDP growth (%)	11.6	8.5	8.1	8.5	8.9	8.8	5.5	8.6
Inflation (%)	6.0	5.7	4.1	3.4	5.1	5.8	5.9	5.1
Unemployment (%)	3.9	3.1	3.0	2.6	2.6	1.7	2.0	2.7
Investment (%of GDP)	41.0	42.0	39.8	39.9	40.4	42.3	41.7	41.0
Savings (%of GDP)	33.6	34.0	33.2	34.2	34.7	34.8	33.7	34.0
-Government (%change)	51.8	23.2	-2.8	7.7	7.7	16.3	13.0	16.7
-Private (%change)	-1.4	5.7	13.9	16.7	25.8	7.3	6.2	10.6
Consumption (% of GDP)	65.2	64.7	64.6	64.4	63.9	63.3	63.2	64.2
-Government (%change)	17	12.8	21.4	12.8	12.2	12.0	13.1	14.5
-Private (%change)	18.8	13.6	11.1	11.7	13.8	14.6	12.3	13.7
Trade balance (%of GDP)	-11.6	-9.6	-7.2	-6.9	-6.2	-8.9	-9.1	-8.5
Import (%change)	29.0	15.4	5.5	12.0	17.6	31.5	2.3	16.2
Export (%change)	14.4	23.5	13.1	13.0	21.3	24.3	-1.9	15.4
Amount as a percentage of GDP								
Balance of current account	-8.4	-7.7	-5.6	-5.0	-5.6	-8.0	-8.1	-6.9
Government budget balance	3.6	4.1	1.8	0.9	1.1	2.1	1.5	2.2
External debt	29.2	33.7	33.5	36.5	37.2	49.1	49.9	38.4
Net capital movement	11.3	11.5	8.5	8.3	8.4	12.9	10.5	10.2
Balance of payment	4.4	4.2	2.7	3.1	2.8	4.2	1.2	3.2
Capital inflows*	7.4	8.2	6.8	5.9	5.9	7.8	7.2	7.0

Note: Capital inflows = investment-Savings + official international reserves

Sources: Bangkok Bank Monthly Review, May 1996 and June 1997; Bank of Thailand Annual Report 1994-97;and Bank of Thailand Quarterly Bulletin, December 1994 and June 1997.

Table 2.2 shows that Thailand's economic growth during 1990-96 was relatively high, averaging 9 % *per annum*, despite a shortfall of exports in 1996. Domestic prices were generally stable, with inflation on average at around 5% *per annum*, reflecting in part the Government's prudent monetary policy. The unemployment rate was relatively low, and investment remained at high levels (on average 40% *per annum* of GDP). Domestic savings grew at a slow rate, despite the authorities pursuing policies to mobilise savings, e.g. removing the ceilings on interest rates and allowing banks and other financial institutions to open more branches.

An important change in economic policy during the 1990-96 period was the launch of the financial liberalisation programme in 1990. This followed the acceptance of obligations of Article VIII of the IMF's Agreement, regarding the relaxation of foreign exchange control in May 1990 (*Bangkok Bank Monthly Review,* May 1990). As a result, current account convertibility was virtually achieved. Subsequently, there was a substantial increase in foreign capital inflows, which gave rise to rapid growth in external debt.

Table 2.2 shows that the ratio of external debt to GDP increased from 29% in 1990 to 50% in 1996. This, in turn, widened the current account deficit. The authorities responded to these developments by tightening fiscal policy in order to raise savings in the Government sector. However, fiscal reform in 1992 stimulated private consumption and increased pressure on domestic demand[1]. It is evident that, on average, the amount of imports grew at a faster rate than exports, resulting in a continued large trade deficit and current account deterioration.

2.2 Monetary system and monetary policy

Monetary policy plays a key role in the financial stabilisation of the economy. The monetary policy of the Thai central bank, the Bank of Thailand, has generally aimed at maintaining price stability (Nijathaworn, 1995).

The Bank of Thailand has taken a number of measures in order to maintain monetary control. First, a minimum reserve requirement at 7 percent of commercial banks' deposits was introduced in 1974 that was aimed at absorbing excess liquidity in the banking system. Second, a repurchase market was developed in 1979. Third, the Bank of Thailand provides loan windows for commercial banks in order to improve their liquidity positions and, as a result, the evolution of broad money supply is partly dependent on the credit policy stance of the Bank of Thailand. Fourth, given that the value of the Baht has been pegged to a basket of currencies since 1984, the Bank of Thailand controls capital flows and international trade by determining the official exchange rate for commercial banks to purchase and sell foreign currencies. According to the *Bank of Thailand Quarterly Bulletin (December 1997)*, the US dollar accounted for on average, 95 percent of purchasing, and 89 percent of the selling amount of foreign currencies during 1990-96.

Monetary developments during 1990-96 were affected by the impact of large foreign capital inflows arising from the liberalisation of the capital account in 1990. These rapid foreign capital inflows reflected an increase of foreign borrowing to finance

[1] As stated in the Bank of Thailand Annual Report 1992, tax reform measures involved reducing income tax from 11 to 5 percent, reducing import tariffs and duties, replacing a complex business tax with a 7 percent value added tax, and decreasing tax on international banking business.

domestic investment. In response, the authorities have made considerable efforts to expand domestic savings.

Table 2.3 Monetary indicators, 1990-96

	1990	1991	1992	1993	1994	1995	1996	Average 1990-96
Annual change as a percentage of broad money								
Net foreign assets	3.8	5.8	1.6	0.1	-10.8	-4.4	-2.2	-0.9
Domestic credits	25.1	16.9	17.6	20.0	28.0	26.2	16.8	21.5
- Government sector	0.6	-1.6	-0.3	-1.2	-1.1	-0.0	-0.3	-0.6
- private sector	23.8	15.7	16.4	19.6	27.1	23.7	16.0	20.3
Share in total domestic credits (%)								
- Government sector	10.1	6.9	5.5	3.5	1.8	1.5	1.1	4.3
- private sector	83.7	85.2	86.5	88.5	90.3	90.3	90.9	87.9
Bank rate[1] (%)	12.0	11.0	11.0	9.0	9.5	10.5	10.5	10.5
Mid-rate[1] (Baht/US$)	25.6	25.5	25.4	25.3	25.2	25.9	25.3	25.5
Interest spread[2] (%)	2.2	3.5	3.0	3.5	2.5	3.5	4.7	3.3
M2 (%change)	26.7	19.8	15.6	18.4	12.9	17.0	12.6	17.6
M1/M2 (%)	12.7	12.1	11.8	11.8	12.2	11.7	11.4	12.0
Inflation (%)	6.0	5.7	4.1	3.4	5.1	5.8	5.9	5.1
Capital inflows[3]	7.4	8.2	6.8	5.9	5.9	7.8	7.2	7.0

Notes: 1) Bank rate refers to the average annual rate at which the Bank of Thailand lends or discounts eligible paper for deposit money banks, while mid- rate refers to the annual average rate of buying and selling US dollar
2) Interest spread = minimum lending rate - one-year time deposit rate.
3) Capital inflows = investment- savings + official international reserves.

Sources: Bank of Thailand *Quarterly Bulletin*, December 1994 -1997; and Bank of Thailand *Annual Report*, 1994-97.

Table 2.3 shows that there was a marked reduction of credit to the Government sector, from 10% to 1% of total domestic credit, during the 1990 to 1996 period: this allowed credit to the private sector to increase without rekindling excessive liquidity growth. In 1990, interest rate ceilings on deposits were removed in order to give commercial banks the opportunity to increase their savings. Subsequently, the bank rate and mid-rate (see notes to Table 2.3) were reduced in 1991, but there was an increase of capital inflows (see Table 2.2) owing to the declining amount of domestic credit. There was a decline in capital inflows during 1992-94 (see Table 2.2) that resulted partly from an increase in the amount of credit to the private sector. However, Table 2.3 shows that a decline in net foreign assets suggested that the external position of the Thai economy worsened significantly.

Beginning in 1995, the Bank of Thailand introduced further measures to reduce the potential of further capital inflows and to rebuild net foreign assets. First, commercial banks were required to maintain a minimum 7% reserve ratio of non-resident Baht deposits (from August 1995). Second, short-term offshore borrowing by financial institutions was subject to a 7% reserve requirement in June 1996. At the same time, the change in domestic credit as a percentage of broad money was reduced from 26% in 1995 to 17% in 1996. However, these measures did not prevent a drastic surge of foreign capital into Thailand, because inflows could be intermediated by non-bank financial institutions and by the capital market.

Table 2.3 also shows that domestic credit grew on average 21% *per annum* during 1990 to 1996. Reflecting the Bank of Thailand's monetary policy, broad money expanded at an average of 17% *per annum*, well in excess of output growth, thereby exacerbating excess demand pressure. As a result, in 1994 the inflation rate started to rise.

In summary, the ineffectiveness of monetary measures during 1990-96 can be explained by two important factors. First, additional reserve requirements imposed a tax on bank intermediation by increasing the gap between the interest rates on bank deposits and bank loans. Second, as shown in Table 2.3, the average exchange rate of Baht/US dollar was retained at about 25:1 during the period. Theoretically, a fixed exchange rate policy impedes the implementation of monetary measures: as the authorities intervened in order to maintain stability of the exchange rate by purchasing the foreign currency that flowed into the country, the current account deteriorated dramatically.

2.2.1 Foreign exchange and exchange rate policies

One of the central concerns of monetary policy is the availability of foreign exchange to supplement scarce domestic resources in financing growth. Prior to 1990, monetary management was effected mainly through various types of direct controls such as interest rate ceilings, selective credit and foreign exchange controls. These policies were ineffective in response to the fast-growing economy. A demand for a more competitive and efficient financial system led to the launch of the financial liberalisation programme in 1990.

Foreign exchange and exchange rate policies became more important when Thailand accepted (in May 1990) the obligations under Article VIII of the IMF's Agreement regarding the relaxation of foreign exchange control. This resulted in the liberalisation of international capital transactions, especially commercial banks' foreign exchange transactions and portfolios, direct equity investments of non-residents and outward investments of residents. At the same time, the value of domestic currency (baht) was pegged to a basket of currencies until July 1997. The aim was to encourage international trade and attract more foreign investment.

The combination of an open capital account and a currency peg, however, can reduce the effectiveness of monetary policy (see Hanson, 1992). This is because the exchange rate does not respond to changes in the amount of foreign exchange. An alternative way to manage foreign capital is to target domestic interest rates since domestic and foreign assets are not perfectly substituted. Theoretically, targeting the interest rate is likely to lead to a loss of international reserves. For instance, if domestic interest rates are lower than world rates, this will lead to capital flight and loss of international reserves. In contrast, if domestic interest rates are higher than world rates, this will attract capital inflows and consequently raise net obligations for the country. This appears to have occurred in Thailand, where an open capital account with a currency peg during 1990-96 not only increased capital inflows and external debt but also reduced net foreign assets (see Tables 2.2 & 2.3).

2.3 Thai financial and banking system

The financial system serves as an intermediary between savings and investing activities within an economy. In this context the financial system is a key component of the overall economy since it facilitates the generation of the flow of financial resources within the macroeconomy. A generalised increase in the volume and efficiency of funds intermediated through the financial system should have a resultant positive impact on the efficiency of those sectors that use the financial system (see, for example, Cecchini (1988) and European Commission (1997)).

This section reviews the structure and experience of the Thai money and capital markets, and it examines the process of financial development during 1990-96. Specifically, it provides an overview of Thailand's financial structure and explores the role of commercial banks in economic development.

2.3.1 Money and capital markets

The short-term money market in Thailand consists of the inter-bank market and the repurchase market. These markets have been used by commercial banks as sources of funding to meet their loan operation needs and for liquidity management. The inter-bank market is the main component of the money market, providing loans at the overnight rate.

The repurchase market in Thailand is relatively underdeveloped; Government bonds are the underlying instruments of these repurchase agreements. However, according to the Bank of Thailand *Quarterly Bulletin* (March, 1997), no new Government bonds have been issued since May 1990. Other market segments, such as a Treasury bill market, did not exist up to 1997.

The capital market in Thailand centres on the Stock Exchange of Thailand (SET), which was established in 1974. The range of financial instruments includes Government bonds, state enterprise bonds, monetary authority bonds and local stocks. Activity on the SET expanded significantly after the Securities and Exchange Act 1992 was introduced. Under this Act, commercial banks, finance companies, credit foncier companies, Government-owned financial institutions and limited companies were permitted to issue debt instruments. Such instruments include debentures, certificates of deposit (CDs), warrants, and unit trusts. In addition, there are overseas issues of securities, including Government bonds, state enterprises bonds, floating rate notes, floating rate certificates of deposit, and Asian currency notes. The Thai Rating and Information Services (TRIS) was established in 1993 as a credit rating agency. In addition, the Bond Dealers' Club (BDC) was introduced in 1994 as a market for secondary debt, followed by the establishment of the Bangkok Stock Dealing Centre

(BSDC) in 1995 as another secondary market for small and medium-size firms which are not listed in the SET.

Table 2.4 shows that the performance of the Thai capital market improved considerably during 1990 to 1993, with the SET index registering an annual gain averaging 43% *per annum*; and the ratio of market capitalisation to GDP increased from 29% in 1990 to 105% in 1993. This impressive performance was attributable to the increase of trading volume from 627 billion baht in 1990 to 2201 billion baht in 1993. In the same period, the volume of interbank borrowing increased as the interbank lending rate declined. Table 2.4 also shows a substantial increase of interbank borrowing by 135% in 1993 as the average interbank lending rate declined.

Table 2.4 Money and capital market indicators, 1990-96

At the end of	1990	1991	1992	1993	1994	1995	1996	Average 1990-96
Money market indicators								
Interbank lending rate (%)	14.4	14.0	9.7	9.1	9.4	13.4	11.4	11.6
Interbank borrowing (%change)	1.4	29.6	0.27	135.5	43.7	28.0	13.9	36.1
Repurchase rate (7 days)	11.5	9.7	5.2	5.7	6.8	9.4	9.0	8.2
Government bond (%change)	2.6	-31.7	-13.8	-24.5	-27.1	-22.9	-67.9	-26.5
Stock market indicators								
No. of listed companies	214	276	320	369	450	485	454	367
SET index (1975=100)	612	711	893	1682	1360	1280	831	1053
Trading volume	627	793	1860	2201	2113	1535	1303	1490
Average daily turnover	n.a.	n.a.	7.5	9.0	8.6	6.2	5.3	7.3
Market capitalisation	29.5	35.8	52.2	105.1	91.8	85.9	54.5	65.0

Notes: Interbank lending rates shown are as average daily figures. Trading volume and average daily turnover are in billion baht, while market capitalisation is measured as a percentage of GDP.

Sources: Sirivedhin (1997); Bank of Thailand *Annual Report*, 1990-96; *Commercial Banks in Thailand*, 1990-97.

During 1994-96, the SET was less buoyant than before partly as a result of the Bank of Thailand's tightening credit policy aiming to increase domestic savings. Table 2.4 shows a declining ratio of market capitalisation to GDP: from 92% in 1994 to 54% in 1996 as the trading volume decreased from 2114 billion baht in 1994 to 1303 billion baht in 1996. In the event, interest rates in the money market increased steadily and recourse to commercial bank borrowing to finance the growing investment subsequently decreased. The volatility of market rates during 1990-96 reflects an active money market and Thai interest rates became generally more market-determined.

Table 2.5 Types of securities, 1992-96

	1992		1993		1994		1995		1996	
	N/C	Value	N/C	Value	N/C	Value	N/C	Value	N/C	Value
Shares	3	1248	41	34028	72	80065	72	62041	52	64971
Shares and warrants	-	-	-	-	1	2000	2	2524	-	-
Preferred stock	-	-	-	-	-	-	-	-	1	207
Debentures	5	5107	8	10810	16	31928	18	30329	22	29695
Secured debentures	-	-	-	-	1	3500	4	5500	2	10700
Off-shore debentures	-	-	1	1000	11	26214	11	28162	12	45884
Short-term debentures	-	-	-	-	-	-	2	3112	2	6048
Warrants	-	-	3	880	8	2442	11	470	17	2946
Convertible debentures		-	3	690	7	5090	5	8200	1	2740
Off-shore convertible debentures			17	39295	9	22424	4	7932	12	37790
Debentures and warrants			7	9645	9	19286	1	3500	-	-
Off-shore debenture and warrants		-		-	1	1608	-	-	-	-
Total	8	6335	80	96348	135	194557	130	151770	121	200981

Notes: 1) N/C= Number of companies. The figures are shown in million baht.
2) Figures in 1992 are from May 16 – December 31, 1992.

Source: The Securities and Exchange Commission, http://www.sec.or.th/indexe.html

Table 2.5 illustrates the types and value of securities offered in the stock market during 1992-96: the most preferred types were shares, debentures, off-shore debentures, warrants and off-shore convertible debentures. The growth of the stock market can be seen from the number of companies offered, increasing from 8 in 1992 to 121 in 1996; also the value of securities grew from 6335 million baht to 200981 million baht over the same period.

2.3.2 Financial development

Goldsmith (1969) in his seminal work defines financial development as the change in financial structure over time. Financial development can be examined using four broad types of financial indicators:

(a) Financial Interrelation ratio (FIR). This ratio is defined as total financial assets divided by GDP. The bigger this ratio, the higher is the level of financial development *ceteris paribus*.

(b) The share of financial institutions in total financial assets reflects the process of savings and investments of financial institutions. The higher the ratio, the larger the share of indirect savings through financial institutions.

*(c) **The size of financial institutions in comparison with GNP*** indicates the comparative importance of financial institutions in the process of financial development.

*(d) **The distribution of the total assets of financial institutions*** reflects the development of new financial institutions and differences in the growth rates of existing types of institutions.

This section explores the level of financial development in Thailand during 1990 to 1996 by using a sample of financial indicators developed by Goldsmith (1969). In addition, the process of financial deepening will be tracked using the ratio of broad money to GDP. As the development of the financial sector involves the increasing provision of financial services, this ratio is expected to rise over time.

The major financial institutions in Thailand comprise the central bank (Bank of Thailand), commercial banks, specialised financial institutions, the major finance companies, life insurance companies, securities companies and mutual fund management companies. Beginning in 1990, the Government implemented a series of measures designed to deregulate the banking system with a view to making it more market-oriented and to improve the mobilisation and allocation of resources. Several of these measures - including interest rate liberalisation, improved banking supervision and the introduction of Bangkok International Banking Facilities (BIBF)[2] - were part of a wider financial liberalisation programme adopted by the Thai Government.

Table 2.6 shows that the Thai financial sector grew considerably from 1990 as illustrated by an increasing FIR; this is consistent with the increased ratio of broad money to GDP. Initial exploratory evidence suggests an increased financial intermediation role of the banking sector after the process of financial liberalisation began in 1990. While there appeared to be a large number of financial institutions, the commercial banks have been the dominant financial intermediaries (see Table 2.7). In 1996, commercial banks, including Thai banks and foreign bank branches, accounted for about 67% of total assets in the system. However, the share of Thai commercial

[2] BIBF refers to the off-shore banking license that allows banks to intermediate funds in foreign currencies.

banks in total financial assets declined gradually since 1990 as a result of increased competition from foreign banks and finance companies.

Table 2.6 Financial development, 1990-1996

At the end of	1990	1991	1992	1993	1994	1995	1996	Average 1990-96
(Total assets as a percentage of total financial assets)								
Thai banks	70.8	70.8	67.3	62.3	58.8	54.3	54.3	62.7
Foreign bank branches	3.4	3.6	3.4	3.9	4.3	4.5	5.0	4.0
New foreign BIBF	-	-	-	-	4.0	8.5	7.5	6.7
Finance companies	13.8	13.8	16.0	18.2	18.9	19.2	19.3	17.0
Specialised financial institutions								
- GSB	4.9	4.4	3.9	3.3	2.8	2.5	2.5	3.5
- GHB	1.3	1.4	1.4	1.5	1.7	1.8	2.2	1.6
- BAAC	2.0	2.1	1.9	2.1	1.9	1.9	2.2	2.0
- IFCT	1.4	1.4	1.4	1.4	1.1	1.4	1.5	1.4
- EXIM	-	-	-	0.0	0.2	0.3	0.3	0.2
Life insurance	1.6	1.7	1.7	1.6	1.5	1.4	1.5	1.6
Securities companies	0.2	0.3	0.5	0.8	0.6	0.6	0.5	0.5
Credit foncier	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1
Mutual fund management companies	n.a.	n.a.	1.8	4.2	3.5	2.9	2.6	3.0
Total financial assets**	2641	3152	3843	4965	6352	8254	9368	5510.7
GDP(current price)**	2191	2505	2827	3179	3634	4194	4689	3317.0
FIR	1.20	1.25	1.35	1.56	1.74	1.96	1.99	1.58
M2/GDP	0.69	0.73	0.74	0.78	0.77	0.78	0.79	0.75

Notes: (**)The figures are shown in billion baht. GSB = Government Savings Bank, GHB = Government Housing Bank, BAAC = Bank for Agriculture and Agricultural Cooperative, IFCT = Industrial Finance Corporation of Thailand, EXIM = Export-Import Bank of Thailand, BIBF = Bangkok International Banking Facilities.

Sources: Bank of Thailand *Quarterly Bulletin*, December 1996-1997.

Table 2.7 Total assets/GDP, 1990-1996

At the end of	1990	1991	1992	1993	1994	1995	1996	Average 1990-96
Thai banks	85.4	89.1	91.5	97.4	102.8	107.0	108.4	97.4
Foreign bank branches	4.1	4.5	4.7	6.1	7.6	8.9	10.0	6.6
New foreign BIBF	-	-	-	n.a.	7.0	16.8	15.0	12.9
Finance companies	16.6	17.4	21.8	28.5	33.0	37.8	38.6	27.7
GSB	6.0	5.5	5.3	5.1	5.0	5.0	5.0	5.3
GHB	1.5	1.7	2.0	2.4	3.0	3.6	4.5	2.7
BAAC	2.4	2.6	2.6	3.3	3.3	3.7	4.7	3.2
IFCT	1.6	1.8	2.0	2.2	2.4	2.8	3.0	2.3
Life insurance	2.0	2.1	2.3	2.5	2.7	2.8	3.0	2.5
Securities co.	0.3	0.3	0.7	1.3	1.0	1.1	1.1	0.8
Mutual fund co.	n.a.	n.a.	2.5	6.6	6.2	5.8	5.2	5.3

Note: The figures are shown in percentage.
Sources: Bank of Thailand Annual Report, 1990-97.

The change in size of different financial institutions through time indicates *inter alia* their comparative development. Table 2.7 confirms that Thai commercial banks are clearly the largest group of financial institutions. The banks' total assets to GDP ratio increased from 85% in 1990 to 108% in 1996.

In summary, Thai commercial banks experienced an increase in their ratio of total assets to GDP (see Table 2.7) and a decline in their respective share of total financial assets (see Table 2.6). The evidence shows that there was substantial growth in the financial sector together with increasing diversification in the Thai financial sector during the 1990-96 period.

2.3.3 Financial institutions

Financial institutions in Thailand consist of the Bank of Thailand, the country's central bank, together with the commercial banks, foreign bank branches, specialised financial institutions, finance companies, and a number of financial institutions that do not accept deposits such as foreign BIBF banks[3], foreign bank representative offices, securities companies, mutual fund management companies, insurance companies and credit foncier companies. Selected data on the comparative size and development of these major financial institutions are shown in Table 2.8.

Table 2.8 Major operations of the Thai financial institutions

	1990	1991	1992	1993	1994	1995	1996
Thai commercial banks							
Total deposits	1471761	1773537	2055160	2431137	2826920	3376637	3805408
Total loans	1499245	1825239	2185213	2595886	3146658	3783695	4329142
Total assets	1872265	2234804	2589914	3098533	3737125	4488176	5087121
No. of branches	2286	2482	2617	2745	2889	3029	3203
Foreign bank branches							
Total deposits	31569	37979	40251	58206	52306	52621	71280
Total loans	75861	101197	116211	169373	242811	334483	422664
Total assets	91642	115187	133028	197460	277032	376279	471910
New foreign BIBF banks							
Total lending	-	-	-	N/A	160177	549502	536495
Total assets	-	-	-	N/A	257761	707468	707040
Finance companies							
Total borrowing	257400	300600	413300	542000	747500	914600	1040100
Total lending	314900	405100	547700	733100	1008000	1301000	1488200
Total assets	365600	436800	617900	908400	1200900	1588100	1812000
No. of companies	94	92	92	91	91	91	91
Specialised Financial Institutions							
- GSB							
Savings	97342	101630	111668	142105	156411	179409	205580
Lending	6263	6976	14697	18098	26779	35443	45541
Total assets	132809	140158	150855	165481	183900	210487	237442
No. of branches	502	504	524	532	537	540	548

[3] This covers those foreign banks with a BIBF license, which have no branching status in Thailand.

Table 2.8 Major operations of the Thai financial institutions (continued)

	1990	1991	1992	1993	1994	1995	1996
– GHB							
Savings	25425	33784	38254	47347	56459	72298	69287
Lending	29587	39704	53534	71942	100579	142040	198499
Total assets	35782	45386	57069	78260	111803	155787	213994
No. of branches	10	13	18	N/A	99	119	169
– BAAC							
Savings	17981	24731	33472	43881	60515	82657	N/A
Lending	38821	48654	62060	77690	96660	125709	N/A
Total assets	54798	67228	76941	105742	122685	159962	207003
No. of branches	159	199	266	303	362	495	629
– IFCT							
Bonds, debentures and other borrowing	14849	22382	27339	32243	32880	54029	61298
Lending	24440	31885	41158	55761	59458	93991	121288
Total assets	37990	47848	57137	71134	73264	119098	145031
No. of branches	N/A	7	7	8	8	15	23
– EXIM							
Lending	-	-	-	-	107	3739	8672
Total assets	-	-	-	1872	16364	28119	34623
Life insurance companies							
Premium received	13640	16660	20360	23700	28070	33200	54400
Lending	14860	18440	19720	21300	19870	25040	N/A
Total assets	44690	54690	66870	82650	99290	120400	145200
Securities companies							
Investment	3170	4310	N/A	9260	N/A	26000	39670
Total assets	7480	10390	20170	44800	38600	50000	55100
Thai	11	12	12	N/A	14	15	17
Foreign	N/A	N/A	N/A	19	24	21	29
Credit foncier companies							
Borrowing	3060	3280	4620	5740	5440	6000	6700
Lending	3220	3540	5000	6010	6190	6600	7100
Total assets	4380	4690	5860	7400	7020	7900	8500
No. of companies	18	N/A	N/A	16	14	13	12
Mutual fund management companies							
No. of funds	N/A	N/A	37	64	101	143	205
Net assets	N/A	N/A	73927	210606	226372	246342	247156
No. of companies	1	1	8	8	8	8	12

Notes: 1) The figures are shown in million baht.
2) New foreign BIBF banks refers to foreign banks with BIBF license, yet have not been given full branch status in Thailand. New foreign BIBF banks began their operation in 1993 and EXIM bank began its operation in 1994.
3) GSB = Government Savings Bank, GHB = Government Housing Bank, BAAC = Bank for Agriculture and Agricultural Co-operative, IFCT = Industrial Finance Corporation of Thailand, EXIM = Export-Import Bank of Thailand.
4) Data on mutual fund management companies are taken from http://www.sec.or.th/indexe.html

Sources: Bank of Thailand, *Annual Report*, 1990-96
Bank of Thailand, *Quarterly Bulletin*, December 1994-97
Bangkok Bank, *Commercial banks in Thailand*, 1994-97

Bank of Thailand

The Bank of Thailand performs all the main functions of a central bank. The predecessor of the Bank of Thailand was the Thai National Banking Bureau, established in 1939. Its initial operations were limited to selected central banking functions, such as managing the issues of Government bonds; taking deposits from and lending to the Government, Government agencies and commercial banks; and transferring funds between the central region and the other parts of the country. After the Second World War, the Government changed the status of the Bureau to that of a central bank.

According to the Bank of Thailand Act 1942, the Minister of Finance is empowered to oversee the overall affairs of the Bank of Thailand with the general control and direction being entrusted to a Court of Directors. The Bank of Thailand is responsible for issuing currency; acting as the Government's banker and fiscal agent; managing official international reserves; licensing and regulating financial institutions; and exercising prudential supervision of the financial sector. The Bank has the autonomy to conduct monetary and credit policy; act as a lender of last resort by extending credit to financial institutions; set guidelines for interest rates; and formulate exchange rate policy.

Within the Bank's remit for supervising commercial banks, the authorities focused on three main areas: capital adequacy, liquidity and large exposures. The main legislation governing commercial banks is the Commercial Banking Act (CBA) 1962 and its amendments, the CBA 1979 and the CBA 1985. Practically, commercial banks were required to maintain the capital funds to risk assets ratio of 8% before the Bank formally adopted the 1988 BIS international bank capital adequacy standard in 1993. To maintain liquidity, commercial banks are required to hold cash reserves of not less than 7% of their total deposits. In addition, commercial banks are prohibited from lending to any person an amount exceeding 25% of the bank's capital funds. Other key areas of supervision include foreign exchange activities, bank administration, scope of investment and the entry (licensing) of new banks.

Commercial banks

Banking business in Thailand was pioneered initially by the Hongkong and Shanghai bank in 1888. During 1990 to 1996, the commercial banking sector comprised 15 domestic banks and 14 foreign bank branches. Domestic banks expanded rapidly during this period, and the number of bank branches increased from 2286 in 1990 to 3203 in 1996 (see Table 2.8). This rapid expansion occurred because the bond holding requirements for opening new branches were abolished in 1993[4]. Table 2.8 depicts the growth of domestic banks in terms of assets, deposits and loans. During 1990-96, assets increased, on average 18% *per annum*, while deposits and loans grew respectively by 17% and 19% *per annum*.

Table 2.9 Thai commercial banks ranked by total assets (Million baht)

At the end of 1996	Total assets	% of total	Total deposits	% of total
Bangkok Bank	1155109	22.7	836354	22
Krungthai Bank	715995	14.1	578406	15.2
Thai Farmer Bank	646007	12.7	516906	13.6
Siam Commercial Bank	541417	10.6	395812	10.4
Bank of Ayudhaya	414879	8.1	334899	8.8
Thai Military Bank	333994	6.6	249913	6.6
First Bangkok City Bank	252146	5	181545	4.8
Siam City Bank	234145	4.6	168948	4.4
Bangkok Metropolitan Bank	191550	3.8	143675	3.8
Bangkok Bank of Commerce	185575	3.6	110061	2.9
Bank of Asia	126508	2.5	86209	2.3
Thai Danu Bank	119958	2.3	81918	2.1
Union Bank of Bangkok	64610	1.3	45075	1.2
Nakornthon Bank	64471	1.3	46832	1.2
Leam Thong Bank	41117	0.8	28855	0.7
Total	5087121	100	3805408	100

Source: Bangkok Bank, *Commercial Banks in Thailand*, 1997.

Table 2.9 shows that Bangkok Bank is the largest domestic bank, and it accounted for over 20% of total assets and bank deposits in 1996. The four largest banks each had assets of more than 500000 million baht, and they commanded around 60% of total assets and deposits of Thai commercial banks. Eight medium-sized banks, each one in the 100000-500000 million baht asset size range, together held a 36% share of total assets and a 38% share of total bank deposits. The remaining three small banks, each with an asset size less than 100000 million baht, had about a 3% share of total assets and total bank deposits.

Foreign banks are differentiated from domestic banks in that they are more severely restricted in opening additional branches and in the supplying of facilities such as cash dispensers (Asvanund and Kamchadduskorn, 1989). These differences pose restrictions on foreign banks in expanding their businesses. Foreign bank branches in Thailand specialise in trade finance, foreign exchange and corporate finance (Sargent, 1989). They concentrate more on corporate lending and custodial business. The scope of

[4] Prior to 1988, the requirement of Government bonds held by commercial banks in order to open a new branch was 16 percent of bank deposits. This ratio was gradually reduced to 8 percent in 1991, 6.5 percent in 1992 and abolished in May 1993.

business of foreign bank branches was increased under the financial liberalisation programme i.e. they were permitted to obtain the BIBF license in 1993, under which each bank can mobilise funds from abroad in order to finance domestic and foreign businesses. In addition, the Bank of Thailand granted 7 new entries at the end of 1996, of which 6 banks began their operations in 1997.

Foreign bank branches have grown faster, in terms of assets and loans, compared with domestic commercial banks in Thailand. Table 2.8 illustrates that during 1990-96, assets of foreign banks increased on average by 32%, while loans increased by 39% *per annum*. During the same period, foreign bank deposits grew, on average by 16% *per annum*, slightly less than the growth of domestic bank deposits.

Table 2.10 Foreign bank branches ranked by total assets (Million baht)

At the end of 1996	Total assets	%of total	Total deposits	% of total
Bank of Tokyo Mitsubishi	122419	25.9	17768	24.9
Sakura Bank	83569	17.7	10412	14.6
Citibank	61099	13	13327	18.7
Hongkong & Shanghai Banking	47025	10	9043	12.7
Standard Chartered Bank	32468	6.9	6655	9.3
Deutsche Bank	26692	5.7	3871	5.4
Bank of America	25650	5.4	1967	2.8
Chase Manhattan Bank	23322	4.9	2012	2.8
Banque Indosuez	21019	4.5	2188	3.1
ABN Amro Bank	15228	3.2	749	1.1
Overseas-Chinese Banking	5542	1.2	546	0.8
Int'l Commecial Bank of China	4885	1	1457	2
Sime Bank Berhad	1497	0.3	294	0.4
Bharat Overseas Bank	1495	0.3	991	1.4
Total	471910	100	71280	100

Source: Bangkok Bank, *Commercial Banks in Thailand*, 1997

Table 2.10 shows that Bank of Tokyo-Mitsubishi is the largest foreign bank branch with a 26% share of total assets and a 25% share of total deposits of foreign bank branches in Thailand. In 1996, there were four large foreign banks each with total assets greater than 40000 million baht. Together they accounted for about 66% of total assets and 71% of total bank deposits of foreign banks in Thailand. Six medium-size banks each with total assets between 10000-40000 million baht, held together a 30% share of total assets and a 24% share of total bank deposits. Each of the four remaining small banks had asset size less than 10000 million baht. Together they had a 3% share of total assets and a 5% share of total bank deposits of all foreign bank branches in 1996.

New foreign BIBF banks

As part of the financial liberalisation programme, the Bangkok International Banking Facility (BIBF) was introduced in March 1993. The scope of BIBF business included providing foreign currency loans to domestic and foreign businesses, cross currency exchange services, financial guarantees, credit confirmations, and investment banking activities such as loan syndication[5].

Under the Bank of Thailand's regulations, the source of funds for BIBF banks must come from abroad (*Bank of Thailand Quarterly Bulletin,* 4/92, p.39). The BIBF was introduced partly as a means of making Thailand more accessible to foreign banks, i.e. the BIBF license allows foreign banks without existing branches in Thailand to compete on the same basis as the domestic banks in the retail sector[6]. In practice, BIBF banks perform two main activities: domestic lending (out-in) and international lending (out-out).

New foreign BIBF banks have a BIBF license, but have not been given a full branch status in Thailand. According to the Bank of Thailand's regulations[7], these banks are exempt from holding the minimum capital adequacy ratio.

BIBF banks were permitted to begin operations in 1993. There were 12 Thai commercial banks, 11 foreign bank branches, and 21 new foreign banks with BIBF licenses in 1994. The number of BIBF banks without branching status decreased to 19 during 1995-96 when Skandinaviska Enskilda Banken withdrew its business from Thailand and the Mitsubishi bank merged with the Bank of Tokyo, which already had branching status in Thailand. Subsequently, 7 existing foreign BIBF banks (without branching status) were upgraded to full-branch status in November 1996, and 6 new foreign banks were given BIBF licenses in December 1996.

Table 2.11 shows the presence of BIBF banks and their assets in 1997. Sanwa Bank was the largest BIBF bank, with assets of over 200 billion baht. There was one Thai bank (Bangkok Bank) and four foreign bank branches, each one in the range

[5] As described in "Recent Financial Developments", http://www.bot.or.th/supervis4.html

[6] Regulations on the operation of the International Banking Facilities by a commercial bank state that a bank must manage business in a separate manner as a person different from the commercial bank itself, including the separation of assets, documents, records, and accounts.

[7] As published in "Recent Supervisory Issues", http://www.bot.or.th/supervis2.html, the minimum capital adequacy ratio required for Thai banks was 7% in 1993, 7.50% in 1994 and 8.0 percent in 1995. For foreign bank branches, the minimum capital adequacy ratio required was 6.25 % in 1993, 6.50% in 1994, and 6.75 % in 1995.

between 100-200 billion baht of asset size. Each of the remaining BIBF banks had an asset size less than 100 billion baht.

Table 2.11 BIBF banks, 1997

Thai banks	Total assets	Foreign banks (1)	Total assets	Foreign banks (2)	Total assets
Bangkok Bank	131.8	Sakura Bank	97.4	Sanwa Bank	215.2
Krung Thai Bank	90.7	Bank of Tokyo Mitsubishi	171.2	Long-term Credit Bank of Japan	46.3
Thai Farmer Bank	41.1	Hongkong & Shanghai Banking Corporation	27.3	Korea exchange Bank	12.2
Siam Commercial Bank	78.4	Bank of America	21.7	Societe Generale	25.8
Bank of Ayudhaya	42.1	Standard Chartered Bank	14.7	Development bank of Singapore	11.5
Thai Military Bank	22.31	Chase Manhattan bank	39.4	Internationale Nederlanden Bank	8.5
Siam City Bank	46.2	Banque Indosuez	13.3	Credit Lyonnais	13.1
Bangkok Metropolitan Bank	7.0	Deutsche Bank	22.4	American Express Bank	0.9
Bank of Asia	24.9	Citibank	23.3	Bank of New York	2.0
First Bangkok City Bank	43.0	Overseas Chinese Banking Corporation	6.6	Bankers Trust Company	3.2
Thai Danu Bank	14.9	ABN AMRO Bank	17.6	United Overseas Bank	1.6
Nakornthon Bank	11.3	Sumitomo Bank*	178.1	Overseas Union Bank	4.2
		Dai-Ichi Kangyo Bank*	168.7	National Australia Bank**	0.9
		Industrial Bank of Japan*	114.7	Tokai Bank**	18.6
		Dresdner Bank*	20.5	Fuji Bank**	3.3
		Bank of Nova Scotia*	13.4	Royal Bank of Canada**	0.9
		Bank of China*	6.1	General Bank**	0.7
		Banque Nationale de Paris*	21.3	Korean Development Bank**	0.9

Notes: Total assets are shown in billion baht. Foreign banks (1) refers to foreign bank branches with BIBF licenses and Foreign banks (2) represents foreign BIBF banks without branching status in Thailand. (*) Refers to banks which have been upgraded to a full branch status in November 1996 and (**) refers to banks which have been given BIBF license in December 1996.

Sources: *Commercial Banks in Thailand*, 1995-98.

Table 2.12 Total assets of BIBF banks, 1994-97 (million baht)

	1994	%of total	1995	%of total	1996	%of total	1997	%of total
Thai banks	203594	35.93	269088	22.43	352003	27.14	554064	29.12
Foreign (1)	105220	18.57	159622	13.31	237578	18.33	978437	51.42
Foreign (2)	257761	45.50	771112	64.26	707040	54.53	370254	19.46
Total	566575	100.0	1199822	100.0	1296621	100.0	1902755	100.0

Notes: The figures are shown in million baht. Foreign (1) refers to foreign bank branches with BIBF licenses and foreign (2) represents foreign BIBF banks without branching status in Thailand.

Sources: *Commercial banks in Thailand*, 1995-98.

Table 2.12 illustrates the growth of BIBF banks in terms of total assets during 1994-97. New foreign BIBF banks had the highest share of total BIBF banks' assets, followed by Thai banks and foreign BIBF bank branches during 1994-96. So new foreign BIBF banks were the largest group of BIBF banks over the 1994 to 1996 period. In 1997, however, foreign BIBF bank branches had the highest share of total BIBF banks' assets, due to the entry of six new bank branches.

In terms of assets growth, on average, Thai BIBF banks grew at 40% *per annum*, while foreign BIBF bank branches grew at 137% *per annum* as a result of an increase in the number of foreign bank branches in 1997. In addition, the assets of new foreign BIBF banks increased by about 200% during 1994-95, but declined during 1995-97 due to a reduction in the number of new foreign BIBF banks.

Foreign bank representative offices

In addition to foreign bank branches and new foreign BIBF banks, there were 44 foreign bank representative offices in December 1994 (Bank of Thailand *Quarterly Bulletin*, 4/96,p.21). Under the CBA 1979, a representative office of a foreign bank is not permitted to engage in commercial banking business. The role of a foreign bank representative is to act as a liaison office for collecting and disseminating information, and facilitating communication between the head office and its customers (Asvanund and Kamchadduskorn, 1989).

Specialised financial institutions

Specialised financial institutions in Thailand comprise the Government Savings Bank, the Bank for Agriculture and Agricultural Cooperatives, the Government Housing Bank, the Industrial Finance Corporation of Thailand, and the Export-Import Bank of Thailand. These institutions are under the supervision of the Ministry of Finance. Each institution is restricted to conduct business within its explicitly prescribed functions. The following sections consider the role of these organisations.

- *Government Savings Bank (GSB)*

The Government Savings Bank (GSB) was established in 1946. Its main function is to encourage the general public to save. The GSB offers various savings schemes, ranging from ordinary deposits to premium bonds and savings certificates for such purposes as housing, education and raising families. Practically, the GSB allocates most of its tapped funds to the Government, Government agencies and state enterprises by way of notes and bonds. Short-term credits are occasionally extended to the private sector (Vichyanond, 1994).

The growth of the GSB is illustrated in Table 2.8. During 1990-96, bank assets and deposits from business and household sector increased respectively, on average, by 10% *per annum*, while lending to business and the household sector substantially increased by 42% *per annum*.

- *Bank for Agriculture and Agricultural Cooperatives (BAAC)*

The Bank for Agriculture and Agricultural Cooperatives (BAAC) was established in 1966. Its function is to provide low interest credits to farmers and agricultural cooperatives. The role of BAAC is to cooperate with the Government and private corporations in order to supply credits, farming instruments, expertise and raw materials to participating farmers and cooperatives under a number of agricultural development projects such as rice and para-rubber productions.

Under current regulations, BAAC is not allowed to extend direct credits to sectors outside of primary agriculture (Vichyanond, 1994). Table 2.8 showed that during 1990-96 assets of the BAAC increased, on average, 25% *per annum*. Its sources of funds come from deposits from the public and commercial banks, loans from the Bank of Thailand and foreign sources such as the Asian Development Bank (ADB) and Japan's Overseas Economics Cooperation Funds (OECF).

- *Government Housing Bank (GHB)*

The Government Housing Bank (GHB) was established in 1953. The GHB is permitted to accept deposits of any type and maturity from the public. The role of GHB is to provide mortgages to low and middle income earners for housing and real estate purposes; the loan repayment period is up to 25 years. The GHB mobilises funds by taking deposits, borrowing from the Bank of Thailand, and issuing bonds. Branch expansion became a more important policy for the GHB in order to increase its business.

Table 2.8 showed that the number of GHB branches increased rapidly after the reform period, from 10 branches in 1990 to 169 branches in 1996. At the same time, assets of the GHB increased on average 35% *per annum.*

- *Industrial Finance Corporation of Thailand (IFCT)*

The Industrial Finance Corporation of Thailand (IFCT) was established in 1959. Its main purpose is to promote domestic industries and the capital market. The IFCT function is to provide long-term loans to rural and small-scale industries for financing fixed assets and permanent working capital. These loans are repayable in up to 15 years, but the average maturity is seven to eight years, including a grace period of two to three years. In addition to lending activities, IFCT also provides specialised services to industries e.g. the issuance and trading of unit trusts.

The IFCT mobilises medium and long term funds by issuing debentures, promissory notes, IFCT preference bonds, Asian Currency Notes, and Global Medium Term Notes. Its sources of funds are the Bank of Thailand, the World Bank, the Asian Development Bank and other international markets.

- *Export-Import Bank of Thailand (EXIM Bank)*

The Export-Import bank of Thailand was established in 1994. Its basic function is to provide medium and long term credits for exports, export guarantees, and export insurance to Thai exporters who have no access to commercial bank lending. The EXIM bank also finances the imports of machinery and equipment used for exports production and imports of goods beneficial to the environment. Its main sources of funding are the Bank of Thailand, local and overseas financial institutions, and from the issuing of short-term and long-term financial instruments.

Finance companies

Finance companies were introduced in the late 1960s when the banking industry needed competition (Vichyanond, 1994). Prior to 1972, finance companies were allowed to operate without restriction, and they had neither specific licenses nor supervision. The Revolutionary Council Announcement 1972 was the first Act to regulate finance and securities businesses. At present, finance companies are authorised and regulated by the Securities and Exchange Commission of Thailand and the Bank of Thailand under the Securities and Exchange Act 1992.

The scope of finance companies' business includes acceptance or purchase of bills; mobilisation of funds for lending or discounting bills and other negotiable instruments; trading of debt instruments and securities; brokerage management; and advisory services relating to the trading or debt instruments and securities. The development of financial liberalisation in Thailand has allowed the finance companies to perform some of the functions of an investment bank such as underwriting and marketing the securities of private sector companies, and issuing negotiable certificate of deposits. These changes have brought them into direct competition with commercial banks for deposits and the provision of financial services.

Table 2.8 shows that total assets of finance companies increased from 365 billion baht in 1990 to 1812 billion baht in 1996. At the same time, total lending increased from 315 billion baht to 1488 billion baht. There were over 90 finance companies during 1990-96. However, the operations of many companies were suspended in 1997 as a result of the financial crisis. As a consequence, the number of finance companies declined to 35 at the end of 1997 (Bank of Thailand *Annual Report*, 1997).

Securities companies

Securities companies began their operations in 1955. They are regulated and supervised by the Securities and Exchange Commission of Thailand (SEC). Under the SEC Act 1992, securities businesses include securities brokerage, securities dealing, securities underwriting, and investment advisory service. Different types of securities business require different kind of licenses. In 1996, there were 46 securities companies, comprising 17 domestic and 29 foreign companies. Their major sources of funds are borrowing and shareholders' equity.

Mutual fund management companies

Mutual fund management companies are regulated by the SEC Act 1992 under the supervision of the Securities and Exchange Commission of Thailand. Mutual fund business has become significant since 1992 when the authorities granted permission for 7 new companies, thereby increasing the total to 8 mutual fund management companies. In 1996, there were 12 mutual fund management companies holding mutual fund management licenses.

Mutual fund investment projects include issuing investment units of each project for sale to the public and investing in securities and other assets or investing for profit by other means to diversify risks for mutual benefit. The variety of funds has been developed to cover both closed-end and open-end funds; each of these has different investments comprising equity funds, fixed income funds, or balanced funds.

Insurance companies

Insurance business in Thailand was first undertaken in 1929. Insurance companies play the important role of averaging the risks for the public, acting as financial intermediaries between savings and investments. They help finance economic development by accepting insurance premiums and using the funds to invest in the stock market. At present, insurance companies are regulated by the Ministry of Commerce under the Life Insurance Act 1992.

Table 2.8 shows that total assets of life insurance companies increased from 44 billion baht in 1990 to 145 Billion baht in 1996. According to Kripalani (1997), there were 67 general insurers in 1997, of which 42 had market share less than 1%. The poor performance of the Thai insurance industry has stemmed from a number of infrastructural problems. First, the number of people insured was relatively low: for example, in 1995 only 7% of the Thai population had a life insurance policy; this was partly due to poor income distribution in the Thai economy (Cutbill and Bloomfield, 1995). Second, there has been a limited range of new and innovative products and, thirdly, there is a shortage of skills and expertise (Ping, 1995).

Credit foncier companies

Credit foncier companies were established in 1958 under the supervision of the Bank of Thailand; they specialise in mortgage lending. Borrowing from financial institutions, and shareholders' equity are the main sources of funds for these institutions. Under the SEC Act 1992, credit foncier companies are required to maintain capital funds of 100 million baht. The total amount of loans, investment and obligations which each credit foncier company provides to any one person is limited to 40% of the company's capital funds. Table 2.8 shows that total assets of credit foncier companies increased from 4 billion baht in 1990 to 8 billion baht in 1996.

2.4 Commercial banks and economic development

A crucial condition for sustained economic growth is the effective mobilisation of financial resources to finance investment. The financial system, especially banks, performs a particularly important role in screening investment projects and relaxing budget constraints, thereby enabling deficit units to invest in excess of their current income. At the same time, banks impose budgetary discipline and monitor the activities of borrowing firms in order to help ensure that their investment target returns are achieved. This section reviews the theory and empirical evidence that relate commercial banks to economic development, discusses the development role of banks in Thailand, and explores the impact of the 1997 financial crisis on Thai commercial banks.

2.4.1 Theory and empirical evidence

A substantial theoretical literature analyses the role of financial intermediation as an important determinant of economic growth and identifies the respective channels of transmission from financial intermediation to growth. Early studies include the important work of Goldsmith (1969), McKinnon (1973) and Shaw (1973), who emphasised the role of financial intermediation in the credit supply process and concluded that there is a strong positive correlation between the extent of financial development and growth.

More recent studies, for example, Greenwood and Jovanovic (1990), highlight financial intermediaries' risk pooling and monitoring functions. They argue that financial intermediaries like banks could ensure higher expected rates of return to promote growth by pooling savings for diversified investment projects and by monitoring the behaviour of the borrowing firms. Bencivenga and Smith (1991) considered the liquidity management role of banks and concluded that financial intermediaries could reduce low return investment due to premature liquidation, and redirect funds into longer term, high yield projects, thereby leading to faster growth.

Empirical evidence on the impact of financial intermediation on real growth is provided by, for example, King and Levine (1993) who proposed a set of financial measures in order to capture the various services provided by financial intermediaries. These are:

- *The ratio of liquid liabilities of the financial system to GDP*: this measure approximates the intermediaries' role in overcoming market imperfections.
- *The ratio of deposit money bank domestic assets to deposit money bank domestic assets plus central bank domestic assets*: this measure indicates the importance of banks relative to the central bank.
- *The ratio of claims on the non-financial private sector to total domestic credit*: this measure indicates the proportion of credit allocated to private sector by the financial system.
- *The ratio of claims on the non-financial private sector to GDP*: this measure reflects the level of domestic asset distribution.

King and Levine (1993) found that their measures were positively correlated with real GDP growth rates after controlling for initial conditions, education, Government spending, inflation, political stability, and some other policy measures.

More recently, Johnston and Pazarbasioglu (1995) examined the simultaneous impact of financial sector variables on economic growth using panel data from 40 countries. Financial intermediation is hypothesised to affect economic growth through three main channels:

- *Real interest rate*: this indicator represents its role in financial savings and the cost of capital.
- *The volume of intermediation*: there are two proxies for the volume of financial intermediation through the banking system. First, the share of credit to the private sector by banks in GDP reflects the credit allocation role. Second, the share of M2 in GDP represents the deposit mobilisation role of financial intermediaries.
- *Efficiency of intermediation*: the spread between the average lending and deposit rates and the ratio of reserve money to deposits are used to proxy the efficiency of intermediation. These measures indicate the efficiency of the banking system in the allocation of credit.

Johnston and Pazarbasioglu (1995) found that financial sector variables appear to have been significant determinants of economic growth. Upward adjustments in real interest rates and increased financial intermediation are associated with improvement in economic performance, while the efficiency of financial systems apparently has an indirect but positive impact on growth.

Fry (1995) notes that financial systems in developing countries are typically dominated by commercial banks; other types of financial intermediaries are relatively small at these early stages of financial development. Commercial banks perform two major economic functions in almost all countries. First, they create money and administer the payment mechanism. Practically, a central bank or monetary authority issues currency, and depository institutions supply deposit money. Commercial banks administer a country's payments mechanism by providing currency notes of desired denominations and by transferring deposits upon instructions. Second, banks can increase the savings rate and reduce the cost of investment finance through specialisation and scale economies. In theory, savings rise with an increase in the net return on savings and investment increases with a decline in the real cost of borrowing. As banks become more efficient, the cost of intermediation falls, thereby reducing the difference between gross savings and lending rates. This implies that savers can achieve higher return on savings, and the real cost of borrowing for investors reduce. These developments should result in a greater volume of savings, investment and output growth. Hence, the efficiency of banks affects growth positively by influencing the cost of financial intermediation.

The possibility of increasing the level of bank efficiency and respective potential growth in the economy is often presented as an argument in favour of financial deregulation[8]. In the Single European Market study Cecchini (1988), for example, suggested that the removal of national legal and cross-border barriers, such as frontier controls and different technical standards, could promote the efficiency and competitiveness of EU banks through increased market size and heightened levels of competition. According to Cecchini (1988), the integration of European banking markets should have three primary categories of economic effects (Molyneux, Altunbas and Gardener, 1996, pp.38-39):

(a) The cost of financial intermediation declines as a result of exploiting economies of scale, scope and learning, brought about by the associated larger volume of financial output and by the restructuring process.

(b) The pressure of competition on prices (e.g. interest rates) should lead to a reduction in price cost margins and to incentives for banks to increase their technical efficiency by minimising their costs so as to maintain their margins. In effect, the process should reduce X-inefficiency[9].

(c) The non-price effect of banks being encouraged to improve their organisation and the quality and range of their products and services, and to engage in process and product innovation.

The combination of these effects is expected to increase the efficiency of banks, which brings about an expansion of investment and market size, and, in turn, increases the

[8] That is, the freeing up of financial institutions and markets to compete more freely.

[9] X-inefficiency refers to the difference between actual and minimum (maximum) costs (profits), reflecting managerial ability to control costs (maximise revenues).

output growth of the EU countries. Cecchini (1988) assumed that the completion of the EC internal market would converge the prices of financial products and services, which should be lower than the pre-integration prices in individual countries i.e. prices would fall to the levels of the lowest (most efficient) countries in the EU. Cecchini (1988) estimated that in the first six years after 1992, up to one-third of the future economic gains from deregulating and integrating (globalising) all economic sectors in the EU would flow (directly and indirectly) from the financial services sector. This is because the financial sector has the unique role of catalysing the economy as a whole. These economic gains comprise increased consumer surplus from the financial sector itself, the increased efficiency of those sectors, using the financial sector and improved macro policies facilitated through a more efficient financial sector.

2.4.2 Development role of banks in Thailand

Table 2.13 Commercial banks and economic development, 1990-96 (percent)

At the end of	1990	1991	1992	1993	1994	1995	1996	Average 1990-96
Bank deposits/GDP	65.1	69.0	71.1	75.4	74.6	76.2	77.1	72.6
Bank credit/GDP	80.5	82.5	86.6	95.1	109.1	117.1	115.9	98.1
Bank credit/domestic credit	88.8	90.7	92.3	94.0	94.5	93.9	94.2	92.6
Real deposit rate	8.0	4.8	4.4	3.6	4.1	4.4	2.6	4.6
Real lending rate	10.2	8.3	7.4	7.1	6.6	7.9	7.3	7.8
Interest spread	2.2	3.5	3.0	3.5	2.5	3.5	4.7	3.3

Notes: - Real deposit rate = 1 year deposit rate - inflation rate
- Real lending rate = Minimum Lending Rate - inflation rate
- Interest spread = Real lending rate – Real deposit rate
- Bank credit = Bills, loans and overdrafts of commercial banks

Sources: *Commercial banks in Thailand*, 1991-1997, Bangkok Bank *Annual Report*, 1991-1997, Bank of Thailand *Quarterly Bulletin*, December 1994-98.

Table 2.13 shows various ratios that reflect the developmental roles of banks. The ratio of bank deposits to GDP in Thailand, for example, increased from 65% in 1990 to 77% in 1996, while the ratio of bank credit to GDP increased from 80 % to 116% over the same period. The ratios of bank deposits to GDP were smaller than the bank credit to GDP ratios. This is due mainly to the decrease in real deposit rates, which limited the role of banks in deposit mobilisation. Meanwhile, the improvement in the ratio of bank credit to GDP indicates an increasing role of banks in credit allocation. In addition, the prominent role of bank finance is shown by the amount of bank credit, which accounted for about 90 % of total domestic credit.

The indicators of the efficiency of banks' intermediation, however, reflect a relative decline in efficiency. Table 2.13 shows that the real deposit rates decreased from 8% in 1990 to about 4% in 1993. This indicates the declining rate of return on savings. At the same time, the cost of borrowing declined, but to the lesser extent, resulting in a widened spread of interest rates. The efficiency of intermediation appeared to improve in 1994 when there was a reduction in the spread of interest rates reduced. However, the efficiency of banks' intermediation worsened further as the spread of interest rates rose to around 5% in 1996.

Table 2.14 The allocation of bank credit, 1990-96 (percent)

At the end of	1990	1991	1992	1993	1994	1995	1996	Average 1990-96
Agriculture	6.7	7.0	6.2	5.5	4.4	3.7	3.4	5.3
Mining	0.6	0.5	0.6	0.6	0.5	0.6	0.5	0.5
Manufacturing	25.1	25.3	23.7	24.0	24.2	25.8	27.1	25.0
Construction	4.0	4.0	4.1	3.8	4.1	4.4	4.9	4.2
Real estate	11.9	11.5	11.5	11.3	10.5	9.4	8.8	10.7
Imports	4.6	4.0	4.0	3.3	3.3	3.3	3.0	3.6
Exports	6.1	5.3	5.4	5.0	4.8	4.3	4.0	5.0
Wholesales and retail trade	17.6	17.4	17.0	17.7	18.2	17.8	17.9	17.7
Public utilities	1.7	1.7	1.9	2.3	2.5	2.5	2.9	2.3
Banking and finance	5.1	5.5	6.1	6.0	7.1	8.0	7.1	6.4
Services	6.1	6.8	7.3	7.8	7.8	7.9	7.8	7.3
Personal consumption	10.6	11.2	12.3	12.6	12.7	12.3	12.6	12.0
Total	100	100	100	100	100	100	100	100

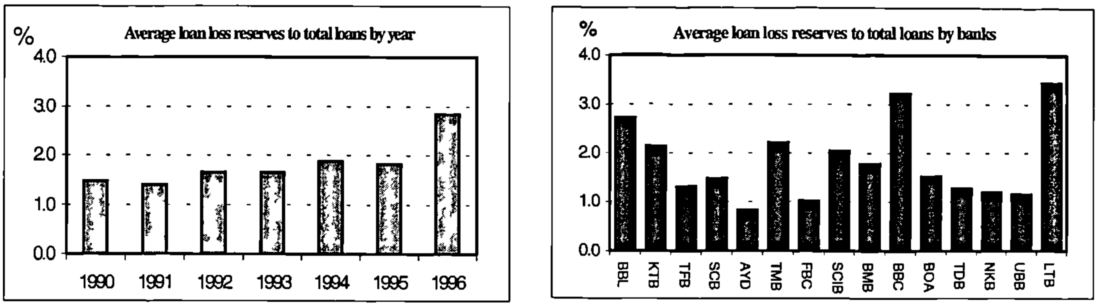
Source: Bank of Thailand *Quarterly Bulletin*, December 1997

The developmental role of banks in the Thai economy can also be seen from the allocation of bills, loans and overdrafts of commercial banks to each economic sector. Table 2.14 shows that during 1990 to 1996, bank lending was focused on four main areas: manufacturing, wholesale and retail trade, personal consumption, and the real estate sector, which together account for about 60% of the total. Table 2.14 also illustrates an increasing trend of credits to the banking and finance sector: from 5% to 7% of the total bank credits during the period.

The results shown in Tables 2.13 and 2.14 suggested that the role of banks in the Thai economy became increasingly important during 1990-96.

Next, it is interesting to examine the lending quality of Thai banks as they dominated the Thai banking sector (see, Table 2.6). This can be seen from the ratio of loan loss reserves to total loans, which measures credit risks according to the bank's actual losses or past due loans. Higher ratios indicate greater exposures of banks to credit risks and poorer quality of lending.

Figure 2.1 Average loan loss reserves to total loans of Thai banks, 1990-96



Note: Bank full names are shown in the list of acronyms.

Source: *Commercial banks in Thailand*, 1991-98.

Figure 2.1 shows that average loan loss reserves to total loans for 15 Thai banks markedly increased in 1996; two banks (BBC and LTB) had comparatively large ratios during 1990-96. This seems to be related to an increased intermediation of loans to the unproductive sectors such as personal consumption (see Table 2.14). Generally, these data suggest a decrease in the quality of lending of Thai banks on average.

In summary, there is evidence of an apparent increasing development role of banks in Thailand. The importance of banks in the Thai economy can be seen from an increase in the ratio of bank assets to GDP (see Table 2.7), bank deposits and bank credit to GDP (see Table 2.13). However, it is important to note that rapid growth of bank lending has also been found to be a crude measure of over-lending and incipient weaknesses in a banking system (Berg, 1999).

There is some evidence to suggest that the efficiency in intermediation, and lending quality of banks, decreased over 1990-96. The lending data imply some apparent risk-taking as banks built up their loan portfolios in cyclical sectors, such as real estate and personal consumption (see Table 2.14). Higher risk-taking was apparently supported by a strong incentive that stemmed from moral hazard due to an implicit, unlimited deposit insurance coverage and the expectation that no bank would be allowed to fail in case of financial crisis[10].

2.4.3 A note on the 1997 financial crisis

There is a growing consensus that the main cause of the financial crisis in Thailand was financial fragility, which involves four related aspects (Lane, 1999). First, many banks (especially banks with a BIBF license) had borrowed in foreign currencies and loaned in local currency without adequate hedging, thereby increasing the risk of currency depreciation. Second, many banks used short-term renewable credits from foreign banks to finance long-term loans and as a result, they were more exposed to liquidity risk because foreign loans were not renewed. Third, prices in equity and real estate markets had risen substantially before the crisis and therefore, the probability of deflation in asset prices increased. Fourth, there is some reason to believe that an increase in bank lending was not efficiently deployed. Berg (1999) found a large growth rate in bank lending to the private sector as a percentage of GDP from 1992 to 1996 and a low efficiency of investment during 1996-97. The deterioration in the quality of the Thai banking system was apparent when the Thai banking index fell by 92% from its peak in January 1994 to the onset of the crisis in July 1997.

Financial fragility reflected ineffective financial supervision and regulation in the context of the country's liberalisation of the banking sector (Lane, 1999). It is widely accepted that financial liberalisation and deregulation need to be accompanied by strong prudential supervision (see, for example, Fry, 1995). This is because financial liberalisation accompanied by the deregulation of the banking sector allows new areas for bank's business and new kinds of competition into the market. These developments could increase risks and pressures that might not be handled within the contemporary supervisory system. Adequate bank supervision, then, appears to be is one of the most effective means to reduce the incidence and severity of potential financial crises as Ebert (1998) notes:

[10] There was no explicit deposit insurance scheme. The Government implicitly acknowledged that no bank would be allowed to fail.

> The prudential supervision of banks is one of the most effective means to prevent the onset of a financial crisis in emerging economies. Because banks play such an integral financial intermediary role in emerging economies, the collapse of the banking sector can precipitate the demise of the entire financial system.

An example of deficiencies in prudential supervision in the Thai banking system can be illustrated by the response of the Bank of Thailand to the discovery in 1997 that the Bangkok Bank of Commerce (BBC) had 47% of its assets as low quality. Instead of ordering BBC to reduce its capital to write off part of the losses, the Bank of Thailand provided 100 billion baht to BBC to improve its financial position (Corrie, 1998). This indicates that deregulation of the Thai banking sector was not accompanied by appropriate supervision and re-regulation of financial institutions. Without the latter, financial discipline by banks was apparently compromised. Moral hazard and governance issues were apparent problems in bank lending and risk-taking.

Another important factor that led to the 1997 banking crisis in Thailand was the foreign exchange and exchange rate policies. A combination of an open capital account and a currency peg between 1990 and 1996 reduced the effectiveness of monetary policy in handling the surge of capital inflows. In addition, an alternative policy, targeting interest rates, led not only to a decline in net foreign assets but also to an increase in external debt. For instance, a reduction in real deposit rates from 8% in 1990 to about 4% in 1993 (see Table 2.13) reduced the annual change in net foreign assets as a percentage of broad money from 3.8% to 0.1% over the same period (see Table 2.3). Meanwhile, an increase in real lending rates from 7% in 1993 to 8% in 1995 (see Table 2.13) raised the ratio of external debt to GDP from 36% to 49% over the same period (see Table 2.2). A decline in net foreign assets and growth in external debt, in effect, deteriorated the country's financial credibility, which subsequently led to the financial crisis in 1997.

Table 2.15 shows the effects of the 1997 financial crisis in Thailand. In the macroeconomy, GDP growth declined to -0.4% while the unemployment rate rose to 3.5% in 1997 from 2% in 1996. These features were the result of a substantial decline in the balance of payments as a percentage of GDP from 1.2% in 1996 to –6.2% in 1997. Meanwhile, the ratio of external debt to GDP rose from 50% in 1996 to 64% in 1997. It appears that an increase in real deposit rates did not improve net foreign assets since the mid-rate of the baht/US dollar increased substantially. On the other hand, an increase in real lending rates from 7.3% in 1996 to 9.6% in 1997 markedly raised the external debt.

Table 2.15 The effects of the 1997 financial crisis

	1990-92	1993-95	1996	1997
Macroeconomic indicators				
GDP growth (%)	9.4	8.7	5.5	-0.4
Inflation (%)	5.3	4.8	5.9	5.6
Unemployment (%)	3.3	2.3	2.0	3.5
External debt (%of GDP)	32.1	40.9	49.9	64.3
Balance of payment (%of GDP)	3.8	3.4	1.2	-6.2
Monetary indicators				
Annual change as a percentage of broad money (%)				
– net foreign assets	3.7	-5.0	-2.2	-9.6
– domestic credits	19.8	24.7	16.8	33.2
Share in total domestic credit (%)				
– Government sector	7.5	2.3	1.1	0.71
– private sector	85.1	89.7	90.9	85.4
Real deposit rate (%)	5.7	4.0	2.6	5.9
Real lending rate (%)	8.6	7.2	7.3	9.6
Mid-rate (Baht/US$)	25.5	25.5	25.3	31.4
M2(% change)	20.7	16.1	12.6	16.4
M1/M2 (%)	12.2	11.9	11.4	9.88
Money market indicators				
Interbank lending rate (%)	12.7	10.6	11.4	21.7
Interbank borrowing (%change)	10.4	69.1	13.9	-15.8
Repurchase rate (%)	8.8	7.3	9	22.4
Government bond (%change)	-14.3	-24.8	-67.9	-23.8
Capital market indicators				
No. of listed companies	270	435	454	431
SET index (1975=100)	739	1441	831	372
Trading volume (billion baht)	1093	1950	1303	929
Average daily turnover (billion baht)	7.5	7.9	5.3	3.7
Market capitalisation (% of GDP)	39.2	94.3	54.5	23.5
Average financial ratios of Thai banks (%)				
Return on assets (ROA)	0.8	1.3	1.1	-2.9
Loan loss reserve/total loans	1.6	1.8	2.8	4.3
Equity/total assets	6.6	7.5	8.9	4.8

Notes: Real deposit rate = 1year deposit rate – inflation rate. Real lending rate = Minimum lending rate – inflation rate. Mid-rate refers to an annual average rate of buying and selling US dollar, while interbank rate and repurchase rate are shown in average figures.

Sources: Tables 2.2, 2.3, 2.4 & 2.13, Bank of Thailand *Quarterly Bulletin*, December 1998.

In the money market, an increase in the interbank lending rate in 1997 led to a substantial decline in interbank borrowing. Meanwhile, a marked increase in the repurchase rate from 9% in 1996 to 22% in 1997 did not increase the amount of Government bonds. Table 2.15 shows that there was a substantial decline in capital market indicators in 1997. For instance, trading volume fell from 1303 billion baht in 1996 to 929 billion baht in 1997, while average daily turnover declined from 5.3 billion baht to 3.7 billion baht over the same period.

Table 2.15 also shows a decline in the average performance of Thai banks in 1997. Bank profitability, as measured by average ROA, declined to –3% in 1997. There was an increased credit risk, on average, as measured by the ratio of loan loss reserves to total loans. These adverse features resulted in a discernible decline in the average capital of Thai banks in 1997.

Overall, it appears that the 1997 financial crisis has largely been a consequence of excessive bank lending, increasing credit risks, and the weakening of the monetary and supervisory frameworks in which capital inflows were not monitored (particularly the type and maturity of borrowings). The Government policies during 1990-96 were inadequate for three reasons. The authorities failed to see the need to tighten prudential bank regulation, deposit insurance was not introduced and monetary conditions were not tightened sufficiently and in a timely manner. In theory, adequate bank supervision and a system of deposit insurance should help to ensure a robust and liquid financial system, while a more flexible exchange rate regime should prove a sustainable condition: see, for example, Drage and Mann (1999) and Lane (1999).

Soon after the beginning of the crisis, the Government responded by taking measures to reassert the stability of the financial system. The restructuring programme included adopting a managed floating exchange rate policy, reducing the liquidity requirement ratio for commercial banks from 7 to 6 percent of total deposits, imposing temporary ceilings on interest rates, and issuing guidelines for mergers and acquisitions. In August 1997, the IMF approved financial support under the Fund's adjustment programme, which emphasised broad-ranging structural reforms of the financial and corporate sectors, competition and governance policies[11]. Under the IMF restructuring program, the authorities have become increasingly concerned with improving prudential regulation and making the banks become more market-oriented.

[11] Complementary structural policies included, for instance, the closure of insolvent financial institutions, together with recapitalisation and mergers of others; measures to strengthen prudential regulations (loan classification, provisioning requirements, and capital adequacy standards); the liberalisation of foreign investment in management of banks; and the introduction of deposit insurance scheme. Detailed information on these policies can be found in Kochhar, Oungani, and Stone (1998).

2.5 Conclusion

This chapter analysed the nature of economic policy and the financial services industry in Thailand between 1990 and 1996. It presents evidence of the important role of commercial banks within the changing structure of the financial system in Thailand. Two points can be highlighted with regard to economic policy in 1990-96. First, tight monetary policy did not impose constraints on private sector activity, largely because the credit squeeze was concentrated on the public sector. The expansion of credit to the private sector, together with tax reform measures, increased the pressure on domestic demand. Second, a liberalising capital account worsened the external position of the Thai economy through the resultant influx of foreign capital and the ineffectiveness of the fixed exchange rate arrangement. In addition, reserve requirements on new short-term foreign liabilities were an ineffective tool for sterilising capital inflows as they imposed a distortion in the banking system by increasing the spread between deposit and lending rates. The analysis of financial development suggests an apparently limited financial intermediation role of commercial banks.

Finally, it has been suggested that the efficiency of financial institutions could increase the volume of savings and investment which is apparently an important source of sustainable growth. The literature on financial liberalisation and deregulation argues that a more deregulated financial system should improve bank efficiency through incentives such as greater bank micro-level efficiency, thereby facilitating a more efficient macro-level allocation of resources. The next chapter will explore in greater detail the importance of financial liberalisation and its impact on the structure of commercial banks.

Chapter 3 Financial Liberalisation and Deregulation in Thailand

INTRODUCTION

This chapter explores the theory and practice of financial liberalisation, and the respective experiences of Thailand. The process of financial liberalisation includes the freeing up of exchange and interest rate controls, foreign bank entry and the structure and conduct deregulation of financial services, especially the banking sector. The latter deregulation is accompanied by a supervisory (or prudential) re-regulation of banking and credit institutions that is widely accepted as a necessary condition to help capture the economic gains sought via deregulation. It is generally argued that a more liberalised (deregulated) banking system *ceteris paribus* is a fundamental condition for the more efficient allocation of savings and investment (see, for example, McKinnon, 1973 and Shaw, 1973).

The purpose of this chapter is to explore the importance of financial deregulation that takes place within the wider liberalisation of the financial sector. The chapter begins (Section 1) with a discussion of the definition and theory of financial liberalisation, the practical features of a successful financial liberalisation, and the relevant experience of those countries that have liberalised their financial sectors. We then explore the link between financial deregulation and the efficiency of the banking sector. Section 2 outlines the process of financial liberalisation in Thailand, while Section 3 examines the impact of deregulation on the structure of commercial banks, both Thai and foreign banks operating in Thailand. Section 4 concludes the chapter.

3.1 Financial liberalisation: theoretical and policy perspectives

Financial liberalisation can apparently have a major beneficial impact on the efficiency of financial intermediation and economic growth. This section explores, first, the definition and theory of financial liberalisation and, second, the practical features of a successful financial liberalisation and the relevant comparative experiences of countries that have implemented this policy. Finally, the links between financial liberalisation and the efficiency of the banking sector are discussed.

3.1.1 Global movement towards financial liberalisation

In recent decades, many countries have moved towards liberalisation of their financial systems: examples include Korea, Thailand, Malaysia, Indonesia, Argentina, Chile and the Philippines. These countries eased or lifted bank interest rate ceilings, lowered compulsory reserve requirements and entry barriers, reduced government interference in credit allocation decisions, and privatised banks and other financial institutions. In addition, they promoted the development of domestic stock markets and encouraged the entry of foreign financial institutions.

In general, the trend towards financial liberalisation is part of a broader movement towards reduced direct intervention of the state in the economy. This movement was strongly advocated by the influential work of McKinnon (1973) and Shaw (1973), who argued that financial repression, by forcing financial institutions to pay low or negative real interest rates, reduced private financial savings, thereby decreasing the resources available to finance capital accumulation. From this perspective, McKinnon (1973) and Shaw (1973) proposed that a country should stimulate domestic savings and economic growth and reduce its dependence on foreign capital flows through financial liberalisation. Their argument was based on the assumption that financial development facilitates economic growth. Since the 1970s, the financial liberalisation approach has received considerable practical attention and the policy implications of this model have been widely acknowledged in political circles, the IMF and The World Bank.

3.1.2 Definition and theory of financial liberalisation

The term "financial liberalisation" is generally used to describe the freeing up of interest rate controls, exchange and capital controls, the entry of foreign banks, deregulation of financial services (especially the banking sector) and the kind of supervisory re-regulation that is apparently needed to accompany bank deregulation (see, for example, Tseng and Corker, 1991 and Dekle and Pradhan, 1997). The objectives of financial liberalisation are to increase competition and efficiency in the financial system, strengthen the supervisory framework, and promote the growth of the financial sector. This process, in its turn, is designed *inter alia* to improve the efficiency and raise the investment levels of real economic sectors who use financial services. At the same time, a more efficient and resilient financial sector should improve monetary and credit policies.

The theory of financial liberalisation is strongly influenced by McKinnon (1973) and Shaw (1973), who argued that rising real interest rates induce more savings and investment and, therefore, act as a positive stimulus to economic growth. In this model, a positive real rate of interest encourages savings and thereby increases the availability of loanable funds. This expands investment, which in turn leads to greater economic growth.

To illustrate the point, McKinnon (1973) developed a model of an economy with an underdeveloped financial market, in which investors must accumulate money balances before undertaking investment. Practically, if returns on financial assets are higher, the greater will be the accumulation of money balances and the larger will be the incentive to invest. Thus, liberal financial policies (especially interest rate liberalisation) encourage economic growth through the positive impact of the complementarity of financial assets and physical capital. This complementarity is given in the following function of the demand for money (Fry, 1995, p.27):

$$M / P = f(Y, I / Y, d - \pi^{e}) \tag{3.1}$$

Where M is the money stock (M_2), P is the price level, Y is the real GDP, I/Y is the ratio of gross investment to GDP, and $d-\pi^e$ is the real deposit rate of interest.

Like McKinnon (1973), Shaw (1973) underlined the benefits of an efficient and well-functioning financial system that helps to improve the level of per capita income. In Shaw's analysis, there will be efficiency gains in the intermediation process if more individuals hold their financial assets with banks. In theory, efficiency of financial intermediaries could be achieved by accommodating liquidity preferences, reducing risk through diversification, reaping economies of scale in lending, increasing operational efficiency, and lowering information costs to both savers and investors through the specialisation and division of labour.

Shaw (1973) argued that increased institutionalisation of savings could increase the real return to savers and at the same time reduce the costs of lending for investors. This development, in turn, increases the efficiency of investment and, hence, economic growth. Shaw's debt-intermediation money model can be characterised as the following function for the demand for money (Fry, 1995, p.29):

$$M / P = f(Y, v, d - \pi^{e}) \tag{3.2}$$

Where v is the vector of opportunity costs in real terms of holding money that have a positive effect on the savings ratio. This implies that higher real interest rates could improve the intermediation role of financial institutions. In principle, the theory of financial liberalisation envisages the withdrawal of controls on international asset trade together with the removal of price and quantity rationing in domestic financial intermediation.

Analyses of the superiority of financial liberalisation by McKinnon (1973) and Shaw (1973) initiated policy measures which have been followed by many countries under the auspices of international institutions like the World Bank and IMF. Examples of countries that have implemented financial liberalisation include Korea, Sri Lanka, Thailand, the Philippines, Malaysia, Indonesia, Turkey, Argentina, Chile, and Uruguay.

Financial liberalisation is basically aimed at relaxing the liquidity constraints on the investment of the private sector. *A priori* financial liberalisation should allow the interest rate on deposits to find its market-clearing level and lead to an increased supply of credit to finance investment. As outlined previously, the important practical measures of financial liberalisation are the abolition of interest rate ceilings, the relaxation of restriction on banking activities and entry of foreign banks, the relaxation of foreign exchange controls, and the strengthening of supervisory regulation. The implementation of these polices is expected to increase the volume of financial savings and improve the efficiency of financial institutions.

There exists substantial empirical evidence to support the theory of financial liberalisation (see, Fry, 1995 for a review). For example, the World Bank (1989) examined a sample of 34 developing countries over the period 1974-1985, and found that economic growth in those countries with strongly negative real deposit rates was substantially lower than growth in countries in countries with positive real interest rates. Khan and Villanueva (1991) estimated the effects of real interest rates on growth for 23 developing countries over the period 1975-87 and found a significant direct positive effect of the real interest rate on per capita growth.

The postulated link between financial and economic growth was subsequently strengthened by the prominent work of King and Levine (1993), who investigated 77 developing countries over the period 1960-1989, using bivariate regressions of four financial and four growth indicators. They found that each financial indicator was positively and significantly correlated with each growth indicator at the 99 percent confidence level.

A later study by Fry (1995) examined the effect of real interest rates on the level of savings, using a sample of 14 Asian countries over the period 1961-1981. He concluded that the real interest rate had no direct effect on the level of savings, but could have an indirect effect by increasing the rate of economic growth. Using the same data, Fry (1995) also found that, on average, a 1 percent increase in the real deposit rate increased the demand for financial assets by 0.8 percent in the short run and 1.4 percent in the long run. In addition, a 10 percent increase in the real deposits rate raised the ratio of financial assets to GDP by 4.4 to 6.6 percent and increased the ratio of national saving to GNP by about 1 percent. All of this kind of empirical evidence appears to support the argument that positive interest rate policies may stimulate output growth through the intermediation of financial asset accumulation.

3.1.3 Features of successful financial liberalisation

There are many countries that have implemented financial liberalisation, but failed to achieve the positive results outlined above. Examples include Argentina, Chile and Uruguay, where financial liberalisation was implemented in the presence of strong inflationary pressures and substantial external deficits. In addition, government controls were abruptly removed despite the fact that there was no deposit insurance and bank supervision was inadequate (see, for example, Diaz-Alejandro, 1985, Alawode and Ikhide, 1997).

In theory, financial liberalisation requires prerequisites, and its timing, sequencing and speed of implementation are also important in practice in order to achieve a successful outcome.

(1) Prerequisites for successful financial liberalisation. Fry (1995, 1997) notes that there are five prerequisites for successful financial liberalisation:

- *Adequate prudential regulation and supervision of commercial banks.* The implementation of financial liberalisation normally increases freedom of entry into the financial sector, and freedom to bid for funds via interest rates and new financial instruments. This, in turn, could lead to excessive risk-taking of financial institutions, especially during the transition phase of a financial liberalisation as new opportunities are exploited. Fry (1997) emphasised that a greater degree of financial liberalisation should be accompanied by a more strict supervisory (prudential regulatory) framework in order to ensure the stability of the banking and financial system.
- *A reasonable degree of price stability*: the success of monetary policy depends on consistent price stability. Fry (1995) suggested that the appropriate average rate of

growth in the money supply should vary from year to year within a moderate range of 5 percentage points.

- *Fiscal discipline*: it is important that governments reduce their borrowing requirements and increase fiscal targets via open market operations in order to reduce price instability and inflationary monetary policy.
- *The competitive behaviour of commercial banks.* In many developing countries, commercial banks are the key institutions involved in the process of financial liberalisation as they invariably dominate the financial sector. It is important that banking markets are competitive and efficient in order to increase savings, investment, and, hence, economic growth.
- *Non-discriminatory taxes on financial intermediation.* A discriminatory tax on financial intermediation, such as reserve requirements, should be reduced or abolished, because it raises an opportunity cost in the form of interest that banks could otherwise earn on these assets. On the other hand, non-discriminatory taxes may help to increase (or at least not reduce) competition in financial markets.

(2) Timing of financial liberalisation. Financial liberalisation is generally implemented within a country's respective economic adjustment programme. Therefore, the timing of liberalisation measures needs to be consistent with economic adjustment (see, for example, Alawode and Ikhide, 1997). There is a growing consensus that macroeconomic stability should precede financial liberalisation. In particular, there should be, firstly, substantial reductions in the size of fiscal deficits and in the rate of monetary growth so as to lessen inflationary expectations. Second, the strengthening of bank supervision is vital for macroeconomic stability in order to reduce moral hazard, adverse selection and high-risk incentives of banks. Finally, the liberalisation of the domestic financial sector should precede the liberalisation of the external sector (such as exchange and capital controls); this is to ensure that domestic banks are fully adapted to compete with international financial institutions (see, Galbis, 1994). A stable and resilient banking sector is itself widely recognised nowadays as a necessary condition for sustained macroeconomic stability.

(3) Sequencing of financial liberalisation. The appropriate sequencing of financial liberalisation is essential in order to avoid adverse consequences for macroeconomic stability (see, for example, Khatkhate, 1998). It is important to ensure that indirect monetary techniques are well established before credit controls are removed. Meanwhile, a measure such as prior reinforcement of bank prudential regulation and supervision can prevent banks from taking unnecessary risks as they adapt to a new and developing deregulated and competitive environment.

(4) Speed of financial liberalisation: the pace at which the financial system is liberalised is a vital practical policy issue. It is generally inappropriate to adopt the "big bang" approach if financial institutions are accustomed to operating within an environment of tight government intervention and extensive controls. Under these circumstances, Alawode and Ikhide (1997), for example, argue that there is a need to liberalise gradually so that institutions and markets can adjust more easily to the new deregulated environment. For example, the removal of interest rate ceilings should be progressive, initially involving frequent incremental adjustments in regulated rates. Credit controls should also be eased gradually over an extended period of time. As expectations towards more deregulation are formed and practical experiences within a deregulating environment are accumulated, liberalisation and deregulation can be correspondingly accelerated. In this general connection, the EC Single Market Programme experiences support this kind of policy scenario. On the one hand, liberalisation and deregulation require a positive, firm and transparent commitment by government. At the same time, there must be a significant change. But attempting a "big bang" approach *ab initio* can be problematic and may lead to systematic risks. The latter potential is likely to be heightened in a developing country.

3.1.4 Comparative experiences

Since the 1970s, financial liberalisation has been implemented with a varying degree of success in many countries. The countries cited as most successful - at least until the

South East Asian banking crisis erupted in 1997 - are Korea, Indonesia, Malaysia and Thailand. On the other hand, countries like Chile, Argentina and the Philippines have been generally categorised as less successful (see Khatkhate, 1998).

According to Dekle and Pradhan (1997), financial liberalisation can be classified into five categories:

- *The liberalisation of interest rates*: include the relaxation or the abolition of controls on both deposit and lending rates.
- *Bank deregulation and increased competition*: include the relaxation or the removal of entry requirements and the permitting of new banking activities.
- *Financial market development*: include the introduction of new financial instruments and institutions in the stock markets, the improvement of market infrastructure and supervision, the abolition or relaxation of duties and fees in money markets, and the establishment of credit rating agencies.
- *The strengthening of prudential regulation and supervision*: include the imposition of the Basle (or BIS) standards of capital adequacy on banks.
- *The openness of the capital account*: include the relaxation or the removal of controls on capital inflows and outflows, and foreign exchange controls.

Table 3.1 shows the chronology of financial liberalisation in eight countries using the above classifications.

Table 3.1 Timing of financial liberalisation

	Liberalisation of interest rates	Bank deregulation and increased competition	Financial market development	Strengthening of prudential regulation and supervision	Capital account liberalisation
Singapore	1975	Late 1960s	1975	Early 1990s	1978
Korea	1992	1981-83	1987	1984-96	1988
Malaysia	1978-91	1985-89	1979-90	1989	1970s
Thailand	1989-92	1985-93	1992	Early 1990s	1970s, 1991-96
Indonesia	1983	1983-88	1984-85	Early 1990s	Late 1960s
The Philippines	1980-83	1980-84	1981-85	1986	1984
Argentina	1976	1976	1976-84	1976-81	1976-82
Chile	1979	1979-96	1979-96	1979-94	1979-96

Sources: Dekle and Pradhan (1997), Khatkhate (1998).

Bank deregulation took place earliest (see, Table 3.1) in Singapore. The success of financial liberalisation in Singapore mainly reflected its strong monetary policy and the stabilisation of the nominal exchange rate (Dekle and Pradhan, 1997). It began with the deregulation and increased competition of the banking sector, followed by the liberalisation of interest rates and the development of the financial markets. All foreign exchange controls were abolished in 1978, while the Basle 1988 guidelines on bank capital adequacy were adopted in the early 1990s.

Korea's financial liberalisation was part of a broader economic adjustment policy. The success of Korea's financial liberalisation was influenced strongly by the strengthening of its bank supervision. The pace of financial liberalisation was gradual: interest rates were adjusted upward in 1979 to yield positive real interest rates, while all preferential lending rates were abolished in 1982. The real deregulation of interest rates was initiated after 1992 when measures to broaden money and capital market developments were intensified. Meanwhile, liberalisation of the capital account took place gradually after 1988, taking due account of the country's balance of payments position.

Malaysia had a relatively less repressed financial system than most of the other countries in Table 3.1 (Khatkhate, 1998). As a consequence, financial liberalisation measures were relatively uncomplicated. The major changes were the removal of direct credit in 1988 and the development of the money and capital markets. The successful financial liberalisation of Malaysia relied on a well-functioning financial regulatory and supervisory framework.

Thailand's financial liberalisation differed from the above three countries. The capital account was initially liberalised in the 1970s, when foreign direct investment, portfolio investments and foreign borrowing were allowed, although controls on capital outflows were subsequently and gradually liberalised. Interest rate and credit controls were relaxed, while bank supervision was improved in the 1990s. The success of financial liberalisation in Thailand (up until 1997), therefore, depended mainly on the relaxation of barriers to entry.

In contrast, financial liberalisation in Indonesia did not initially ease barriers to entry until after 1988, when restrictions on banks and non-banks to establish branches were relaxed. Financial liberalisation was initiated by the elimination of ceilings on bank credit, the deregulation of the State banks' interest rates, and the introduction of rediscount facilities and money market instruments. Capital account liberalisation was regarded as a final measure, which was effected after 1985 in a gradual process.

The Philippines was the only country in South East Asia that experienced a financial crisis immediately following financial liberalisation (Dekle and Pradhan, 1997). The crisis was brought about by the adverse macroeconomic impacts of the second oil shock at the end of the 1970s, and subsequently by a political turmoil, the deterioration of the balance of payments and the excessive credit expansion following financial deregulation.

The failure of financial liberalisation in Chile was linked to the oligopolistic structure of the banking system, which continued to lend at high interest rates (Khatkhate, 1998). As a result, bad loans and doubtful debts mushroomed. Meanwhile, the failure of financial liberalisation in Argentina was mainly related to the riskiness of lending and distress borrowing.

The similar pattern of financial liberalisation in the Philippines, Argentina and Chile reflects the fact that most of their policies were initiated at the same time (see Table 3.1). The common features of failure of financial liberalisation in these countries were macroeconomic instability, uncompetitive and undeveloped financial systems and the lack of adequate prudential controls and deposit insurance.

It can be concluded from this survey that financial liberalisation requires a timing of relevant policy measures and this timing varies according to the characteristics specific to each country. Practical policy experiences suggest that financial liberalisation should be preceded by reforms in the real sector, together with consistent macroeconomic policies on exchange rate, fiscal and monetary adjustments. The preconditions for financial sector liberalisation are macroeconomic stability and the adequacy of bank supervision and prudential rules. Meanwhile, the preconditions for capital account convertibility are successful liberalisation of the internal financial sector and well-established bank supervisory regulations. These are clear policy lessons and they can be stated in quite simple terms. Applying them in practice, of course, is not so straightforward and simple. Nevertheless, they are important lessons from practical experiences and should be used to help inform policy.

3.1.5 Financial liberalisation and efficiency of the banking sector

It is argued that the banking sector could benefit from financial liberalisation through the deregulation process that reduces the government's direct control over the financial industry. Banking deregulation comprise the freeing up of bank structure and conduct rules and the re-regulation of bank supervision (see, for example, European Commission, 1997).

Structure rules cover areas like the functional separation of institutions and entry restrictions; conduct rules encompass *inter alia* regulations of banks' deposit and lending rates, regulations of fees and commissions, credit quotas and branching limitations. Deregulation is generally (and in the present thesis) taken to refer to the freeing up or liberalising (easing) of these kinds of structure and conduct rules in banking. Supervisory (or prudential) rules encompass the capital adequacy ratio and other bank regulations such as deposit insurance, discount window, solvency ratios, ownership, asset concentration and information disclosure. These three different kinds of banking regulation are also summarised in Chapter 1 (see, Table 1.1, Section 1.1).

Deregulation is motivated by the desire (target) to improve bank operating performance *via* increased competition. In such circumstances, deregulation is expected to enhance the productive efficiency and capital allocation efficiency of the banking firm. The potential benefits of bank deregulation are confirmed, for example, from comprehensive research spanning more than a decade on the Single Market Programme (SMP) and the impact of the new, developing European financial and monetary environment on bank strategies. These studies include Cecchini (1988), European Commission (1997) and Gardener *et al.* (1998). The EU experiences also encompass financial sectors that were highly deregulated and efficient (like the UK) to ones that were much less so (like Portugal and Greece).

Cecchini (1988) envisaged deregulation as a kind of supply-side shock to the system in which price reductions and output increases stimulate demand, which in turn leads to further price reductions and output increases. Deregulation is expected to enhance the efficiency of banks in three ways. First, banks should lower their input costs as the industry comes under the pressure of more competitive markets. Second, banks become more responsive to competition and related innovation demands as the size of the markets increases. Finally, banks are able to regain technological leadership from increased innovation, new business processes and products. The EC's 1988 Cecchini study predicted that up to one-third of the total economic gains from the SMP during the first six years after 1992 would come directly or indirectly from the deregulation of the financial services sector (banking, insurance and securities firms). The Cecchini (1988) study was an *ex ante* simulation exercise.

A later *ex post* empirical study by the EC (1997) found that EU banks became significantly more competitive during the late 1980s and into the early 1990s. The study focused on the simultaneous effects of structure and conduct rules deregulation and the concomitant re-regulation of prudential rules (especially capital adequacy) and horizontal rules such as anti-trust and competition policy, labour markets and employment regulations. The EC (1997) study found that there was an increase in bank concern with productive efficiency (improved cost management), a greater strategic priority towards internal capital allocation and risk management, and more concern with shareholder value targets within banks.

Gardener *et al.* (1998) suggests that one of the most important impacts of the more competitive environment facilitated by the SMP is to incentivise banks to improve their overall efficiency. The kind of (structure and conduct rules) deregulation and (supervisory) re-regulation process within the SMP had important effects on bank decision-making and strategy. Deregulation of bank structure and conduct rules intensifies competition, which in turn is argued to lead to price falls, convergence of prices and margins, increases in output, innovation and exploitation of economies of scale and scope, a greater pressures on banks to be more efficient, a generally greater role of the market in bank resource allocation and a greater incentive to allocate capital more efficiently. In practice, empirically validating these predictions is not easy. One problem (as we have seen and argued), is that deregulation and supervisory re-regulation typically occur together. Both have potential countervailing effects on key variables like bank prices, margins and profit levels.

Parallel to the process of deregulation of bank structure and conduct rules, the re-regulation of supervisory rules improves risk management, and leads to increases in bank compliance costs, the relative cost of bank intermediation as well as attempted bank innovation of ways around (to avoid) regulation. It also leads to greater pressures on banks to price for risk, to balance risks and returns, and to allocate their own internal capital adequacy more efficiently.

It can be concluded that the major benefit of deregulation is to improve bank efficiency, both productive and risk and return (internal capital allocation efficiency). In this world, shareholder wealth maximisation and a greater role of the external market in bank resource allocation assume a higher practical prominence.

3.2 Thailand and financial liberalisation

This section explores the process of financial liberalisation in Thailand. We discuss first, the build-up to financial liberalisation and, second, the launch of financial liberalisation.

3.2.1 The build-up to financial liberalisation

The Thai banking system was characterised by a relatively high degree of government control and restrictions until the early 1980s, when the initial financial liberalisation programme took place (Okuda and Mieno, 1999). The measures adopted were primarily implemented in response to specific problems. These involved the introduction of laws empowering the authorities to vary the ceilings on interest rates offered by commercial banks and finance companies, the introduction of the repurchase market for government bonds, and measures to restore the stability of failing financial institutions. In common with other developing countries, banks were considered as the key strategic drivers for economic development. However, they were prohibited from competition, which constrained their ability to keep pace with the country's fast growing economy. The most obvious sign of weakness was the widening gap between savings and investment and the chronic shortage of medium- to long-term finance as well as the pre-liberalisation constraints on increasing bank capital (Sargent, 1989).

There was a broad consensus among policymakers concerning the liberalisation of the Thai financial sector in the late 1980s (see, for example, Supinit (1990), Shreeve (1990) and Thanachanan (1990)). Their main strategic focus rested on building a financial system that could provide a broader array of more efficient services at lower cost, and to promote savings mobilisation and the efficient allocation of resources. Another important consideration of financial liberalisation was the need to prepare Thai financial institutions to be competitive internationally as part of the opening up of trade in financial services under the Uruguay Round negotiations. The stability of the financial system was recognised to be crucial to the further growth of the Thai economy where most investment projects would be undertaken by the private sector based on the market mechanism without direct government intervention or aid.

Since 1990, the process of financial liberalisation has been implemented in the three-year financial development plan as part of Thailand's overall economic programme. The objectives were to reduce direct government intervention and strengthen the role of market forces in the allocation of financial resources, improve the capacity of financial institutions to mobilise domestic savings, promote competition among banks, and strengthen their financial soundness (see, Nijathaworn, 1995). In addition, recognising the increasing globalisation of financial and capital markets, the authorities sought to internationalise Thai financial institutions with a view to developing Thailand into a regional financial centre.

3.2.2 Launch of financial liberalisation

The implementation of financial liberalisation in Thailand has been a gradual, phased, and continuing process. Liberalisation measures were incorporated in the three-year financial development plan.

The first Financial System Development plan (1990-92) was introduced with a view to increasing competition and efficiency in the banking system. The measures included the abolition of interest rate ceilings, the relaxation of capital and foreign exchange controls, and the expansion of financial services of banks and other financial institutions.

The second Financial System Development plan (1993-95) aimed at increasing domestic savings and developing Thailand into a regional financial centre. The measures included the strengthening of bank supervision, the relaxation of reserve requirements and entry barriers, and the further relaxation of capital and foreign exchange controls.

The third Financial System Development plan (1996-98) was designed to strengthen bank supervision and to develop financial infrastructure. The measures included reinforcement of the supervisory framework and the further relaxation of barriers to entry and foreign exchange controls.

Table 3.2 provides an illustration of the major changes in the Thai banking system from 1990 to 1997. The liberalisation has been a gradual process, starting with the deregulation of interest rates, the relaxation of foreign exchange controls, the improvement of capital adequacy and, then, the entry of foreign banks. This process did not reflect the apparent features of previous successful liberalisation in other countries, which suggests that liberalisation of the domestic financial sector should precede liberalisation of the external sector, like exchange and capital controls, while strong bank supervision should be established prior to the liberalisation of interest rates and bank credit. As a result, the potential was enhanced and that the Thai banking sector would become exposed to more risks as it adapted to a new deregulated and more competitive environment.

Table 3.2 shows that the 1990-97 financial liberalisation entailed both deregulation and re-regulation of the Thai banking sector. For example, the abolition of interest rate controls is a kind of deregulation of bank conduct rules. The expansion of financial activities for commercial banks and other non-bank credit institutions is a kind of deregulation of structure rules. Contemporaneously, there was a re-regulation of bank supervisory rules in line with the Basle 1988 standard for capital adequacy.

Table 3.2 Chronology of major financial liberalisation, 1990-97

Date	Events
June 1989	The interest rate ceiling on time deposits with a maturity of more than one year was lifted. Abolition of interest rate on time deposits with a maturity of one year or less.
March 1990	Acceptance of the IMF Article VIII, agreement regarding a relaxation of foreign exchange controls. All current account transactions are liberalised.
May 1990	Second-stage of liberalising foreign exchange controls, including a relaxation of capital outflows.
April 1991	Removal of interest rate ceiling on saving deposits.
January 1992	Expansion of financial service activities of commercial banks, finance companies and securities companies, based on the Securities and Exchange Act 1992.
March 1992	Ceilings on all lending rates are abolished, but minimum lending rates are maintained as the BOT guidelines.
June 1992	Adopting the Basle standard for commercial banks. Thai banks are subject to 7% capital/risk asset ratio, while a 6.25% ratio is applied to foreign bank branches.
January 1993	The introduction of Bangkok International Banking Facilities (BIBF).
March 1993	Abolition of bond holding requirement on the setting up of new Thai bank branches.
May 1993	Further relaxation of capital outflows.
February 1994	Finance companies are granted permission to establish credit offices outside Bangkok.
March 1994	Total capital/risk asset ratio increased to 7.5% for Thai banks and 6.5% for foreign bank branches.
April 1994	The provision for doubtful debt is raised from 50% to 75% of doubtful assets.
June 1994	Adopting the Basle standard for finance companies, with a 7% capital/risk assets ratio.
July 1994	Finance companies are allowed to set up representative office abroad. Banks with BIBF license are allowed to set up provincial branches.
August 1994	Total capital/risk asset ratio increased to 8% for Thai banks and 6.75% for foreign bank branches.
January 1995	Finance companies are free to mobilise funds by issuing bill of exchange (B/E).
May 1995	Commercial banks are given permission to act as customers' unsecured debenture holder representatives.
July 1995	
August 1995	Commercial banks are subject to hold no less than 7% of non-resident Baht account.
September 1995	Net foreign exposures for Thai banks are reduced.
October 1995	Finance companies are allowed to issue short-term B/E and Certificate of Deposit in foreign currency.
May 1996	The provision against doubtful debt is raised to 100%.
June 1996	Short-term foreign borrowings are subject to a 7% reserve requirement.
October 1996	Total capital/risk asset ratio increased to 8.5% for Thai banks and 7.5% for foreign bank branches, and finance companies.
November 1996	Upgrade 6 foreign banks with BIBF licenses to full-branch status.
June 1997	Ceilings on deposit rates are temporarily imposed.
July 1997	Change in exchange rate regime from a basket of currencies to a managed float.
September 1997	The liquidity ratios were reduced from 7 to 6 percent of total deposits for commercial banks and from 7 to 6 percent of total borrowing for finance companies.

Sources: Bank of Thailand Annual report, 1990-97

An important element in the process of financial liberalisation has been the introduction of the BIBF (Bangkok International Banking Facilities) in 1993. This move has been an important strategy in increasing the presence of foreign banks in domestic markets. One consequence has been the introduction of new financial services, such as offshore banking and underwriting. The reduction of entry barriers was expected to increase competition and heighten the emphasis on cost reduction and improved levels of efficiency brought about by technological developments as well as industry restructuring. The period from 1990 to 1997, therefore, introduced significant changes to the Thai banking system.

3.3 Impact on the banking structure: exploratory analysis

This section undertakes an exploratory analysis of the impact of changes in regulations within the banking sector during the 1990-97 financial liberalisation. These regulatory changes are summarised in Table 3.3.

Table 3.3 Changes in bank regulation, 1990-97

		Before liberalisation	After liberalisation	Year
Structure and conduct rules				
1.	**Entry of new banks**			
–	Thai banks	Moratorium since 1978	Permitted	1996
–	Foreign banks	Moratorium since 1978	– Entry under BIBFs' license	1993
			– Full branch status	1996
2.	**Branching expansion**			
–	Thai banks	16% bond holding requirement	Abolished	1993
–	Foreign banks	Restricted	Permitted for sound bank	1996
3.	**Interest rate ceilings**			
–	Deposit rates	Controlled by the BOT	– Free to set	1989-90
			– Temporary controlled	1997
–	Lending rates	Controlled by the BOT	Set according to the BOT guidelines*	1992
4.	**Entry of new banking activities**			
–	BIBF		License required	1993
–	Credit cards		Directly	1994
–	Underwriting and trading debt instruments		Approval required	1992
–	Mutual funds		License required	1992
5.	**Portfolio requirement for Thai bank branches**	Credit at least 60% of deposits in each province	Credit at least 60% of deposits in each region	1991
Supervisory rules				
1.	**Capital requirement**	8% of total assets	BIS standard	1993
2.	**Foreign exchange exposure**	– 15% of tier1 capital (liabilities)	– reduced to 10%	1993
		– 20% of tier 1 capital (assets)	– reduced to 15%	1993
3.	**Provision for doubtful debt**	50% of doubtful assets	Increased to 100%	1994-95
4.	**Reserve requirement**	7% of total deposits	– 7% of total deposits, 7% of non-resident baht account and 7% of short-term foreign borrowings	1995-96
			– A reduction of 7% to 6% for total deposits	1997
5.	**Ownership of non financial business**	10% of a company's total shares	Approval required if over 10%	1994

Note: (*) Banks are advised to base their lending rates on the Minimum Lending Rate (MLR), Minimum Overdraft rate (MOR), and Minimum Retail Rate (MRR).
Sources: Bank of Thailand *Annual report*, 1990-96

Deregulation of structure and conduct rules involves the freeing up of interest rate controls, allowing the entry of new banks, removing the restriction on branching expansion, expanding the range over which banks could geographically provide loans, and extending the scope of banking activities. The basic purpose of these measures was to increase competition and to enhance the efficiency of banks by exposing banks to a greater reliance on market forces.

Re-regulation of supervisory rules included policies designed to reduce the impact of capital inflows, to reduce foreign exchange exposure and to maintain the financial stability of banks. The re-regulation of supervisory measures is reflected in changes in bank capital requirements, foreign exchange exposure, provisions for doubtful debt, reserve requirements and ownership of non-financial business.

The major changes related to the 1990-97 financial deregulation were as follows:

1. It allowed entry of new banks and expansion of bank branches.
2. It abolished requirements of Thai bank branches to maintain a minimum level of capital.
3. It abolished controls on deposit rates.
4. It introduced new banking activities.
5. It established the supervisory standards relating to minimum capital requirements, which are consistent with those of the 1988 Basle Committee Capital Accord on international banking capital adequacy.

Between 1990 and 1997, there were 15 Thai banks[1] and 14 foreign banks between 1990 and 1996 and all are also present in 1997 with the addition of 6 new foreign banks[2].

The following sections analyse at an exploratory level the impact of Thailand's new regulatory regime on:

(a) interest rates;
(b) operating costs; and
(c) the structure of commercial banks.

[1] The 15 Thai banks are BBL, KTB, TFB, SCB, AYD, TMB, FBC, SCIB, BMB, BBC, BOA, TDB, NKB, UBB, and LTB (see full names presented in the list of Acronyms).
[2] The 14 foreign banks are Tokyo, Sakura, Citibank, Deutsche, STCB, Indosuez, HSBC, Chase, America, ABN, Bharat, ICBC, SIME, and OCBC. The 6 new foreign banks are DKB, Dresdner, BNP, Sumitomo, IBJ and BOC (see full names presented in the list of Acronyms).

3.3.1 Interest rates

The impact of deregulation on bank interest rates can be examined by, first, examining the average interest rate on customer deposits and, second, the average interbank rate which reflects the borrowing rate in money markets.

Table 3.4 Deposit and interbank lending rates, 1990-97 (in percent)

	1990	1991	1992	1993	1994	1995	1996	1997
Deposit	14.00	10.50	8.50	7.00	9.25	10.25	8.50	11.50
Money market	14.36	13.96	9.71	9.09	9.39	13.39	11.42	21.73

Notes: interest rates on deposits are based on a one-year period as offered by leading commercial banks at the end of period. Money market interest rates are figured by a daily average interbank lending rate.

Sources: Bangkok Bank *Monthly Review*, May 1996 and June 1997. Bank of Thailand *Quarterly Bulletin*, September 1998.

Table 3.4 shows that the daily average interbank rate was relatively higher than the average interest rate on bank deposits. There was a declining trend of both deposit and money market rates between 1990 and 1993. This matches the *a priori* expectation that interest rate deregulation during 1990-92 would bring down interest rates. Table 3.4 shows that the spread between the deposit and money market rates narrowed in 1994. Subsequently, there was an increase in deposit and money market rates between 1995 and 1997, and a much wider interest spread in 1997. A substantial increase in both rates in 1997 was explained partly by the banking crisis.

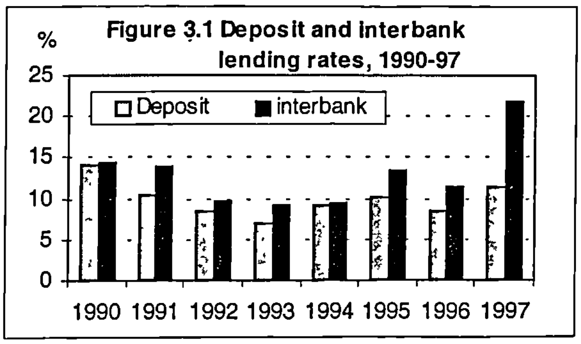


Figure 3.1 shows that the average interest rate on interbank borrowing was higher than that on deposits. There was a declining trend of both rates during 1990-93. Thereafter,

average interest rates on deposits and in the money market continued to rise and the latter increased markedly in 1997.

Overall, Table 3.4 and Figure 3.1 are consistent with the view of a positive impact of financial deregulation on interest rates during 1990-94. From 1995 onward this impact was apparently mitigated in the build-up to financial crisis.

3.3.2 Operating costs

It is expected that financial deregulation should help to lower bank operating costs. Table 3.5 shows that average operating costs of foreign banks declined by about 2% during 1990-97. During the same period, however, the average ratio for Thai banks did not fall. There was a notable increase in the variability and relative dispersions of the ratio for Thai banks during 1996-97, as measured by standard deviation and coefficient of variation, which may suggest a more risky and less stable position of Thai banks.

Table 3.5 Average ratio of bank operating expenses to total assets, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-97
Thai banks									
Mean	2.25	2.17	2.54	2.25	2.35	2.20	2.95	6.11	2.85
STDEV	0.34	0.34	0.57	0.39	0.43	0.34	3.07	4.01	1.19
CV	0.15	0.16	0.23	0.17	0.18	0.15	1.04	0.66	0.34
Foreign bank branches									
Mean	3.36	2.90	2.80	2.40	2.17	1.96	2.05	1.40	2.38
STDEV	1.75	1.27	0.99	0.88	1.04	1.08	1.07	1.11	1.15
CV	0.52	0.44	0.35	0.37	0.48	0.55	0.52	0.79	0.50

Notes: The figures are shown in percentage. STDEV = standard deviation, CV = coefficient of variation. Operating expense is defined, by the Bank of Thailand, as the aggregate of non-interest expense and loan loss provision.

Figure 3.2 summarises graphically the downward trend of average operating expense to assets ratio of foreign banks during 1990-97. Thai banks had an average ratio of around 2% during 1990-95 and the highest average ratio of 6% in 1997[3].

[3] Three banks (BBC, FBC, BMB) had high ratios, respectively 11, 13 and 15%, in 1997. After excluding these banks, the average ratio of Thai banks in 1997 was 4.33 with variability 1.6.

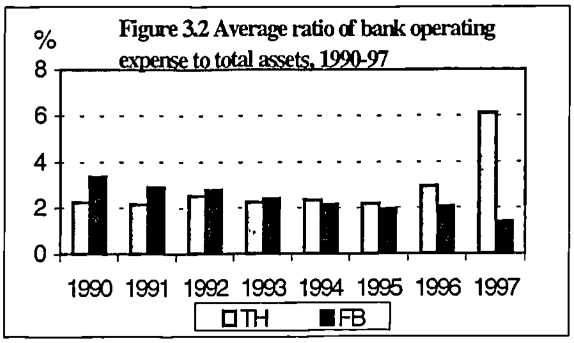


Figure 3.2 Average ratio of bank operating expense to total assets, 1990-97

Table 3.6 Operating expenses to total assets ratio of Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	2.48	4.15	67	Tokyo	1.01	0.42	-58
KTB	2.27	4.22	86	Sakura	0.64	0.25	-61
TFB	2.34	4.56	95	Citibank	3.79	4.01	6
SCB	2.30	3.71	61	Deutsche	2.19	1.79	-18
AYD	2.10	3.44	64	STCB	3.34	3.43	3
TMB	2.35	2.82	20	Indosuez	2.49	2.33	-6
FBC	1.49	13.27	791	HSBC	2.41	1.97	-18
SCIB	2.15	8.93	315	Chase	2.71	1.36	-50
BMB	2.13	15.13	610	America	3.38	1.33	-61
BBC	3.77	11.27	199	ABN	2.84	1.66	-42
BOA	2.68	3.00	12	Bharat	2.35	1.05	-55
TDB	2.45	4.24	73	ICBC	3.34	1.84	-45
NKB	2.04	4.03	98	Sime	3.12	2.88	-8
UBB	2.76	5.29	92	OCBC	1.63	0.68	-58
LTB	2.49	3.54	42				

Note: The figures are shown in percentage.

Table 3.6 shows that the operating ratio for 12 out of 14 foreign banks decreased in 1997 compared to their 1990-96 averages. Meanwhile, the ratio for Thai banks was relatively high in 1997, especially for four banks (FBC, SCIB, BMB, and BBC), which may indicate the possible impact of the financial crisis in 1997.

The results in this section show that the operating costs of foreign banks, on average, seem to have decreased following the deregulation. On the other hand, the operating cost data of Thai banks suggest a complex trajectory and more variability with deregulation. These latter data by themselves appear counter to the expected impact of deregulation.

3.3.3 The structure of commercial banks

This section examines the change in structure of Thai and foreign banks during 1990-97. We investigate the bank deposit and asset concentration ratios, the changes in number of employees and the ratios of equity to assets, loans to assets and deposits to assets and the change in numbers of Thai bank branches.

It is expected that financial deregulation during 1990-97 increased competition in the Thai banking market. As a result, we should expect to see less bank concentration. The removal of interest rate ceilings on deposits and lending is expected to increase the ratios of customer deposits and loans to total assets, and the adoption of the 1988 Basle standard for bank capital should improve the bank's financial strength. At the same time, the abolition of the bond holding requirement on the setting up of new Thai bank branches is expected to increase the number of bank branches.

Table 3.7 Three- and six-bank concentration ratios of Thai and foreign banks combined, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	% change 1990-96	% change 1990-97
Concentration % of total deposits										
CR3	56	55	53	53	53	50	50	50	-10	-11
CR6	78	77	77	76	76	75	75	78	-4	-1
Concentration % of total assets										
CR3	53	53	51	50	49	47	45	40	-15	-25
CR6	75	74	73	72	71	69	68	62	-8	-17

Notes: the n-bank concentration ratio is the market share of n largest banks for assets and deposits. CR3= three-bank concentration ratio, CR6= six-bank concentration ratio.

Table 3.7 shows that the three-bank concentration ratios for deposits and assets decreased respectively by 10% and 15% during 1990-96. The three- and six- large banks are Thai banks. There was a 25% decrease in the concentration ratio for bank assets when data for 1997 are included. This is due to the entry of 6 new foreign banks in 1997[4]. However, these new banks did not have large shares in total deposits. As a result, the three-bank concentration ratio for deposits did not change and the six-bank ratio was the same as in 1990, when 1997 data were included.

Table 3.8 Concentration ratios of Thai and foreign banks, 1990-96 and 1997

Bank	Concentration % of total deposits		% change	Concentration % of total assets		% change
	1990-96	1997		1990-96	1997	
BBL	23.66	22.17	-6	23.54	18.93	-20
KTB	15.12	13.58	-10	13.41	10.65	-21
TFB	13.87	13.78	-1	12.82	10.69	-17
SCB	9.99	13.09	31	9.62	9.64	0
AYD	7.66	9.11	19	6.78	6.64	-2
TMB	6.03	6.03	0	5.67	5.23	-8
FBC	4.33	3.08	-29	4.40	4.25	-3
SCIB	3.85	3.70	-4	3.86	3.66	-5
BMB	3.32	1.88	-43	3.37	2.56	-24
BBC	3.56	2.36	-34	3.55	1.96	-45
BOA	2.06	1.88	-9	2.20	2.10	-5
TDB	1.66	2.10	27	1.64	1.75	7
NKB	1.09	1.10	1	1.09	0.99	-9
UBB	1.27	1.13	-11	1.28	0.98	-23
LTB	0.57	0.62	9	0.56	0.70	25
Tokyo	0.43	0.72	67	1.27	2.89	128
Sakura	0.27	0.47	74	1.17	2.14	83
Citibank	0.35	0.99	183	0.89	1.61	81
Deutsche	0.13	0.32	146	0.44	0.68	55
STCB	0.20	0.42	110	0.47	0.72	53
Indosuez	0.08	0.17	113	0.38	0.45	18
HSBC	0.22	0.48	118	0.56	1.15	105
Chase	0.08	0.06	-25	0.31	0.68	119
America	0.06	0.16	167	0.37	0.58	57
ABN	0.02	0.13	550	0.14	0.52	271
Bharat	0.04	0.06	50	0.05	0.05	0
ICBC	0.03	0.08	167	0.07	0.10	43
Sime	0.02	0.01	-50	0.04	0.03	-25
OCBC	0.02	0.03	50	0.07	0.13	86

Table 3.8 shows that the share in total assets for each of the three Thai large banks (BBL, KTB and TFB) decreased about 20% in 1997 compared to the average during 1990-96. At the same time, LTB was the only Thai bank that gained market share in total assets. There was a big improvement (of over 100%) in the share of total deposits for each of 7 foreign banks and most of the banks in this group (except for Chase and Sime) gained market shares in both deposits and assets in 1997 compared with the 1990-96 average. Two Thai banks (BMB and BBC) had a relatively large shortfall in 1997 compared with their 1990-96 averages, suggesting that they may have been

[4] The three-bank concentration for assets decreased by 18% from 1990 to 1997, when data of 6 new banks in 1997 were excluded.

adversely affected by the financial crisis. The overall results shown in Table 3.8 show a pronounced increase in the market shares for foreign banks, while Thai banks experienced contemporaneous falls.

Table 3.9 Structure of Thai and foreign banks, 1990-96 and 1997

Bank	Number of employees		Equity to assets		Loans to assets		Deposits to assets	
	1990-96	1997	1990-96	1997	1990-96	1997	1990-96	1997
BBL	24646	25000	0.08	0.07	0.85	0.76	0.74	0.67
KTB	16185	16252	0.06	0.06	0.83	0.87	0.83	0.73
TFB	15589	15370	0.08	0.07	0.83	0.77	0.80	0.74
SCB	11595	12679	0.08	0.06	0.81	0.79	0.77	0.78
AYD	8878	12322	0.08	0.05	0.83	0.82	0.83	0.79
TMB	7811	8149	0.07	0.06	0.84	0.78	0.79	0.66
FBC	3061	3778	0.09	0.07	0.85	0.91	0.72	0.42
SCIB	5003	6130	0.07	0.04	0.82	0.86	0.74	0.58
BMB	5014	5760	0.07	-0.04	0.81	0.98	0.73	0.42
BBC	4935	5390	0.07	-0.03	0.81	1.02	0.74	0.69
BOA	2687	2319	0.07	0.06	0.82	0.86	0.69	0.51
TDB	2613	3410	0.07	0.07	0.84	0.89	0.75	0.69
NKB	1478	2149	0.07	0.06	0.84	0.81	0.75	0.63
UBB	2733	2721	0.06	0.04	0.81	0.79	0.73	0.66
LTB	762	1177	0.08	0.08	0.76	0.81	0.77	0.51
Tokyo	237	353	0.14	0.20	0.89	0.94	0.27	0.14
Sakura	192	241	0.22	0.82	0.91	0.81	0.18	0.13
Citibank	637	1097	0.11	0.06	0.87	0.68	0.31	0.35
Deutsche	145	202	0.27	0.47	0.88	0.68	0.23	0.27
STCB	364	466	0.23	0.48	0.82	0.78	0.33	0.34
Indosuez	162	195	0.30	0.64	0.85	0.79	0.18	0.22
HSBC	350	650	0.15	0.26	0.90	0.75	0.36	0.24
Chase	189	106	0.44	0.69	0.87	0.86	0.21	0.05
America	151	172	0.43	0.65	0.83	0.81	0.16	0.16
ABN	70	108	0.46	0.31	0.76	0.59	0.11	0.14
Bharat	53	51	0.16	0.09	0.79	0.54	0.71	0.76
ICBC	64	67	0.24	0.14	0.77	0.73	0.37	0.44
Sime	57	49	0.58	0.50	0.70	0.65	0.35	0.20
OCBC	55	52	0.37	0.71	0.78	0.91	0.24	0.13

Table 3.9 shows that, first, Thai banks had a comparatively larger number of employees than foreign banks: this is due to the fact that Thai banks had branches throughout the country, while branch expansion was restricted for foreign banks. On the other hand, an increase in the number of employees in 1997 relative to the 1990-96 average for most of the banks implies that there was an expansion of bank size. Second, foreign banks had higher equity to assets ratios than Thai banks and there is notable variation between the ratios for each of the foreign banks. This suggests that they may follow the guidelines given by their parent companies, which are apparently higher than for Thai banks. Third, the ratios of loans to total assets are similar for Thai and foreign banks, but the deposits-to-assets ratios of foreign banks (except for Bharat) were relatively low. Again,

this divergence was mainly due to the difference in number of branches. Also, it might suggest that foreign banks have used other sources of funds, (like from their parent companies), to fund their assets and/or they are acting in areas of banking business (like corporate and investment banking) that are not so deposit-dependent. It would appear from Table 3.9 that the restriction on branch networks is by far the most important barrier foreign banks face. This may also help to explain their apparent better operating cost performance compared with Thai banks.

Table 3.9 also shows that there was an increase in bank risk as indicated by a reduction of the deposits- and equity- to -assets ratios in 1997 compared to the 1990-96 average. In particular, two Thai banks (BMB and BBC) that were insolvent in 1997 had substantial decreases in both equity and customer deposits to assets ratios as well as large increases in the ratios of loans to assets in 1997 compared with the average during 1990-96.

Table 3.10 Number of Thai bank branches

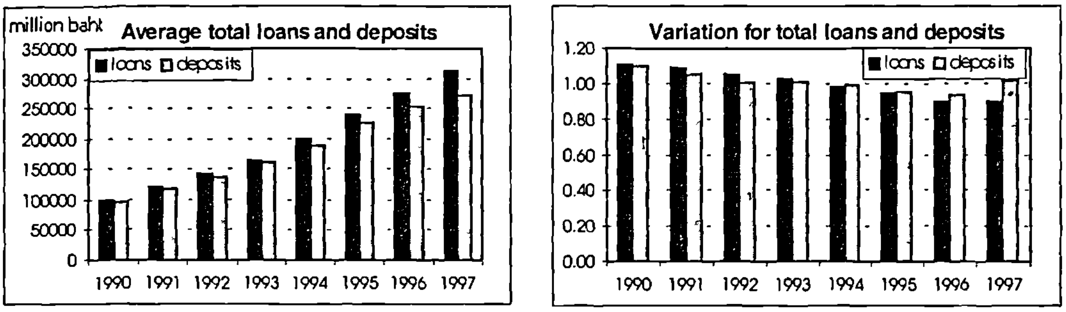
Bank	1990	1996	1997	Average 1990-96	% change in 1996 compared to 1990	% change in 1997 compared to 1990-96
BBL	353	472	498	418	25	19
KTB	359	437	464	407	18	14
TFB	327	433	451	387	24	17
SCB	226	351	368	282	36	30
AYD	198	316	327	260	37	26
TMB	180	293	306	224	39	37
FBC	55	84	89	70	35	27
SCIB	105	163	171	134	36	28
BMB	115	150	153	130	23	18
BBC	141	148	148	145	5	2
BOA	58	80	84	70	28	20
TDB	38	82	84	60	54	40
NKB	31	60	65	46	48	41
UBB	88	97	99	93	9	6
LTB	12	37	42	22	68	91

Table 3.10 shows an increase in the number of Thai bank branches during 1990-97. There were six large-sized banks that had over 300 branches in 1997. However, the percentage increases were higher for small-sized banks (TDB, NKB, and LTB), suggesting greater opportunities to benefit from potential economies of scale and scope[5]. Table 3.10 shows that LTB had the highest increase in the number of branches in 1996 relative to 1990 and in 1997 compared to the 1990-96 average; this reflects its

[5] Economies of scale refers to declining average cost as output increases, whereas economies of scope refers to cost savings generated from joint production (Sinkey, 1998, p.321).

increased market share in total assets (see Table 3.8). Finally, an increase in 1997 compared to the 1990-96 average suggests that the number of Thai bank branches had not then been adversely affected by the financial crisis. As suggested earlier, the growth in Thai bank branches is likely to explain an important part of their higher operating costs compared with the foreign banks.

Figure 3.3 Average and variation for total loans and deposits of Thai banks, 1990-97



Note: Total loans refer to net of allowance for doubtful accounts.
Source: Commercial Banks in Thailand, 1991-1998

Figure 3.3 shows an upward trend of the average total loans and customer deposits of Thai banks during 1990-97, which again suggests an expansion of bank size following the deregulation. It is apparent that the gap between average total loans and customer deposits became wider as the deregulation progressed. This implies that Thai banks had not raised enough savings although their branches increased over the period studied (see, Table 3.10). Figure 3.3 also shows that Thai banks' data had become less dispersed (as measured by the coefficient of variation), except for deposits in 1997 because two banks (FBC and BMB) had a substantial decrease in 1997 relative to 1996. The data suggest an expansion of small-sized banks.

The exploratory analysis in this section suggests that deregulation was responsible for (or at least contemporaneous with) changes in the structure of commercial banks. Competition from foreign banks has apparently been an important factor in bank strategic development in Thailand during the era of liberalisation. There was an expansion of bank size as shown by a greater number of employees for banks in 1997 relative to the 1990-96 average as well as increases in the number of branches, total loans and customer deposits of Thai banks. These kinds of trends may also explain why Thai banks performed less well in their operating costs compared with foreign banks. Overall, the results confirm the more competitive environment facilitated by the deregulation. These data also suggest that this environment was associated with an increase in the riskiness of Thai banks.

3.3.4 General assessment of experience to date

The primary aim of financial deregulation was to increase competition and the strategic emphasis of banks towards improving their performance, products and services. The preceding analysis shows that financial deregulation created some improvements in the Thai banking sector. First, there was a positive response to the removal of interest rate ceilings, where there was a decline in both interest rates on deposits and borrowing from the money market. Second, there was a decline in operating costs of foreign banks, which suggests that foreign banks were better at reducing operating expenses as a percentage of their assets. At the same time, though, foreign banks did not expand their branches and staff levels to the same extent as Thai banks, and this kept their operating expenses down relative to Thai banks. Third, most of the foreign banks gained market shares of total deposits and assets. Fourth, there was an increase in the number of employees for most of the Thai and foreign banks, but this did not improve the ratio of deposits to assets. There is evidence to suggest that interest rate deregulation did not promote savings as expected, although there was an increase in the number of Thai bank branches aimed at attracting more savings. The lower deposits-to-assets ratios also suggest that banks increased their liabilities from borrowings and other sources to fund their assets.

Financial deregulation has apparently been an important strategic driver and facilitator of all these kinds of changes. Nevertheless, disentangling the specific impact of deregulation is not easy and there are various factors (in terms of their impact on bank strategies) which are difficult to measure. These difficulties are well documented in the European Commission (1997)'s study on the impact of the SMP. First, there are many other external strategic drivers, like globalisation and technology that also help to shape bank strategies at the same time. Second, many effects flowing from deregulation are indirect. In the Thai case, a good example would be the liberalisation of capital controls that resulted in a major capital inflow during 1990-96 (see Chapter 2, Section 2.2). Third, financial deregulation encompasses two kinds of regulatory changes: a deregulation of banking structure and conduct rules and a re-regulation of supervisory rules, which may have different effects on bank strategies. As stated earlier, these can have countervailing effects on key bank variables, like prices and profits. Finally, the expectations of policymakers towards a more open banking environment are difficult to measure and they are one of the important external drivers of bank's strategies.

Overall, it may be argued *ex post* that the sequencing of financial liberalisation, in which supervisory re-regulation was placed after other measures, exposed Thai banks to higher risk. On the other hand, the exploratory evidence suggests that most of the foreign banks seemed to benefit from the financial deregulation during 1990-97.

3.4 Conclusion

Financial liberalisation is a process of financial development that reduces government controls over the financial services industry. It involves the liberalisation of the external sector (exchange and capital controls), the deregulation of the domestic banking sector and the re-regulation of bank supervision. It is expected that financial liberalisation will induce greater savings and investment and, in effect, increase the rate of economic growth. Successful financial liberalisation requires appropriate prerequisites, timing, sequencing and speed of implementation. In particular, well-established bank supervision should precede the deregulation of the financial sector.

Financial liberalisation in Thailand was implemented in the three-year financial development plan which began in 1990. The process entailed the deregulation of bank structure and conduct rules and the re-regulation of bank supervision. The exploratory analysis of the 1990-97 financial deregulation in this chapter showed that interest rates temporarily declined. The average operating costs for Thai banks increased, while those for foreign banks fell. The market shares of bank assets became less concentrated and many foreign banks gained market share, but the concentration in total deposits did not change. The evidence showed that Thai banks had a wider gap between total loans and customer deposits, although the number of branches increased; this may suggest that banks did not increase savings enough following the deregulation. Although it is problematic to disentangle the deregulation effects from other structural developments, the analysis in this chapter points towards a heightened competitive environment resulting from the reduction of entry barriers brought about by the deregulation.

Overall, foreign banks seem to have gained more from the Thai financial deregulation. However, it is important to note that there are many strategic drivers and facilitators of changes in the Thai banking industry which are difficult to measure. A more in-depth analysis in other areas, such as changes in efficiency and productivity of banks, is needed for more conclusive evidence to be drawn on the impact of financial deregulation.

A key feature of financial liberalisation is that it is targeted to improve the efficiency and productivity of banks through the deregulation of bank structure and conduct rules. This is a fundamental target of deregulation. The present chapter has provided the policy context of these targeted gains and undertaken a limited exploratory analysis of banking productivity and other related changes. The next chapter will explore more rigorously the nature and importance of the productive efficiency and productivity of the banking firms, and examine the empirical evidence on the respective impact of financial deregulation.

Chapter 4 Productive Efficiency and Productivity in the Banking Sector

INTRODUCTION

This chapter explores theoretical and empirical studies of productive efficiency and productivity in the banking industry. The objective is to review the measurement issues related to bank efficiency and productivity and the respective effects of financial deregulation. The chapter is structured as follows. First, we discuss the definition of productive efficiency and its importance in the banking industry. Section 2 surveys the recent frontier approaches for estimating productive efficiency and measuring productivity of banks, and the consistency conditions of efficiency measures that have been proposed as well as summarises the recent studies which details are shown in Appendix I. Section 3 explores empirical studies of the effects of financial deregulation and section 4 concludes this chapter.

4.1 Productive efficiency in the banking industry

This section aims to explore, first, the definition of productive efficiency and second, the important of bank productive efficiency. Finally, the rationales for estimating the efficiency of the banking firm are reviewed.

4.1.1 The concept of productive efficiency

Productive efficiency relates to the economic concepts of production, which define the dual relationship between the production function and the cost, revenue or profit function representations of a production technology. It is assumed that a firm faces perfectly competitive input and output markets. A firm's economic behaviour is to maximise its production by choosing either optimal input choices under a cost minimisation objective or optimal output choices under a revenue maximisation objective or a simultaneous choice of inputs and outputs under a profit maximisation objective.

Most studies of productive efficiency in the banking industry have used definitions based on the discussion of Farrell (1957), who proposed that the overall (cost) efficiency of a firm consists of two components: technical and allocative efficiencies.

Farrell (1957) introduced an input-orientated measure of technical efficiency, which reflects the ability of a firm to minimise input usage in order to produce a set of given outputs. If a firm has the objective of minimising costs, then a measure of cost efficiency can also be calculated; this reflects the ability of a firm to use inputs in the optimal proportions, given their respective prices. Cost efficiency reflects both the firm's ability to use the best practice technology (technical efficiency) and the firm's chosen mix of inputs (allocative efficiency).

If revenue maximisation is a firm's objective, productive efficiency is measured as output-orientated. Technical efficiency reflects the ability of a firm to obtain maximum output from given inputs, while allocative efficiency reflects the ability of a firm to produce outputs in optimal proportions given their prevailing prices. Revenue efficiency reflects both a firm's ability to adopt the best practice technology (technical efficiency) and choosing the optimal mix of outputs.

This study adopts the input-orientated concept of productive efficiency. Banks are assumed to have control over the use of inputs and recognise that resources are scarce and should not be wasted. The reasons for choosing the input-orientated measure are:

1) Banks are in the business of financial intermediation whose production can be viewed as the transformation of bank liabilities and equity into earning assets (Sinkey, 1998, p.319). The ability of bank managers to generate financial products and services at minimum cost is clearly a critical factor in remaining competitive. And as suggested by Spong *et al.* (1995), cost control must be a central objective of bankers and that

utilizing resources in an efficient and effective manner would be of paramount importance to banking success.

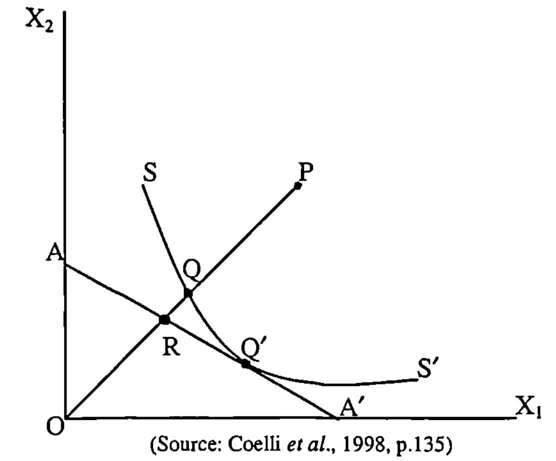
2) It is important to investigate whether deregulation has reduced bank costs. In theory, improvements in technology and a less restrictive regulatory environment should enable banks to produce the same level of output at lower costs than before. However, the costs of using new technology (such as, telephone banking and credit cards) may be high and consequently, cost control is a concept that banks must emphasise.

3) There is reason to believe that deregulation has incentivised banks to pay more attention to their costs. As supported by Berg et al. (1992), Zaim (1995) and Okuda and Mieno (1999), who investigated the impact of financial deregulation, the objective of input saving efficiency are in coherence with the expressed interest in the banking sector in reducing costs.

Following the input-orientated concept, a productive efficient bank should adopt the best practice technology in order to minimise the usage and the cost of inputs. The input-orientated approach has been employed by, for example, Aly *et al.* (1990), Ferrier and Lovell (1990), Berg *et al.* (1992), Fukuyama (1993, 1995), Elyasiani *et al.* (1994), Grabowski *et al.* (1994), Elyasiani and Mehdian (1995), Zaim (1995), Miller and Noulas (1996), Resti (1997), Bauer *et al.* (1998), Avkiran (1999), Worthington (1999), and Glass and McKillop (2000).

The definition of Farrell input-orientated productive efficiency can be illustrated in Figure 4.1 (see, Coelli, Rao and Battese, 1998, pp.134-136). Here, it is assumed that a firm uses two inputs, X_1 and X_2, to produce a single output Y. The isoquant SS' represents the production frontier that corresponds to the minimum combination of inputs which can produce the same amount of output.

Figure 4.1 Technical and allocative efficiencies



(Source: Coelli *et al.*, 1998, p.135)

Figure 4.1 shows that points Q and Q' are technically efficient because they lie on the production frontier, and point P is technically inefficient because it lies in the interior of the production frontier. If a firm uses the combination of inputs at point P, the firm's technical efficiency is measured by the ratio OQ/OP, which is the amount by which all inputs could be proportionally reduced without a reduction in output, since the firm could operate at the point Q and still produce the same output.

In Figure 4.1, the isocost line AA' represents the same amount of input costs, given fixed prices of X_1 and X_2. The allocative efficiency of point P is measured by the ratio OR/OQ and the overall cost efficiency is given by the ratio OR/OP. Note that input costs at point R are the same as at point Q', but point R is not feasible since it lies outside of the production frontier. Point Q is technically efficient but allocatively inefficient because it lies above the isocost line. The distance RQ represents the reduction in production cost that would occur if production moved from point Q to the allocatively and technically efficient point Q'.

4.1.2 The importance of productive efficiency

The primary role of bank management in deregulated markets is to maximise shareholder value (Sinkey, 1998, p.69). Productive efficiency is a necessary condition for shareholder wealth maximisation (SWM): shareholder value cannot be maximised unless production costs are minimised and/or respective income is maximised. The higher the bank's productive efficiency, the greater the possibility that shareholders' wealth will be maximised. Necessary and sufficient conditions for maximising bank SWM are productive efficiency and capital allocation (risk and return) efficiency.

It is, therefore, practically important for bankers and policymakers to know whether and how banks are becoming more efficient. Gardener (1995, p.7) notes:

> Greater efficiency might be expected to lead to improved financial products and services, a higher volume of funds intermediated, greater and more appropriate innovations, a generally more responsive financial system, and improved risk-taking capabilities if efficiency profit gains are channeled into improved capital adequacy positions.

The importance of productive efficiency in banking has been heightened considerably in the 1990s. Developments such as financial market deregulation and the growing importance of financial services in economic activity have induced changes, along with new technology and wider market developments which increase competitive pressures and accelerate the capacity and need for change. These changes have placed banks in a situation where their success depends on their ability to adapt and operate efficiently in the new environment. There is a need for banks to use all of their resources to maximum advantage.

Productive efficiency has been the subject of a significant amount of investigation in the banking industry and the reasons for this are summarised by Berger and Humphrey (1997) and listed below:

(1) To inform government policy. Knowledge of productive efficiency is important for the regulation of banks by government. Regulatory authorities require detailed information on the efficiency of individual banks in order to follow policies aimed at improving the performance of the industry and to estimate the consequences of their decisions. The discussion of informing government policy toward depository financial institutions is divided into four categories.

- The efficiency effects of financial deregulation (see, for example, Berg *et al.*, 1992; Elyasiani and Mehdian, 1995; Fukuyama, 1995; Zaim, 1995; Grifell-Tatjé and Lovell, 1996; Humphrey and Pulley, 1997).
- The efficiency associated with institutional failure, risk, problem loans and management quality (see, for example, Berger and Humphrey, 1992a; Cebenoyan *et al.*, 1993a; Mester, 1993, 1996, 1997; Hermalin and Wallace, 1994; De Young, 1998; Berger and De Young, 1997).
- The efficiency associated with market structure and concentration (see, for example, Berger, 1995; Berger and Hannan, 1998).
- The efficiency effects of mergers and acquisitions (see, for example, Berger and Humphrey, 1992b; Rhodes, 1993; Peristiani, 1997 and De Young, 1997b).

(2) To address research issues. Knowledge of productive efficiency is important for research implications. It is essential to determine how measures of efficiency vary with different frontier approaches, output definitions and time periods in order to provide more meaningful insight into efficiency analysis. The discussion of methodology and measurement issues related to efficiency of financial institution is classified into seven categories.

- The similarity of efficiency results derived from different frontier models (see, for example, Atkinson and Wilson, 1995; Bauer *et al.* 1998).
- The sensitivity of efficiency results when different input and output definitions are applied (see, for example, Ferrier and Lovell, 1990; Berger and Humphrey, 1991; Berger *et al.*, 1997).
- The association between efficiency and firm organisational structure (see, for example, Cebenoyan *et al.*, 1993b; De Young and Nolle, 1996; Bhattacharyya *et al.* 1997).
- The different ways to measure efficiency (see, for example, Berger and Humphrey, 1991; Berger, 1993; Berger and Mester, 1997; Lovell and Pastor, 1997).
- The effects of incorporating opportunity cost and product diversification into the analysis (see, for example, Mester, 1996, 1997; Berger and Mester, 1997).

- The consistency among cost, profit and production efficiency measures (see, for example, Berger and Mester, 1997; Humphrey and Pulley, 1997).
- The variability of efficiency estimates over time (see, for example, Berger and Humphrey, 1991; De Young, 1997a).

(3) To improve managerial performance. Knowledge of productive efficiency can be used as a tool for managers to improve performance by identifying the determinants of bank efficiency. It is axiomatic that the usefulness of efficiency analysis depends on the availability of detailed data. For example, many inputs and outputs can be expressed in physical flow terms (e.g. hours worked by type of labour, numbers of transactions processed), and more accurate measures of stock inputs may be specified (e.g. square footage of office used).

Banks are more likely to improve their efficiency if they are better informed. Efficiency analysis can be directed towards very practical bank management concerns. There has been, for example, a number of studies focusing on branch performance within a single banking firm. The results of efficiency analysis can assist management to determine the best and the worst practice branches within a bank and to identify branches which are in most need of reform, local management replacement or closure. Studies that focus on the performance of bank branches are, for example, Oral and Yolalan (1990), Sherman and Ladino (1995), Drake and Howcroft (1997) and Berger *et al.* (1997).

4.2 The measurement of productive efficiency

No general consensus exists as to the best method for measuring the productive efficiency of the banking firm (Berger and Humphrey, 1997). The recent development of frontier analysis techniques is considered superior to the traditional financial ratio analysis because the programming or statistical techniques help to remove the effects of differences in input prices and other exogenous factors that affect the standard performance ratios. Productive efficiency can be measured via many combinations and configurations of inputs and outputs. The preferred measure of productive efficiency for a bank, therefore, depends on the aims of the researcher. There are two main approaches in frontier analysis: parametric and nonparametric.

This section outlines three important issues in frontier efficiency measurement in the banking industry: first, the specification of a bank's inputs and outputs; second, the estimation techniques and finally, the consistency conditions of efficiency measures. The final part of this section summarises studies of bank efficiency.

4.2.1 Specification of bank inputs and outputs

The first step in measuring the efficiency of banks is to determine a bank's inputs and outputs. The definition and measurement of a bank's inputs and outputs is contentious due to the unresolved issue of exactly what constitutes the input and output of a bank. In general, there are two main approaches for measuring the flow of services provided by banks.

(1) The production approach: banks are viewed as producers of loans and deposits account services using capital and labour. Outputs are measured by the numbers of deposit and loan accounts, and costs are defined as operating expenses. The production approach is appropriate for studying cost efficiency of banks since it concerns the operating costs of banking (Ferrier and Lovell, 1990). It is also useful in evaluating the efficiencies of branches of financial institutions, because it depicts the operational capability of branch managers (Berger and Humphrey, 1997). Studies that use this approach include, for example, Sherman and Gold (1985), Oral and Yolalan (1990), Ferrier and Lovell, 1990, and Berger and De Young (1997). However, it is often the case that researchers do not have access to the data required for this approach.

(2) The intermediation approach: banks are viewed here as intermediators of financial services, using capital and labour to transform deposits into loans and other assets. Outputs are measured by the volume of loans and other assets, while deposits and other liability funds are inputs. Total costs include all operating and interest

expenses of the bank. The intermediation approach has the advantages of being more inclusive and capturing the intermediation role of banks (Berger, Leusner, and Mingo, 1997). It incorporates the overall costs of banking and is appropriate for addressing questions concerning the cost minimisation of banks (Ferrier and Lovell, 1990). Studies using this approach include, for example, Elysiani and Mehdian (1990a), Elysiani and Mehdian (1990b), Kaparakis *et al.* (1994), Zaim (1995), Miller and Noulas (1996), Mester (1997), Altunbas and Molyneux (1997) and De Young (1998).

There are three variants of the intermediation approach. These are suggested by Berger and Humphrey (1992a) who identified bank inputs and outputs by classifying bank activities. They argued that researchers should make a decision from the most important feature of banking functions, or according to the purpose of the study. These three variants are:

- ***The asset approach.*** Banks are considered as financial intermediaries between liability holders and those who receive bank funds. Outputs are defined by assets and the production of loans, in which banks have the advantage over other financial institutions, while deposits and other liabilities are inputs to the intermediation process. The main shortcoming of this approach is that it does not take into account the other services provided by banks e.g. supplying transactions, and savings deposits. Studies using this approach include, for example, English *et al.* (1993), Favero and Papi (1995).
- ***The user cost approach.*** The nature of bank inputs and outputs is determined by the net contribution to bank revenue. Under this approach, a financial product is classified as an output if the financial return on an asset exceeds the opportunity cost of the investment, or if the financial costs of a liability are less than its opportunity costs. The drawback of this approach is that it is difficult to obtain accurate data on prices and revenues (Favero and Papi, 1995). Studies that use this approach include, for example, Aly *et al.* (1990), Fixler and Ziechang (1993), Resti (1997), Gilbert and Wilson (1998).
- ***The value added approach.*** Both liability and asset categories are considered to have some output characteristics. The definition of bank inputs and outputs is based on the share of value added. Outputs are classified from activities in which banks create high added value, such as loans, demand deposits and time and saving deposits. Others are treated as unimportant outputs, intermediate products, or inputs depending on the

specifics of the category. Studies that use this approach include, for example, Berg *et al.* (1992), Clark (1996), Grifell-Tatjé and Lovell(1996) and Bhattacharyya *et al.* (1997).

In addition to these classifications, some researchers model bank inputs and outputs in accordance with the assumed objectives of the bank. For example, Leightner and Lovell (1998) specified outputs for which the banks' objective is profit-oriented, such as net interest income and non- interest income, while credit granted and investment in securities are relevant outputs for the regulatory objective. Bergendahl (1998) assumes that banks have two input-saving objectives: risk management and services provision. For a risk management objective, output is measured by gross revenues and credit losses represent bank input. For a service provision objective, output is captured by volume of lending and volume of deposits, and inputs are measured by cost of personnel and cost of material.

4.2.2 Estimation of productive efficiency

There are at present two primary methodologies for measuring bank productive efficiency: parametric and nonparametric. Both methodologies involve the estimation of "best practice" frontiers, with the efficiency of banks measured relative to these respective frontiers.

The parametric approach

The parametric or the econometric approach to measure efficiency requires a selection of economic concepts, distributional assumptions of a composite error term, and functional forms to pre-specify the best-practice frontier. The methodology is stochastic: the error term is hypothesised to consist of an inefficiency component and random noise. Efficiency is measured by separating the inefficiency component from the composite error term.

Berger and Mester (1997) note that there are three most important economic concepts used in the parametric approach: cost, standard profit and alternative profit efficiencies.

Cost efficiency gives a measure of how close a bank's cost is to what the best-practice bank cost would be for producing the same output bundle under the same conditions. A bank is inefficient if its costs are higher than on the best-practice frontier.

Profit efficiency measures how close a bank is to producing the maximum possible profit given a particular level of input prices and output prices.

Alternative profit efficiency or revenue efficiency measures how close a bank comes to earning maximum profits (revenue) given its output (input) levels. A bank is profits (revenue) are lower than on the best-practice frontier.

There are three approaches to disentangle inefficiency from the composite error term. These are the stochastic frontier approach (SFA), distribution free approach (DFA) and thick frontier approach (TFA). The established approaches differ primarily in the distributional assumptions used.

The stochastic frontier approach (SFA) assumes that inefficiency and random error components of the composite error term are disentangled by making explicit assumption about their distributions. The random error is assumed to be two-sided (normal distribution), while the inefficiency term is assumed to be one-sided (usually an exponential, truncated normal or gamma distribution). The parameters of the two distributions are estimated using maximum likelihood techniques and then used to obtain estimates of bank-specific inefficiency. Examples of studies that use this approach are Elyasiani and Mehdian (1990b), Kaparakis *et al.* (1994), Kwan and Eisenbeis (1994), Berger and De Young (1997), Altunbas and Molyneux (1997), Altunbas *et al.* (1997), Mester (1997), Altunbas *et al.* (1998) and De Young *et al.* (1998)

The distribution free approach (DFA) assumes that there is a core or average efficiency for each bank over time and is usually applied to panel data. It is assumed that inefficiencies are stable and random errors tend to average out over time. The resulting inefficiency estimate for each bank is used to compute its average efficiency. Examples of studies using this approach include Schmidt and Sickle (1984), Berger

(1993), Hunter and Timme (1995), Berger *et al.* (1997), Berger and Mester (1997) and Bauer *et al.* (1998).

The thick frontier approach (TFA) assumes that deviations from predicted performance values within the highest and lowest performance quartiles of observations represent random error. Meanwhile, deviations in predicted performance between the highest and the lowest quartiles represent inefficiencies. This approach does not impose distributional assumptions on either inefficiencies or random errors. It is assumed that inefficiencies differ between the highest and lowest quartiles and that random errors exist within these quartiles. It provides an estimate of the overall efficiency instead of the efficiency of individual banks. Examples of studies using this approach are Berger and Humphrey (1991), Bauer *et al.* (1993), Humphrey and Pulley (1997), Bauer *et al.* (1998), and De Young (1998).

Measuring efficiency under an econometric approach requires the specification of functional forms for the above efficiency concepts and estimation approach. The most widely used techniques are the translog and the Fourier-Flexible functional forms for estimating cost frontiers.

The translog (Transcendental logarithmic) functional form was introduced by Christensen, Jorgensen and Lau (1973). The translog functional form has characteristics of linearity in parameters and the ability to provide second-order approximations to any arbitrary functions. It includes linear, quadratic and interaction terms in the independent variables. Translog is one of the most widely used flexible functional forms for a cost function (Molyneux et. al, 1996, p.162). Studies using translog functional form are, for example, Ferrier and Lovell (1990), Mester (1993), Kaparakis *et al.* (1994), Kwan and Eisenbeis (1996), Lang and Welzel (1996), Peristiani (1997) and Cummins and Zi (1998).

The fourier flexible (FF) functional form is a semi-nonparametric approach that can be used to alleviate the problem of different production technologies of small and large banks. It augments the translog functional form by including Fourier trigonometric terms in the function. Studies using this approach are, for example, McAllister and Mcmanus (1993), Mitchell and Onvural (1996), Berger and De Young (1997), Berger and Mester, (1997), Berger *et al.* (1997) and De Young *et al.* (1998).

The nonparametric approach

The nonparametric or mathematical programming approach is an alternative method for estimating the productive efficiency of a firm. This approach is known as Data Envelopment Analysis (DEA). It is based on the work of Farrell (1957), who used the economic concepts of the production frontier and the production possibility set to define technical and allocative efficiencies, and proposed the so called radial measures of relative inefficiency. Subsequently, Charnes, Cooper and Rhodes (1978) described a mathematical programming approach for the construction of a production frontier and the measurement of (technical) efficiency relative to the constructed frontier. Later developments include the extension of the basic programming technique to calculate cost and revenue efficiencies (see, Coelli *et al.*, 1998, p. 162).

The advantage of DEA is that it requires neither a specific functional form to identify the efficient frontier nor distributional assumptions for the error term. As a result, therefore, it is more flexible than the econometric approach. DEA measures technical and allocative efficiencies relative to a best practice frontier, which is derived deterministically from a specific dataset containing measures of pre-specified inputs and outputs for a universe (or sample) of similar firms.

This approach assumes that there are no random fluctuations from the respective production frontier estimates. In effect, all deviations from the estimated frontier comprise inefficiency in the DEA methodology. This implies that the extent of inefficiencies may be over or understated. Despite this drawback, Seiford and Thrall (1990) argued that DEA is a more robust procedure for efficiency estimation, because it measures the relative efficiency of each firm with respect to the efficient frontier that is constructed from the actual data. The studies using this approach include, for example, Sherman and Gold, (1985), Aly *et al.*, (1990), Elyasiani and Mehdian (1990a) and (1990b), Yue (1992), Berg *et al.*, (1992), Fukuyama (1993), Grabowski *et al.* (1994), Grifell-Tatjé and Lovell (1996), Miller and Noulas (1996), Bhattacharyya *et al.* (1997) and Leightner and Lovell (1998).

DEA focuses primarily on the technological aspects of production correspondences; it can be used to estimate relative technical efficiency without requiring measures of input and output prices[1]. There are two main alternative orientated forms of the DEA technique (see, Coelli *et al.*, 1998). The input-orientated form calculates the minimum amounts of inputs, which could be used to produce each DMU's (Decision making Units)[2] actual outputs. In contrast, the output-orientated form calculates the maximum amount of outputs, which could be produced by using the DMU's actual inputs.

DEA is a nonparametric linear programming method by which multiple inputs and outputs of each DMU can be combined into an overall single measure of technical efficiency[3]. The DEA approach finds the DMUs which determine the best-practice frontier (envelopment surface). In terms of Figure 4.1, the estimated frontier is an approximation to the surface generated by isoquant line SS' for different levels of output. The remaining DMUs inside the surface are inefficient by definition and are evaluated relative to the best-practice frontier. The input-orientated efficiency score reflects the radial distance from the estimated efficient frontier to the DMU under evaluation, indicating the minimum proportional decrease in all inputs required for efficiency in the input-orientated form. The output-orientated efficiency score is obtained by calculating the maximum proportional increase in outputs required for efficiency and then taking the reciprocal of this number. The scores fall between values of 0 and 1. DMUs with a score of 1 are efficient and lie on the frontier (for example Q and Q' in Figure 4.1). Inefficient DMUs, like P in Figure 4.1, have scores of less than 1.

DEA can generate a best practice frontier under four different assumptions of returns to scale technology along the frontier (see, Seiford and Thrall, 1990). These are constant returns to scale (CRS), variable returns to scale (VRS), non-increasing returns to scale (NIRS) and non-decreasing returns to scale (NDRS). Each returns to scale assumption is associated with a different type of envelopment surface, which is determined by four different convexity constraints. Figure 4.2 graphically illustrates the four types of envelopment surface of the **x** and **y** vectors of inputs and outputs.

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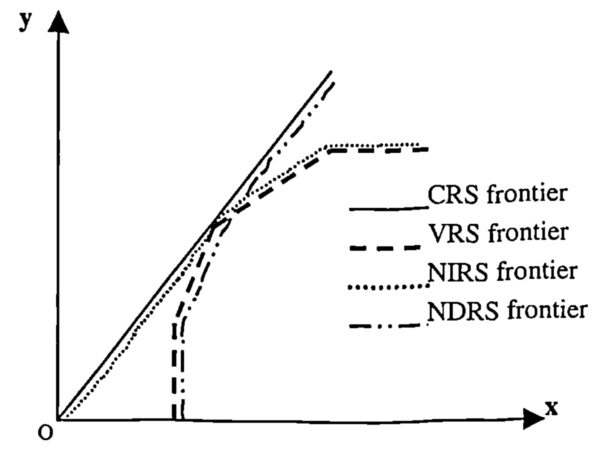
[1] The stochastic frontier methodology can also be used to estimate technical efficiency, but only in the case where one output is defined. The strength of DEA methodology is that it can be applied to multi-input and multi-output DMUs.

[2] DMU is an entity that uses inputs to produce outputs. A DMU can be an individual firm (e.g. a bank) or part of a firm (e.g. a bank's branch).

[3] The mathematical formulations are not reproduced here since they are well-written in many articles (see, for example, Seiford and Thrall (1990) and Coelli *et al.* (1998))

Figure 4.2 Envelopment surface in DEA



Source: Coelli *et al.* (1998), p.152

Table 4.1 Returns to scale assumption in DEA

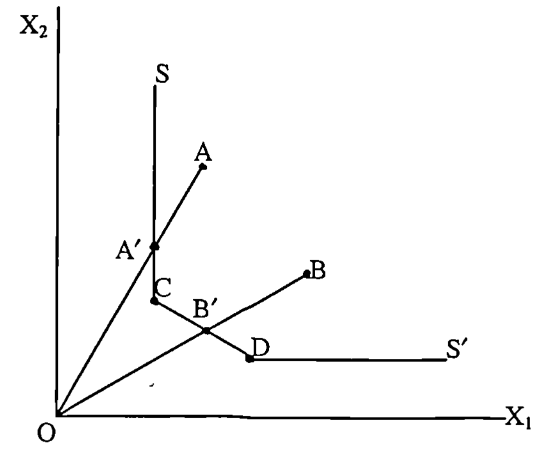
Returns to scale	Convexity constraint	Effects
Constant	No constraint	Inefficient DMUs may be benchmarked against efficient ones, whose sizes are larger or smaller than them.
Variable	= 1	Inefficient DMUs may be benchmarked against efficient ones which are of similar size
Non-increasing	≤ 1	Inefficient DMUs may be benchmarked against efficient ones which are of similar or smaller sizes
Non-decreasing	≥ 1	Inefficient DMUs may be benchmarked against efficient ones which are of similar or larger sizes

The variable returns to scale (VRS) assumption has been the one most commonly used in the 1990s (Coelli *et al.* 1998, p.150). The benefits of VRS assumption are that it separates scale efficiency from technical efficiency, and that it provides information about the returns to scale in production of DMUs on the efficient frontier. Table 4.1 contains the four assumptions and their effects. An efficient DMU's production exhibits increasing returns to scale if a small proportionate increase in all inputs produces a greater proportionate increase in outputs; and it exhibits decreasing returns to scale if a small increase in all inputs produces a less than proportionate increase in outputs. Otherwise, an efficient DMU's production exhibits constant returns to scale when it achieves the most productive scale size, where a small increase (or decrease) in all inputs equals the proportionate increase (or decrease) in outputs, keeping the mix of inputs and of outputs constant.

DEA provides both a measure of technical inefficiency and slacks for each DMU in the dataset. Technical inefficiency as defined by Farrell (1957) reflects the amount by which all inputs could be proportionally reduced without a reduction in outputs. Slacks[4] indicate how much a DMU could further reduce the amounts of one or more inputs and/or increase the amount of outputs over and above the proportion indicated by the technical efficiency score if it were as productive as the best practice DMUs.

Input slacks are the amount of inputs that could be further reduced without a reduction in output if production were to achieve technical efficiency. The amount of inputs that inefficient DMUs could reduce in order to achieve technically efficient production can be illustrated from the definition of input-orientated technical efficiency by Koopmans (1951) and Farrell (1957), which is shown in Figure 4.3.

Figure 4.3 Input-orientated technical efficiency and input slacks



(Source: Coelli *et al.*, 1998, p.143)

Here, it is assumed that each DMU uses two inputs, X_1 and X_2, to produce a single output y and the isoquant SS' represents the locus of efficient DMUs. C and D are two efficient DMUs which define the production frontier, while A and B are inefficient DMUs. The Farrell measure of technical efficiency of DMUs A and B is the ratio of

[4] Slacks (which may be zero) are calculated automatically as part of the linear programming algorithm.

OA′/OA and *OB′/OB*, respectively. Technical or radial inefficiency is then represented by the distances *AA′* and *BB′*, which reflect the amounts of X_1 and X_2 that could be proportionally reduced. Koopmans (1951) defined technical efficiency as points on isoquant *SS′* that are associated with zero input slacks[5]. Thus, the nearest Koopman's efficient point for the DMU *A* is projected at point *C*, where the distance *CA′* is the slack of input X_2 or the amount of X_2 that could be further reduced without a reduction in output. The DMU *A′* is only weakly efficient: it is dominated by the DMU *C* which uses less of input X_2 to produce the same amount of output (using the same amount of X_1).

There are other, so-called "non-radial" measures of efficiencies which can be used, although in banking few researchers have applied them. One of the few examples is Yue (1992) who evaluates the efficiency of the 60 largest Missouri banks between 1984 and 1990. The argument in favor of non-radial efficiency measures is that inefficient units are projected onto the efficient subset in this methodology, which is a more important subset than the isoquant for technical efficiency measurement. For an input orientation, the non-radial reference technology is defined by allowing different scalings of individual inputs in order to ensure that the resulting input vector is an element of the efficient subset. By construction, the input orientated non-radial measure of technical efficiency projects the observed input vector onto the efficient subset of the input correspondence: it thereby eliminates input slacks. The theoretical details of non-radial efficiency measures are given by Färe, Grosskopt and Lovell (1985) and its advantages and disadvantages are extensively discussed by Borger, Ferrier and Kerstens (1998).

4.2.3 Consistency conditions for efficiency measurement

The choice of methods for measuring productive efficiency has important implications for interpretations of the analysis. To date, there is no consensus on which is the best approach for measuring productive efficiency. To make efficiency analysis more reliable, Bauer, Berger, Ferrier and Humphrey (1998) proposed a set of consistency conditions which efficiency measures derived from the various approaches should

[5] In Figure 4.2, these are points on the segment *CD*. Segments *CS* and *DS′* are parallel to the axes, so

satisfy to be most useful for analysis. They suggested six consistency conditions, which are listed as follows:

(i) ***Comparisons of efficiency distributions***: the efficiency scores generated by the different approaches should have comparable means, standard deviations and other distributional properties. This condition should result in similar projected quantitative effects of regulatory policies on bank performance.

(ii) ***Rank-order correlation of the efficiency distributions***: the different approaches should rank the institutions in approximately the same order. Hence, similar results should be obtained when evaluating efficiency of institutions with different approaches.

(iii) ***Identification of best-practice and worst-practice banks***: the different approaches should identify mostly the same institutions as "best-practice" and as "worst-practice". This condition is useful in identifying the characteristics of successful and unsuccessful banks.

(iv) ***The stability of measured efficiency over time***: the different approaches should demonstrate reasonable stability over time i.e. tend to identify consistently the same institutions as relatively efficient or inefficient in different years. This condition could indicate the reality of management patterns over time. Also, it could increase the confidence of regulatory authorities in implementing their policies.

(v) ***Consistency of efficiencies with market competitive conditions***: the efficiency scores generated by the different approaches should be reasonably consistent with competitive conditions in the market. For example, it is suggested that most firms which remain in business for a long period of time should be relatively efficient, as competition in the markets could reduce the number of inefficient firms.

(vi) ***Consistency with standard non-frontier performance measures***: the measured efficiencies from all of the useful approaches should be reasonably consistent with financial ratios, such as return on assets or the cost/revenue ratio. This condition is useful in evaluating the accuracy of the measured efficiencies.

Bauer *et al.* (1998) suggest that consistency conditions (i), (ii), and (iii) can be used to identify the degree to which the different approaches are mutually consistent. These

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points on these segments are only weakly efficient.

conditions are helpful in determining whether the different approaches will give the same answers to regulatory policy questions. Correspondingly, consistency conditions (iv), (v), and (vi) can be used to evaluate the degree to which the efficiencies generated by different approaches are acceptable. These conditions are useful in determining the credibility of the efficiency scores. In addition, Bauer *et al.* (1998) stressed that consistency conditions should be analysed by comparing the application of multiple approaches to a single dataset in order to make efficiency analysis more reliable.

The comparisons of bank efficiencies using more than one approach generate some mixed evidence. Bauer, Berger and Humphrey (1993), Berger and Mester (1997), and Berger and Hannan (1998) compared efficiency using two or more of the parametric approaches. They found that average efficiencies were comparable and consistent with competitive conditions, supporting consistency conditions (i) and (v). In addition, the parametric approaches tend to rank the banks similarly, supporting consistency conditions (ii) and (iii). Bauer *et al.* (1993) and Berger and Mester (1997), however, reported that there are some differences of efficiency measure between SFA (stochastic frontier approach) and DFA (distribution free approach), while Berger and Hannan (1998) found that SFA generates average efficiencies higher than that of DFA.

Ferrier and Lovell (1990), Resti (1997), Bauer *et al.* (1998) and Casu and Girardone (1998) compared bank efficiencies between nonparametric and parametric approaches. DEA and SFA were compared by Ferrier and Lovell (1990), Resti (1997) and Casu and Girardone (1998). These studies reported relatively close average efficiencies generated by the two approaches, supporting consistency condition (i). However, Resti (1997) found high rank-order correlations between DEA and SFA (0.73-0.89), while Ferrier and Lovell (1990) reported insignificant rank-order correlation. Bauer *et al.* (1998) compared SFA, TFA, DFA and DEA, and found that the estimates of parametric approaches supported all consistency conditions. However, the parametric and nonparametric methods were not consistent with each other under these conditions.

Bauer *et al.* (1998) concluded that regulatory policy considerations could be affected by the choice between the parametric and nonparametric approaches; therefore, more robustness checks are needed when using alternative specifications and data sources.

4.2.4 Summary of efficiency studies

There are, then, various approaches for measuring the productive efficiency of the banking firm. Table 4.2 provides a classification of measures, and the number of times the respective measures have been used for 51 efficiency studies between 1985 and 1998, details of which are set out in Appendix I.

Table 4.2 shows that, the most widely used input measures are labour, physical capital, purchased funds and core deposits. The most common output measures are real estate loans, customer loans or loans to individuals, total loans, commercial and industrial loans, and other loans. These are concomitant with the most common use of the intermediation approach in defining bank inputs and outputs. The evidence shows that DEA was the most widely used technique for estimating productive efficiency of banking firms[6].

Table 4.2 Input and output definitions and estimation techniques used in bank efficiency studies

Input measures		*Output measures*	
Classification	**No. of times**	**Classification**	**No. of times**
Labour	45	Real estate loans	19
(physical)capital	28	Customer loans	17
Purchased funds	10	(total)loans	14
(core)deposits	9	Commercial and industrial loans	9
Loanable funds	5	Other loans	9
Time and saving deposit	4	Non-interest income	8
Interest expenses	4	Commercial loans	7
Noninterest expenses	4	(total)securities	6
Borrowed money	3	(total)deposits	5
Total funds	3	Demand deposits	5
Demand deposits	3	Investment securities	4
Certificate of deposits	3	Interest income	3
Expenditures on materials	3	Short-term loans	3
Customer funds	2	Long-term loans	3
Materials	2	Fee-based income	2
Personnel expense	2	Time and saving deposits	2
TOTAL	130	**TOTAL**	116
Definition of inputs and outputs:		*Estimation techniques:*	
Intermediation	36	DEA	23
Production	5	SFA	16
Value-added	5	DFA	8
User cost	3	TFA	6
Asset	2	TOTAL	53
Bank objective	2		
TOTAL	53		

Note: These measures were found to be used in a review of 51 efficiency studies.
Sources: Berger and Humphrey (1997) and author's own updates.

[6] If this study was updated now (2000), there would possibly be a preponderance of SFA (and its variants) techniques.

The review in this section suggests that most banking studies adopt an intermediation approach to specify bank inputs and outputs, and apply the DEA approach for estimating efficiency.

4.3 The measurement of bank productivity changes

This section outlines how productivity can be estimated using efficiency measurement techniques and explains the methodology used to measure total factor productivity for banks.

Total factor productivity (TFP) is an index of output divided by index of total input usage. Grosskopt (1993) noted that total factor productivity is a generalisation of a single –factor productivity measure which is the ratio of (an index of) output to a single input. Total factor productivity growth measures the change in productivity over time.

The Malmquist productivity index (MPI) is one of the standard approaches to measuring productivity change (Coelli, *et al.*, 1998, p.120). MPI measures the differences in total factor productivity between two firms or a single firm at different points of time, based on the assumption that at least one production technology is known. It can be defined using either an output- or an input-orientated approach (see, Coelli *et al.*, 1998, pp.122-3).

The output-orientated productivity measures focus on the maximum level of output that could be produced using a given production technology, relative to the observed level of outputs. Studies using this approach include Grifell-Tatjé and Lovell (1996), Gilbert and Wilson (1998) and Leightner and Lovell (1998)

The input-oriented productivity measures are based on the equiproportionate reduction of inputs, within the context of a given level of output. Studies using this approach include Berg *et al.* (1992), Fukuyama (1995), Worthington (1999) and Glass and Mckillop (2000).

The Malmquist TFP index is defined using distance functions to measure the relative productivity change of each DMU relative to an appropriate production technology. The Malmquist TFP index can be calculated using parametric (stochastic frontier) or nonparametric (DEA) methods for estimating the production frontier, and for measuring the distances of the DMU from this frontier at different points in time. As usually applied, the DEA-like methods require panel data to construct Malmquist TFP indices, which measure the increase in productivity between periods *t* and t+*1*. The reference production technology is either at time *t* or at time *t+1*. This approach can be used to identify the sources of productivity change, as the Malmquist TFP index can be decomposed into technical efficiency and technological change components, and the change in technical efficiency can be further decomposed into changes in scale efficiency and pure technical efficiency. However, a simpler approach is just to use the same production technology as the reference technology for the calculations.

The stochastic frontier methods measure distance for the Malmquist TFP index relative to a parametric technology. This approach requires a pre-specified functional form for technology and distributional assumptions about error terms. The efficiency change component can be calculated from the composite error terms and the technological change index can be calculated from the estimated parameters.

In practice, calculation of the Malmquist TFP index is usually based on the DEA approach. Brown (1996) noted the following reasons:

1. DEA uses a well-tried linear programming methodology for estimating piece-wise linear frontier and calculating relative efficiencies. The method is comparatively more robust because it constructs the best practice frontier from the actual data.
2. There are clear theoretical links between DEA and basic economic concepts. Efficiency can be measured relative to constant, variable, non-increasing and non-decreasing returns to scale production technologies (see, Table 4.1) under both input- and output-orientated approaches.
3. There is no implicit assumption that the units under investigation are operating at full efficiency. Productivity change is the composite of changes in technical efficiency of a DMU and technological changes which shift the production frontier.
4. DEA defines the best-practice frontier from the actual data and therefore, it is not subject to the kind of misspecification errors associated with the stochastic approach.

Coelli *et al.* (1998) noted that the DEA-like linear programming methods suggested by Fare *et al.* (1994) have been the most popular. A commonly used variation of the approach is to calculate the Malmquist TFP index as the geometric mean of two TFP indices. The first is evaluated with respect to period t and the second with respect to period $t+1$ technology. Each MPI index is the product of an index of efficiency change (a catching–up measure) and an index of technological changes (a measure of the local shift of the frontier). As noted in Brown (1996), the productivity change with respect to period t technology is written as:

$$\mathrm{MPI}^t = \left[\frac{\mathrm{E}_{t+1}(t+1)}{\mathrm{E}_t(t)}\right] \times \frac{\mathrm{E}_t(t+1)}{\mathrm{E}_{t+1}(t+1)} \qquad \text{.....................(4.1)}$$

where the first bracket is the measure of efficiency change between the two periods (t and $t+1$) and the second bracket is a measure of technological change between the two periods that based on period $t+1$ inputs and outputs. Equation (4.1) can be re-written as:

$$\mathrm{MPI}^t = \left[\frac{\mathrm{E}_t(t+1)}{\mathrm{E}_t(t)}\right] \qquad \text{.....................(4.2)}$$

where $\mathrm{E}_t(t+1)$ is a cross-efficiency, measures efficiency of a unit in period t using technology in period $t+1$ as a base period[7]. $\mathrm{E}_t(t)$ is a "true" relative (technical) efficiency in period t.

Similarly to equations (4.1) and (4.2), the productivity change with respect to technology in period $t+1$ is written as:

[7] Cross-efficiency may have a value greater than unity if the combination of inputs and outputs achieved by a unit in $t+1$ lies outside the frontier defined by the group in period t.

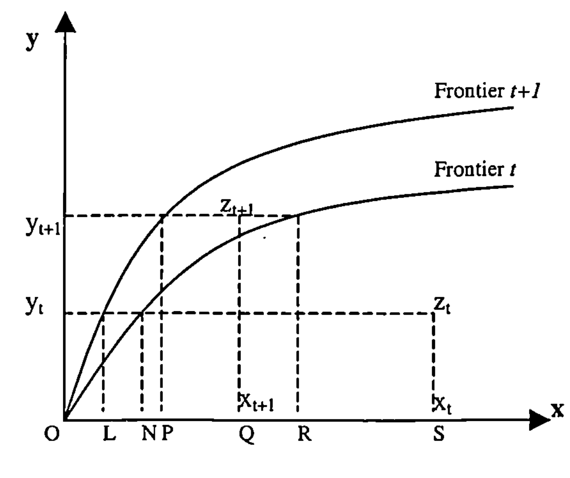
$$\mathrm{MPI}^{t+1} = \left[\frac{\mathrm{E}_{t+1}(t+1)}{\mathrm{E}_t(t)}\right] \times \frac{\mathrm{E}_t(t)}{\mathrm{E}_{t+1}(t)}$$

$$= \left[\frac{\mathrm{E}_{t+1}(t+1)}{\mathrm{E}_{t+1}(t)}\right] \qquad \text{.....................(4.3)}$$

That is, the technological change is measured using inputs and outputs at period *t* as a base period. $\mathrm{E}_{t+1}(t+1)$ is a true relative (technical) efficiency at period *t+1* and $\mathrm{E}_{t+1}(t)$ is a cross-efficiency measure.

The geometric mean of productivity change of the two TFP indices defined above is the square root of $\left[\frac{\mathrm{E}_t(t)}{\mathrm{E}_{t+1}(t)}\right] \times \left[\frac{\mathrm{E}_t(t+1)}{\mathrm{E}_{t+1}(t+1)}\right]$. A value greater (less) than unity indicates an improvement (decline) and a value equal to one indicates a stagnation of productivity.

Figure 4.4 The input-orientated Malmquist TFP index and productivity changes



Source: Worthington (1999)

Figure 4.3 illustrates the input-orientated Malmquist TFP index that will be used in this study[8]. The problem is how to compare a unit (bank) producing output y^t with input x^t

[8] The output-orientated approach is well explained in Chapter 10 of Coelli *et al.* (1998).

in period t with the same unit producing output y^{t+1} with input x^{t+1} in period $t+1$. Figure 4.3 shows production frontiers of the **x** and **y** vectors of inputs and outputs at t and $t+1$ time periods. Given that z^t is an input/output bundle of bank in period t, the relative technical efficiency, E_t, is the horizontal distance ratio *ON/OS*. That is, inputs can be reduced in order to make production technically efficient in period t. It reflects the "catching-up" to the best practice frontier. In comparison with the input/output bundle in period $t+1$ (z^{t+1}), inputs in period $t+1$ should be multiplied by the horizontal distance ratio *OR/OQ* in order to achieve E_t, the technical efficiency found in period t. The distance *OR/OQ* reflects the technological progress or the outward shift of frontier.

4.4 Empirical evidence on the impact of financial deregulation

This section reviews the empirical studies on the impact of deregulation on bank efficiency and productivity. The aim is to identify the methodology used to measure the effects of financial deregulation and examine the findings of the existing studies.

Table 4.3 shows mixed evidence on the impact of deregulation in the banking sector. However, the major findings support the hypothesis that the deregulation improves efficiency and productivity of banks. Table 4.3 shows that 10 out of 13 studies used the DEA approach to estimate efficiency and productivity of banks. The effects of financial deregulation are then measured either by the average change of efficiency and productivity over the periods studied or by regression analysis.

Table 4.3 Review of banking studies on the impact of financial deregulation

Author(s)	Measure of bank performance	Measure of effects from deregulation	Sample	Results
Humphrey, 1991	The growth accounting measures of bank productivity	Average productivity growth rate	US banks, 1977-1987	Productivity growth at –0.07% to 0.60% per year
Berg, Førsund and Jansen, 1992	DEA approach to calculate MPI	Annual average MPI	152 Norwegian banks, 1980-1989	Rapid productivity growth after deregulation
Humphrey, 1993	SUR procedure to estimate three alternative specifications of bank net technical change*	Net technical change	683 of the largest banks in US, 1977-1988	Average rate of net technical change between –0.08% and –1.4% a year. Large banks experienced less negative technical change
Grabowski, Rangan and Rezvanian, 1994	DEA approach to measure efficiency	A comparison of average efficiency	669 US banks, 1979, 1983, 1987	Overall efficiency declined after deregulation (from 1983 to 1987).
Elyasiani and Mehdian, 1995	DEA approach to measure efficiency	The differences between pre-and post-deregulation efficiency measure; rate of technological change	150 US banks, 1979 and 1986	Large banks were more efficient in 1986, while small banks achieved technological progress over 1979-1986
Zaim, 1995	DEA approach to measure efficiency	A comparison of average efficiency	Turkish banks, 1989-1994	Average technical efficiency increased about 10%
Grifell-Tatjé and Lovell, 1996	DEA approach to calculate MPI	Changes in MPI and its components	Spanish savings banks, 1986, 1991	The slight increase in technical efficiency and no improvement in productivity
Bhattacharyya, Lovell, Sahay, 1997	DEA approach to measure efficiency	Stochastic frontier regression	Indian banks, 1986-1991	Foreign banks became more efficient as they expand branch networks into metropolitan areas
Humphrey and Pulley, 1997	TFA approach to estimate the composite profit function	Changes in profit, technology and business environment and profit efficiency for pre-deregulation, concurrent and post-deregulation	683 US banks, 1977-1988	Banks relied on an improved business environment to increase their profits. The values of inefficiency declined.
Gilbert and Wilson, 1998	DEA approach to calculate MPI	Changes in productivity over the periods 1980/85, 1980/89 and 1980/94	Korean banks, 1980-1994	An increase in productivity
Leightner and Lovell, 1998	DEA approach to calculate MPI and MGI	Annual average MPI	Thai banks, 1989-1994	Average productivity increased
Chen and Yeh, 1999	DEA approach to measure efficiency and calculate MPI	Average efficiency and MPI	34 Taiwanese banks, 1995-1996	Privately owned banks are more efficient. Average MPI = 1.013
Okuda and Mieno, 1999	Translog cost function to measure inefficieny, economies of scale and technological progress	Average level of inefficiency, economies of scale and the rate of technological progress	15 Thai commercial banks, 1985-1994	Large-sized banks had the highest inefficiency index. Medium sized banks had the lowest inefficiency, technological progress, but higher level of economies of scale.

Note: DEA = Data Envelopment Analysis, MPI = Malmquist Productivity Index, MGI = Malmquist Growth Index, TFA = Thick Frontier Approach, SUR = Seemingly Unrelated Regression. (*) These are standard time trends, time specific index, and shifts in cross sectional cost functions.

Coelli *et al.* (1998) note that most studies of (in)efficiency used the following two approaches to assess the impact of environmental factors[9].

1) The single-stage approach. This method estimates inefficiencies from a stochastic frontier model, in which environmental variables are incorporated, and inefficiency effects are estimated in a single-stage maximum likelihood procedure.

2) The two-stage approach. This method involves estimating inefficiencies in the first stage, using either econometric or nonparametric approaches. The efficiency scores of firms in an industry are then explained by regressing calculated efficiencies on a vector of environmental variables in the second-stage analysis.

The single-stage approach is well-suited to stochastic frontier analysis, where it is easy to add explanatory variables to the basic model. Coelli *et al.* (1998, p. 171) suggested various reasons for using the two-stage approach to assess the influence of environmental factors on efficiency scores calculated from a DEA analysis, rather than attempting to incorporate environmental variables in the linear programming model:

1. It can accommodate more than one variable.
2. It can accommodate both continuous and categorical variables.
3. It does not make prior assumptions regarding the direction of the influence of the categorical variable.
4. It is possible to conduct hypothesis tests on whether the environmental variables have a significant influence on efficiencies.
5. It is easy to calculate.
6. The method is simple and transparent.

Table 4.4 shows some studies using the two-stage approach to calculate efficiency and productivity indices and examine the effects of environmental factors. There are 8 studies using DEA in the first-stage and the Tobit model in the second-stage analysis.

[9] The term "environmental" refers to factors that could influence the efficiency and productivity of a firm, where such factors are not traditional inputs/outputs and are not under control of management.

Of the 21 studies, 13 used DEA in the first-stage, while 9 studies used the ordinary least-squares regression in the second-stage.

Table 4.4 Example of studies using the two-stage approach

Author(s)	First-stage	Second-stage	Industry type
Efficiency Analysis			
Aly *et al.* (1990)	DEA	OLS	Bank
Bjurek *et al.* (1992)	DEA	Tobit	Daycare center
Mester (1993)	SFA	Logistic	Savings and Loans
Elyasiani *et al.* (1994)	DEA	OLS	Bank
Kaparakis *et al.* (1994)	SFA	OLS	Bank
Luoma *et al.* (1996)	DEA	Tobit	Health center
Mester (1996)	SFA	Logistic	Bank
Miller and Noulas (1996)	DEA	OLS	Bank
Rai (1996)	SFA	OLS	Insurance
Berger and Mester (1997)	SFA	OLS	Bank
Bhattacharyya *et al.* (1997)	DEA	SFR	Bank
Donni and Fecher (1997)	DEA	Tobit	Insurance
Gillen and Lall (1997)	DEA	Tobit	Airport
Mester (1997)	SFA	Logistic	Bank
Peristiani (1997)	DFA	OLS	Bank
Chang and Hsieh, 1998	DEA	Tobit	CDFA
De Young *et al.* (1998)	SFA	OLS	Bank
Viitala and Hänninen (1998)	DEA	Tobit	Forestry organisation
Ruggiero and Vitaliano (1999)	SFA, DEA	Tobit	School
Productivity Analysis			
Worthington (1999)	DEA	OLS	Credit union
Glass and McKillop (2000)	DEA	Tobit	Building societies

Notes: DEA= Data Envelopment Analysis, SFA= Stochastic Frontier Approach, DFA= Distribution Free Approach, OLS= Ordinary Least Square, SFR= Stochastic Frontier Regression, CDFA = the Credit Department of Farmers' Association.

4.5 Conclusion

This chapter defined the concepts of productive efficiency and reviewed the frontier approaches for estimating efficiency and productivity of banks. The review of empirical studies showed that inputs and outputs of banks are mainly specified using the intermediation approach. Currently, there are two main methods; parametric and nonparametric, for measuring productive efficiency and productivity of banking firms. The difference between these two approaches is in the underlying assumptions imposed in the models used for the estimations.

The nonparametric DEA approach has certain advantages that it does not require an *a priori* specification about the underlying unknown technology, nor price information, and it uses a mathematical linear programming formulation which makes these methods comparatively robust. Also, a modification of the DEA methods can be used to calculate productivity indices and identify the sources of productivity and efficiency change.

This chapter has explored the various techniques for measuring productive efficiency in banking. It is clear that no single technique can be argued to be unambiguously superior to others. Nevertheless, the technique has to be chosen and the researcher has selected DEA and the intermediation approach. The latter is widely used in the empirical literature. DEA is also widely used and appears to offer several attractive features for present purposes (and these have been summarised in the present chapter).

Chapter 5 Exploratory Data Analysis of the Thai Banking System

INTRODUCTION

Financial analysis of a bank's balance sheet, income statement, and statement of change in financial position is essential in order to understand the bank's prevailing strengths and weaknesses (see, for example, Sinkey (1998) and Hempel and Simonson (1999)). For bank managers, a thorough analysis of the bank's financial position allows an assessment of their past and present performance relative to where they want the bank to be in the future and where the bank stands relative to others in the industry i.e. to benchmark banking performance. For bank regulators, financial statement analysis permits some evaluation of the potential impact of changes in regulation and supervision on the bank's current and prospective financial performance and condition.

Financial analysis is increasingly important for a bank during the current period of financial deregulation. In operating terms, a commercial bank is a business charged with the responsibility to its owners of attempting to maximise the value of shareholders' wealth invested in the bank at an acceptable level of risk (Rose, 1991, p.127). Therefore, an analysis of the performance and condition of a bank is a necessary step for bank managers in planning for the risks taken in order to produce adequate returns in the future, and for bank regulators in evaluating the impact of changes in regulatory policy.

There are many approaches for analysing bank financial statements. One of the most widely used practical techniques is financial ratio analysis. The basic component of ratio analysis is a single ratio, calculated by dividing one balance sheet and/or income statement item by another. Thus, ratio analysis is a simple way of processing two pieces of information into one and, as a result, it summarises and limits information content. In order to provide a meaningful basis for evaluating a bank's financial statements, it is necessary to make comparisons with other banks and/or with a bank's own performance over time.

The aim of this chapter is to investigate whether the financial performance of banks during the 1990-97 financial deregulation generally improved by examining financial ratios which are indicators of return, risk and efficiency. We investigate financial ratios of bank efficiency which can be used to provide information on bank productive efficiency. *Ceteris paribus*, risk, return and efficiency of a bank should improve if financial deregulation has enhanced the financial performance of banks. This financial ratio analysis, then, is an exploratory data analysis, a prelude to the following more detailed work on efficiency analysis.

An overall improvement or deterioration of return, risk and efficiency is indicated by the respective average financial ratio for Thai and foreign banks and the FSIs (finance and specialised institutions) between 1990 and 1997. The variability of ratios is measured by their standard deviation, while the coefficient of variation is a measure of their relative dispersions. Finally, we examine whether there was a large deterioration of performance, risk and efficiency measures in 1997 relative to the 1990-96 averages since this may have been a possible impact of the financial crisis.

This chapter is organised as follows. Section 1 outlines the data used in this study. Section 2 analyses bank returns (profitability), while section 3 examines bank risk. Section 4 explores the efficiency of banks. Section 5 reviews the overall financial performance of banks during 1990-97. Section 6 explores the relationship between bank size and financial performance and section 7 concludes.

5.1 Data sources and information

This section gives details of the banking institutions that comprise the unbalanced panel data used in this study over the period 1990-1997. The sample of 379 decision making units (DMUs) consist of 15 Thai banks, 20 foreign bank branches, 5 specialised financial institutions and 27 finance companies.

Table 5.1 Sample of Thai financial institutions (DMUs)

	1990	1991	1992	1993	1994	1995	1996	1997	Total
Thai banks	15	15	15	15	15	15	15	15	**120**
Foreign bank branches	14	14	14	14	14	14	14	20	**118**
Specialised institutions	n.a.	n.a.	1	2	4	4	5	5	**21**
Finance Companies	1	7	13	20	25	26	22	6	**120**
Total	30	36	43	51	58	59	56	46	**379**

The 15 Thai banks, shown in Table 5.1, from 1990 to 1997 are the same each year[1]. The 14 foreign banks shown from 1990 to 1996 are the same for each year and all these are also present in 1997 with the addition of 6 new foreign banks[2]. Meanwhile, a list of 5 specialised institutions and 27 finance companies included in one or more individual years in Table 5.1 can be seen in Appendix II. Table 5.1 shows that this study employed 120 DMUs of Thai banks, 118 DMUs of foreign banks and 141 DMUs of finance and specialised institutions over the 1990 to 1997 period.

The data used for this study and explored in this chapter have been obtained from several sources. First, the balance sheets of Thai commercial banks and foreign bank branches are taken from *Commercial Banks in Thailand*, an annual publication of Bangkok Bank. Secondly, the income statements of Thai commercial banks during 1990-96 are drawn from the financial data publication of the Bank of Thailand, while the 1997 data are from the Thai Securities Exchange Commission homepage, the Bangkok Bank and Bangkok Bank of Commerce annual reports. Thirdly, data on expenses of individual foreign bank branches were obtained directly from the Bank of Thailand. Finally, the balance sheet and income statement for 5 specialised financial institutions and 23 finance companies are drawn from the London-based International Bank Credit Analysis *Bankscope* database, which contains fewer institutions in the earlier years.

[1] The 15 Thai banks are BBL, KTB, TFB, SCB, AYD, TMB, FBC, SCIB, BMB, BBC, BOA, TDB, NKB, UBB, and LTB.
[2] The 14 foreign banks are Tokyo, Sakura, Citibank, Deutsche, STCB, Indosuez, HSBC, Chase, America, ABN, Bharat, ICBC, SIME, and OCBC. The 6 new foreign banks are DKB, Dresdner, BNP, Sumitomo, IBJ and BOC.

5.2 An exploratory analysis of bank profitability

This section analyses the returns (profitability) of banks during the 1990-97 financial deregulation. The common measures used are returns on equity (ROE), returns on assets (ROA) and equity multiplier (EM). Return indicators are important in measuring overall bank performance because adequate returns are essential for sustaining the flow of capital resources from the shareholders to a bank. The relationship between ROE, ROA and EM can be summarised in the well-known ROE-decomposition model:

$$ROE = ROA \times EM \tag{5.1}$$

ROE is firstly analysed as an overall performance measure because it reflects how well the bank has performed on all of its profit-generating activities (ROA) as well as the impact of the bank's leverage or equity multiplier (EM).

5.2.1 Return on Equity (ROE)

ROE compares net income after tax to equity capital; ROE is the product of ROA and EM (see equation 5.1). It approximates the rate of return the shareholders have received for investing their capital (Rose, 1991, p.130). *Ceteris paribus*, the higher the ratio, the more profitable the bank.

Table 5.2 Average return on equity, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
Mean	0.11	0.10	0.14	0.16	0.17	0.17	0.14	-0.28	0.14	0.09
Foreign bank branches										
Mean	0.14	0.15	0.16	0.16	0.10	0.08	0.05	0.02*	0.12	0.11
Finance and specialised institutions (FSIs)										
Mean	n.a.	0.20	0.23	0.24	0.21	0.12	0.11	-0.76	0.19	0.05

Note: * The value is exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average of 0.022 in 1997.

Table 5.2 shows that the average ROEs of Thai banks increased by 55% from 1990 to 1995. Similarly, the average ROEs of foreign banks increased by 14% from 1990 to 1993 and FSIs had the relatively higher average than the other two groups during 1990-94. This reflects an increased profitability of banks following the deregulation. However, there was a sharp drop in the average ROEs for the three groups of banks in 1997, which may have been the effects of the financial crisis. Table 5.2 shows that foreign banks had the highest average ROE in 1997 and the decrease was partly due to an entry of 6 new banks.

Figure 5.1 shows that upward trend of average ROEs during 1991-93, indicating a possible positive impact of the financial deregulation. Subsequently, there was a downward trend of average ROEs, which dropped markedly in 1997 as an apparent result of the financial crisis.

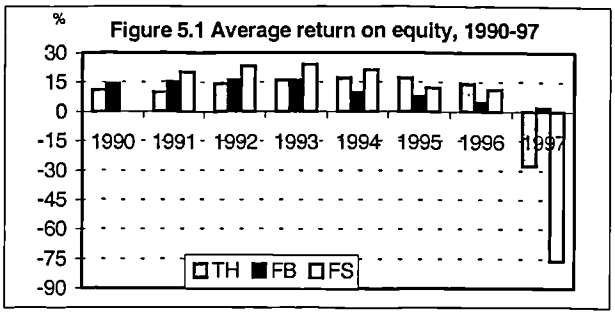


Table 5.3 shows the possible effect of the 1997 financial crisis on the average ROEs of Thai and foreign banks. With the exception for Bharat and ICBC, the 1997 ROE for each of 20 banks was less than that of the 1990-96 average. Individual banks that experienced large financial losses include FBC, SCIB, BOA, NKB, UBB, LTB, Tokyo, Sakura, Deutsche, STCB, Indosuez, ABN and Sime, while BMB and BBC were insolvent in 1997.

Table 5.3 ROE of Thai and foreign banks, 1990-96 and 1990-97

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	20.5	3.9	-81	**Tokyo**	12.5	1.0	-92
KTB	15.9	0.5	-97	**Sakura**	8.4	1.7	-80
TFB	21.2	1.4	-93	Citibank	19.4	n.a.	n.a.
SCB	19.8	7.7	-61	**Deutsche**	12.1	0.0	-100
AYD	16.7	7.5	-55	**STCB**	14.1	-1.2	-109
TMB	18.0	5.9	-67	**Indosuez**	17.3	0.0	-100
FBC	12.5	-147.9	-1283	HSBC	27.3	n.a.	n.a.
SCIB	18.5	-115.8	-726	Chase	10.5	n.a.	n.a.
BMB	7.3	n.a.	n.a.	America	7.1	n.a.	n.a.
BBC	3.1	n.a.	n.a.	**ABN**	8.5	-0.1	-101
BOA	12.5	-4.2	-134	Bharat	11.1	14.9	34
TDB	12.7	0.3	-98	ICBC	10.0	10.5	5
NKB	14.1	-4.0	-128	**Sime**	12.9	-5.1	-140
UBB	11.8	-102.3	-967	OCBC	5.0	n.a.	n.a.
LTB	7.9	-22.7	-387				

Note: The figures are shown in percentage.

The analysis in this section suggests that banks were more profitable at the beginning of deregulation, but less profitable in later years preceding the financial crisis. FSIs and Thai banks were better at maximising the returns for shareholders (up until 1996).

5.2.2 Return on assets (ROA)

ROA indicates how capable the management of the bank is in increasing the earnings from the bank's assets: it is computed by dividing net income by total assets. Sinkey (1998, p.545) argues that ROA is the most comprehensive accounting measure of a bank's overall performance because it measures profitability from the overall efficiency of a bank's use of its total assets. The higher the ratio, the better the management of a bank *ceteris paribus*.

Table 5.4 Average return on assets, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
Mean	0.70	0.68	0.96	1.16	1.34	1.28	1.08	-2.86	1.03	0.54
Foreign bank branches										
Mean	2.37	2.81	3.23	2.79	2.16	2.07	1.95	0.15*	2.48	2.20
Finance and specialised institutions (FSIs)										
Mean	n.a.	1.72	2.64	2.45	2.44	1.43	1.17	-3.16	1.98	1.24

Note: The figures are shown in percentage. * The value is exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average of 0.21% in 1997.

Table 5.4 shows similar results to those in Table 5.2. Average ROAs for Thai banks increased by around 90% from 1990 to 1994, while foreign banks had an increase of 36% from 1990 to 1992 and FSIs had a 53% increase from 1991 to 1992. Subsequently, the averages for the three groups of banks declined to the lowest in 1997 as an apparent result of financial crisis. Overall results are consistent to those in Table 5.2: foreign banks had the highest profitability on average. A better performance in 1997 was partly due to an entry of 6 new banks.

Figure 5.2 Average return on assets, 1990-97

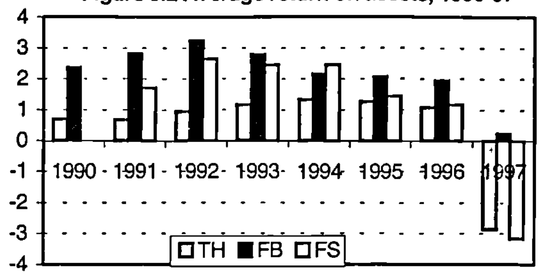


Figure 5.2 shows that there was an upward trend of average ROAs for banks from 1990 to 1993, suggesting a positive response to financial deregulation, taking advantage of the opportunities it afforded for expanding business. Thereafter, the trend appeared to decline and it dropped sharply in 1997. Foreign banks experienced a smaller fall in ROA than did the other two groups analysed.

Table 5.5 ROA of Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	1.58	0.29	-82	Tokyo	1.55	0.20	-87
KTB	1.00	0.03	-97	Sakura	0.95	1.43	51
TFB	1.63	0.10	-94	Citibank	2.04	n.a.	n.a.
SCB	1.49	0.45	-70	**Deutsche**	1.65	-0.01	-101
AYD	1.26	0.40	-68	**STCB**	2.16	-0.57	-126
TMB	1.25	0.35	-72	**Indosuez**	3.01	0.01	-100
FBC	1.19	-9.96	-937	HSBC	3.33	n.a.	n.a.
SCIB	1.30	-5.14	-495	Chase	3.58	n.a.	n.a.
BMB	0.56	-12.39	-2313	America	2.51	n.a.	n.a.
BBC	0.01	n.a.	n.a.	**ABN**	2.60	-0.02	-101
BOA	0.93	-0.27	-129	Bharat	1.71	1.38	-19
TDB	0.90	0.02	-98	ICBC	2.37	1.45	-39
NKB	0.93	-0.23	-125	**Sime**	6.98	-2.56	-137
UBB	0.77	-4.07	-629	OCBC	1.52	n.a.	n.a.
LTB	0.61	-1.72	-382				

Note: The figures are shown in percentage.

Table 5.5 shows in more detail how Thai and foreign banks may have been affected by the 1997 financial crisis. The 1997 ROA for 22 out of 29 banks were less than the 1990-96 averages. A substantial decrease is reported by BMB, SCIB, FBC, BOA, NKB, UBB, LTB, Deutsche, STCB, Indosuez, ABN and Sime. Meanwhile ROA for Sakura Bank in 1997 was 51% greater than its 1990-96 average. Overall results are similar to those in Table 5.3.

The analysis in this section suggests that foreign banks were better at increasing ROA than their Thai counterparts.

5.2.3 Equity multiplier (EM)

EM provides a measure of the bank's degree of financial leverage: it is calculated by dividing total assets by equity capital, the reciprocal of the capital to assets ratio. The larger the multiplier, the greater the probability of bank insolvency *ceteris paribus*, because equity must be used to absorb losses on the bank's assets (Rose, 1991, p.134). In practice, bank regulators seek to restrain large EM values.

Table 5.6 Average equity multiplier, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
Mean	16.0	16.0	15.1	14.3	13.7	13.2	12.1	17.0	14.3	14.7
Foreign bank branches										
Mean	6.4	6.5	6.3	6.6	5.8	3.6	3.3	4.3*	5.5	5.3
Finance and specialised institutions (FSIs)										
Mean	n.a.	11.8	9.0	10.3	9.6	9.3	10.3	22.7	10.0	11.8

Note: Mean of Thai banks in 1997 was calculated after excluding BMB and BBC because their equities are negative. * The value is exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average of 3.5 in 1997, increased by 6% from 1996.

Table 5.6 shows that average EMs for Thai and foreign banks decreased respectively by 24% and 48% from 1990 to 1996, while those for FSIs had a small change partly due to the differences in the number of DMUs (see, Table 5.1). There was a large increase in average EMs in 1997 relative to 1996 for Thai banks (40%), foreign banks (6%) and FSIs (120%) that was possibly due to the financial crisis. A better performance of foreign banks in 1997 was partly due to an entry of 6 new banks. Overall results indicate that foreign banks had the lowest average EMs and hence lower risks than the other two groups.

Figure 5.3 Average equity multiplier, 1990-97

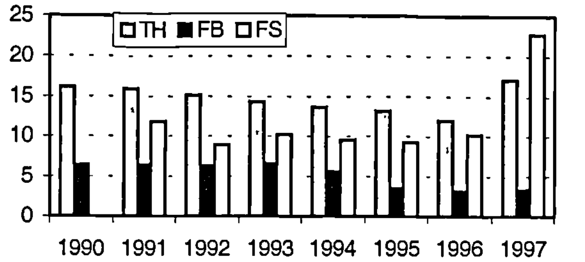


Figure 5.3 shows that the average EMs of Thai banks and the FSIs were higher than those of foreign banks. The results suggest that foreign banks were, on average, less exposed to solvency risk than the others.

Table 5.7 EM of Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	13.6	13.6	0	Tokyo	7.8	5.0	-36
KTB	17.1	17.3	1	Sakura	8.4	1.2	-86
TFB	13.4	14.0	4	Citibank	9.5	17.8	87
SCB	13.4	17.2	28	Deutsche	7.1	2.1	-70
AYD	13.2	18.8	42	STCB	6.1	2.1	-66
TMB	14.7	16.9	15	Indosuez	5.3	1.6	-70
FBC	11.3	14.9	32	HSBC	7.3	3.8	-48
SCIB	14.3	22.5	57	Chase	3.6	1.5	-58
BMB*	13.7	n.a	n.a.	America	3.4	1.5	-56
BBC*	17.1	n.a	n.a.	ABN	2.8	3.3	18
BOA	13.9	15.6	12	Bharat	6.3	10.8	71
TDB	14.3	14.3	0	ICBC	4.4	7.2	64
NKB	15.4	17.4	13	Sime	1.8	2.0	11
UBB	16.7	25.1	50	OCBC	3.3	1.4	-58
LTB	13.0	13.2	2				

Note: (*)The ratios for BMB and BBC were negative in 1997.

Table 5.7 shows that EMs in 1997 for 9 out of 14 foreign banks were lower than the 1990-96 averages, implying their improvement in bank capital. On the other hand, EMs of 13 Thai and 5 foreign banks in 1997 were greater and these may have been the effects of the financial crisis. AYD, SCIB, UBB, Citibank, Bharat and ICBC were apparently more exposed to solvency risk.

The analysis of return measures suggests that foreign banks, on average, produced a better performance than Thai banks and FSIs. The results indicate that the profitability of all banks improved between 1990 and 1993. Subsequently, there was a downward trend in the average ROE, which resulted from a decline in both ROA and EM. Thai banks and FSIs seem to have been more affected by the 1997 financial crisis. The better performance of foreign banks in 1997 was due mainly to their higher ROAs, despite their relatively low EMs.

5.3 An exploratory analysis of bank risk

In evaluating bank performance, risk measures are related to return because a bank must earn adequate profit to cover the risks assumed. In practice, risk-averse banks prefer the highest returns for a given level of risks and the lowest risks for a given level of returns. An appropriate degree of total risks a bank should take is influenced by, first, its past performance in which adequate returns were obtained. A bank's level of risk should also be compared with similar banks and/or peer groups of banks. This section examines five main categories of risk measurement: earnings risk, risk index, capital adequacy risk, liquidity risk and credit risk.

5.3.1 Earnings risk

Earnings risk is simply the risk of unexpected variability in a bank's earnings. Rose (1991, p.142) noted that earnings may decline unexpectedly due to internal factors or due to external factors, such as changes in economic conditions or changes in law and regulation. Earnings risk of a bank can be measured by variability of the bank's ROE and ROA. *Ceteris paribus*, higher variabilities of ROE and ROA indicate a greater earnings risk exposure for a bank.

Table 5.8 Variability of return on equity, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
STDEV	0.06	0.05	0.06	0.07	0.05	0.05	0.08	0.55	0.06	0.12
CV	0.52	0.47	0.43	0.43	0.29	0.33	0.59	1.92	0.44	0.62
Foreign bank branches										
STDEV	0.07	0.09	0.07	0.09	0.04	0.09	0.04	0.06*	0.07	0.07
CV	0.49	0.62	0.41	0.53	0.40	1.19	0.76	2.58*	0.58	0.62
Finance and specialised institutions (FSIs)										
STDEV	n.a.	0.07	0.10	0.09	0.08	0.08	0.06	1.74	0.08	0.32
CV	n.a.	0.36	0.41	0.37	0.40	0.66	0.58	2.28	0.43	6.33

Notes: STDEV= Standard deviation, CV = Coefficient of variation. * The values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had STDEV =0.05 and CV = 2.82 in 1997.

Table 5.8 shows that variability and relative dispersion of ROEs for the three groups of banks during 1990-96 were lower than in 1997. This reflects an increased earnings risk in 1997, which could be viewed as the impact of the financial crisis. The results suggest that foreign banks had lower risks than the other two groups in 1997, although their ROEs were more dispersed partly because of 6 new bank entries.

Variability of ROA is a standard measure of risk in bank financial management (Sinkey, 1998, p.95). It provides a comprehensive measure that captures not only credit risk but also interest-rate risk, liquidity risk, operating risk and any other risk that is realised in bank earnings. The larger the variability of ROA *ceteris paribus*, the higher the earnings risk of a bank.

Table 5.9 Variability of return on assets, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
STDEV	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.05	0.00	0.01
CV	0.52	0.53	0.45	0.39	0.35	0.36	0.80	1.60	0.47	1.83
Foreign bank branches										
STDEV	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.01*	0.02	0.02
CV	0.51	0.79	0.74	0.45	0.74	0.86	0.76	8.64*	0.69	0.74
Finance and specialised institutions (FSIs)										
STDEV	n.a.	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0.01	0.01
CV	n.a.	0.32	0.32	0.35	0.54	0.66	0.53	1.39	0.43	1.10

Note: STDEV= Standard deviation, CV = Coefficient of variation. * The values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had STDEV =0.01 and CV = 4.90 in 1997.

Table 5.9 shows that the results of Thai banks and FSIs are similar to those in Table 5.8: their earning risks in 1997 were greater than those during 1990-96. On the other hand, foreign banks had lower variability but highest relative dispersion in 1997 relative to

1990-96. This suggests that foreign banks had a lower earnings risk in 1997, while their ROAs became the most dispersed from the mean.

The analysis in this section suggests that foreign banks had lowest earnings risk in 1997 and that an increased earnings risk appeared to have resulted from the financial crisis.

5.3.2 Risk index

Risk index (RI) is a measure of how much a bank's accounting earnings can decline before it has a negative book value (Sinkey, 1998, p.96); it reflects overall bank risk. The risk index is computed as follows:

$$RI = [E(ROA) + CAP]/\delta_{ROA} \qquad \text{.......................... (5.2)}$$

where E(ROA) is the expected return on assets, CAP is the bank's ratio of equity capital to total assets, and δ_{ROA} is the standard deviation of ROA. Following Sinkey (1998), it is assumed that E(ROA) is equivalent to ROA. A higher RI indicates a safer bank, while a lower RI suggests otherwise.

Table 5.10 Average risk index, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
RI	20	20	18	18	19	20	12	0.4	18	16
Foreign bank branches										
RI	18	10	10	22	21	25	33	34*	20	24
Finance and specialised institutions (FSIs)										
RI	n.a.	20	18	15	11	14	19	1	16	14

Note: RI= risk index. * The value is exclusive of 6 new banks. Foreign banks, including 6 new banks, had a risk index of 50 in 1997, increased by 52% from 1996

Table 5.10 shows that risk index for Thai banks decreased by 40%, while foreign banks had a 65% increase in risk index from 1990 to 1996. On the other hand, the changes in risk index of FSIs during 1990-96 were partly due to the differences in the number of DMUs. Table 5.10 shows that risk indexes for Thai banks and FSIs in 1997 were less than those averages during 1990-96. A substantial decrease reflects the increased risk in 1997 as an apparent result of the financial crisis. Foreign banks, however, had a large increase (85%) in 1997 relative to 1996 due to an entry of 6 new banks.

This analysis using the risk index shows that there was an increased financial risk of Thai banks and FSIs in 1997, while foreign banks improved their financial strength during 1990-97.

5.3.3 Capital adequacy risk

A bank's capital adequacy indicates its ability to absorb unanticipated losses associated with the various risks of banking (Sinkey, 1998, p.545). The most important risks for commercial banks are portfolio risks like credit risk, liquidity risk and interest rate risk. For bank regulators, capital adequacy standards are regarded as the most important measures of safety and soundness for depository institutions because capital is viewed as a cushion for absorbing losses. *Ceteris paribus*, the greater the capital, the lower the probability of insolvency. Capital risk is inversely related to the EM and, therefore, to the ROE.

The adequacy of bank capital can be gauged, first, by the variability of EMs because EM is a kind of capital ratio that measures capital risk from the shareholders' perspective. The larger the variability the greater the bank's capital risk. In practice, there are many ratios for assessing the adequacy of capital (see, for example, Hempel and Simonson, 1999). The common ratios include capital to deposits, capital to assets, capital to risk assets, tier one capital ratio and tier two capital ratio. This section examines the variability of EM and the ratios of equity capital to total assets and to total deposits, where equity capital consists of issued and paid-up capital plus reserves and retained profits plus other reserves.

Table 5.11 Variability of equity multiplier, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
STDEV	3.2	3.4	2.4	3.1	2.9	1.9	2.7	3.5	2.8	2.9
CV	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2
Foreign bank branches										
STDEV	2.6	2.4	2.9	4.1	3.6	2.7	2.6	4.7*	3.0	3.1
CV	0.4	0.4	0.5	0.6	0.6	0.8	0.8	1.1*	0.6	0.7
Finance and specialised institutions (FSIs)										
STDEV	n.a.	3.5	3.3	2.9	3.2	3.0	3.6	20.0	3.2	5.6
CV	n.a.	0.3	0.4	0.3	0.3	0.3	0.4	0.9	0.3	0.4

Notes: STDEV= Standard Deviation, CV= Coefficient of Variation. * The values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had STDEV = 4.2 and CV = 1.2 in 1997.

Table 5.11 shows that variability of EMs for the three groups of banks in 1997 were greater than those during 1990-96. An increase in capital risk for banks in 1997 was due to the large increases in the EM of some Thai and foreign banks (see, Table 5.7) and the differences in the number of DMUs for FSIs. The results may reflect the adverse impact of the 1997 financial crisis, which was substantial for the FSIs.

Table 5.12 Average equity to assets ratio, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
Mean	0.07	0.07	0.07	0.07	0.08	0.08	0.09	0.05	0.07	0.07
STDEV	0.02	0.01	0.01	0.01	0.02	0.01	0.03	0.01	0.02	0.02
CV	0.25	0.21	0.16	0.17	0.21	0.18	0.35	0.23	0.22	0.22
Foreign bank branches										
Mean	0.20	0.19	0.21	0.24	0.31	0.43	0.47	0.43*	0.29	0.32
STDEV	0.13	0.13	0.13	0.18	0.26	0.24	0.25	0.25*	0.19	0.20
CV	0.67	0.68	0.62	0.73	0.86	0.57	0.54	0.58*	0.67	0.65
Finance and specialised institutions (FSIs)										
Mean	n.a.	0.09	0.13	0.10	0.12	0.12	0.11	0.07	0.11	0.11
STDEV	n.a.	0.04	0.05	0.03	0.04	0.04	0.04	0.04	0.04	0.04
CV	n.a.	0.38	0.41	0.28	0.36	0.30	0.33	0.57	0.34	0.37

Notes: STDEV= standard deviation, CV= coefficient of variation. * The values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average = 0.52 with STDEV = 0.26.

Table 5.12 shows consistent results to those in Table 5.6. Foreign banks had steadily increased their capital strength; an 11% increase in the average equity to assets ratio from 1996 to 1997 was due to an entry of 6 new banks. Meanwhile, capital risks of Thai banks and FSIs in 1997were greater than those during 1990-96. This suggests that they may have been affected by the financial crisis.

Figure 5.4 Average equity to assets ratio, 1990-97

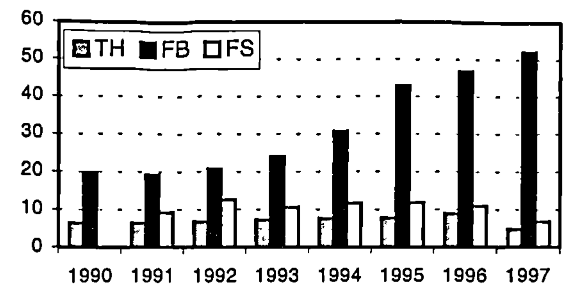


Figure 5.4 shows a clear picture that average equity to assets ratio of foreign banks was much higher than those of Thai banks and the FSIs. This suggests a greater financial strength of foreign banks, which had substantial financial capital from their parent companies. A rapid increase in the average ratios of foreign banks during 1993-97 could be viewed as a positive response to the opportunities afforded by financial deregulation.

Table 5.13 Equity to assets ratio for Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	7.7	7.3	-5	Tokyo	13.6	20.1	48
KTB	6.1	5.8	-5	Sakura	21.6	82.0	280
TFB	7.9	7.1	-10	**Citibank**	10.6	5.6	-47
SCB	7.5	5.8	-23	Deutsche	26.7	47.0	76
AYD	7.7	5.3	-31	STCB	23.4	47.6	103
TMB	6.9	5.9	-14	Indosuez	29.6	64.2	117
FBC	9.2	6.7	-27	HSBC	14.9	26.2	76
SCIB	7.0	4.4	-37	Chase	44.4	68.6	55
BMB	7.5	-4.2	-156	America	43.4	65.4	51
BBC	7.3	-2.6	-136	**ABN**	45.6	30.6	-33
BOA	7.3	6.4	-12	**Bharat**	16.2	9.3	-43
TDB	7.2	7.0	-3	**ICBC**	23.7	13.9	-41
NKB	6.6	5.8	-12	**Sime**	58.2	50.2	-14
UBB	6.3	4.0	-37	OCBC	36.7	71.0	93
LTB	8.0	7.6	-5				

Note: The figures are shown in percentage.

Table 5.13 shows a possible impact of the financial crisis on equity to assets ratio of individual banks, which are consistent with those in Table 5.7. For Thai banks, equity to assets ratio in 1997 was less than the 1990-96 average: BMB and BBC had a large decrease and they were insolvent in 1997. Also, there was a decrease in the ratio for 5 foreign banks (Citibank, ABN, Bharat, ICBC and Sime) in 1997 relative to their 1990-96 averages. The results indicate a greater capital risk of Thai banks in 1997, which may have been the effects of the financial crisis. Table 5.13 also shows a relatively low ratio for Citibank and Bharat compared with the other 12 foreign banks, suggesting that they may not get so much capital downstreamed from their parent companies.

The ratio of equity capital to bank deposits, which is an alternative measure for assessing the adequacy of bank capital. With respect to solvency risk, capital may decline unexpectedly due to unanticipated deposit outflows. Thus, the bank's shareholders always face the possibility of a declining capital, which may leave them with a small fraction of the funds they committed to the institution. For this reason, the ratio of equity capital to deposits can also serve as an early warning sign of bank solvency problems.

Table 5.14 Average equity to deposits ratio, 1990-97

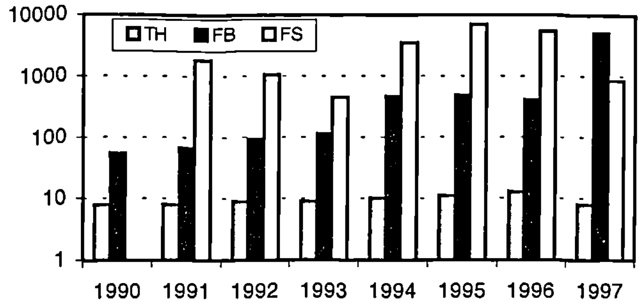
	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
Mean	0.08	0.08	0.09	0.09	0.10	0.11	0.13	0.08	0.10	0.10
STDEV	0.02	0.02	0.02	0.02	0.02	0.02	0.06	0.07	0.03	0.03
CV	0.28	0.21	0.18	0.18	0.22	0.19	0.46	0.87	0.25	0.32
Foreign bank branches										
Mean	0.55	0.66	0.91	1.12	4.51	4.87	4.13	3.06*	2.39	8.45
STDEV	0.41	0.54	1.14	1.23	9.73	5.77	3.19	3.43*	3.14	24.76
CV	0.75	0.82	1.26	1.10	2.16	1.18	0.77	1.12*	1.15	1.44
Finance and specialised Institutions (FSIs)										
Mean	n.a.	18.08	10.51	4.49	34.78	70.51	54.63	8.34	32.16	28.76
STDEV	n.a.	27.08	13.88	7.52	117.68	228.62	151.41	23.06	91.03	81.32
CV	n.a.	1.50	1.32	1.67	3.38	3.24	2.77	2.77	2.32	2.38

Notes: STDEV= standard deviation, CV= coefficient of variation. * The values are exclusive of 6 new foreign banks. Foreign banks, including 6 new banks, had the average = 50.86 with STDEV = 176.11 in 1997 and the average = 11.78 with STDEV = 22.11, if BNP was removed from 1997 data.

Table 5.14 shows similar results to those in Table 5.12. The average equity to deposits ratio of foreign banks increased over the period studied; a large increase in 1997 was due to an entry of 6 new banks, especially BNP, whose ratios were relatively high. On the other hand, the average ratio for Thai banks and FSIs in 1997 was lower than their 1990-96 averages, indicating an increased capital risk. Note that the average ratios for foreign banks and FSIs were larger than Thai banks partly because they raised funds from other sources.

Figure 5.5 shows an upward trend of average equity to deposits ratio for foreign banks. FSIs had the largest average ratio: a decrease in 1993 and 1997 was partly due to the differences in the number of DMUs. The figure reflects a relatively low equity to deposit ratio of Thai banks during 1990-97.

Figure 5.5 Average equity to deposits ratio, 1990-97



Note: The graph is shown in log scale in order to enhance the clarity.

Table 5.15 Equity to deposits ratio for Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	0.10	0.11	10	Tokyo	0.56	1.41	152
KTB	0.07	0.08	14	Sakura	1.58	6.47	309
TFB	0.10	0.10	0	**Citibank**	0.40	0.16	-60
SCB	0.10	0.07	-30	Deutsche	1.72	1.74	1
AYD	0.09	0.07	-22	STCB	0.90	1.4	56
TMB	0.09	0.09	0	Indosuez	2.45	2.97	21
FBC	0.13	0.16	23	HSBC	0.58	1.09	88
SCIB	0.10	0.08	-20	Chase	3.89	12.97	233
BMB	0.10	-0.10	-200	**America**	5.15	4.17	-19
BBC	0.11	-0.04	-136	**ABN**	10.89	2.17	-80
BOA	0.11	0.13	18	**Bharat**	0.23	0.12	-48
TDB	0.10	0.10	0	**ICBC**	0.65	0.31	-52
NKB	0.09	0.09	0	Sime	1.91	2.53	32
UBB	0.09	0.06	-33	OCBC	2.58	5.33	107
LTB	0.11	0.15	36				

Table 5.15 shows similar results to those in Table 5.13. BMB and BBC had a large decrease in the 1997 ratio relative to the 1990-96 average. Also, the equity to deposits ratio of another 9 out of 29 banks in 1997 were less than their 1990-96 averages. The results suggest an apparent increased capital risk, which may reflect the impact of the financial crisis.

This analysis of capital adequacy risk shows that there was an improvement in bank capital of foreign banks following deregulation. In contrast, the capital adequacy of Thai banks and FSIs may have been adversely affected by the financial crisis in 1997.

5.3.4 Liquidity risk

Liquidity risk is the risk that a bank may not be able to accommodate liquidity requirements, such as deposit withdrawals and new loan demand (Rose, 1991, p.140). A bank's liquidity risk arises from unexpected changes in the sources and uses of bank funds, brought about by either an internal factor, such as poor liquidity planning and management, or external factors such as unexpected demands and/or economic or financial collapse (Sinkey, 1998, p.240).

There is a trade-off between returns and liquidity risk. For example, a shift from short-term securities into long-term securities or loans could raise a bank's return, but increase its liquidity risk. Thus, a higher liquidity ratio for a bank indicates less risk and correspondingly a less profitable bank.

This section examines these indicators of a bank's exposure to liquidity risk: the ratio of loans to total assets, customer deposits to total assets, loans to deposits, and cash and due from banks to total assets.

Table 5.16 Average loan to assets ratio, 1990-97

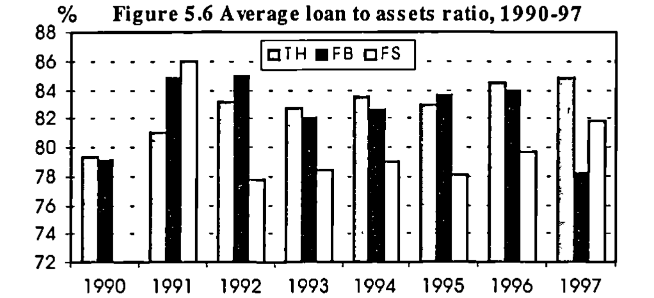
	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
Mean	0.79	0.81	0.83	0.83	0.83	0.83	0.84	0.85	0.82	0.83
STDEV	0.03	0.03	0.03	0.03	0.03	0.04	0.02	0.08	0.03	0.04
CV	0.04	0.03	0.03	0.04	0.04	0.04	0.03	0.09	0.04	0.04
Foreign bank branches										
Mean	0.79	0.85	0.85	0.82	0.83	0.84	0.84	0.75*	0.83	0.82
STDEV	0.08	0.08	0.05	0.07	0.09	0.11	0.10	0.12*	0.08	0.09
CV	0.11	0.10	0.06	0.09	0.11	0.13	0.12	0.16*	0.10	0.11
Finance and specialised institutions (FSIs)										
Mean	n.a.	0.86	0.78	0.78	0.79	0.78	0.80	0.82	0.80	0.80
STDEV	n.a.	0.03	0.09	0.07	0.13	0.13	0.13	0.16	0.10	0.11
CV	n.a.	0.04	0.12	0.09	0.17	0.17	0.16	0.19	0.12	0.13

Notes: STDEV= standard deviation, CV= coefficient of variation. * The values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average = 0.78 with STDEV = 0.13 in 1997.

Table 5.16 shows that average loan to assets of Thai and foreign banks increased by around 6% from 1990 to 1996. In 1997, the ratios for banks in the three groups became more dispersed and there was an increased liquidity risk of Thai banks and FSIs, while foreign banks had reduced their average ratio by 7% relative to 1996. Overall results show similar average liquidity ratios for Thai and foreign banks during 1990-96.

Figure 5.6 shows that there was an upward trend of loans to assets ratio of Thai banks, indicating an increased liquidity risk following deregulation. The average ratio of foreign banks was relatively high during 1991-92 and 1995-96 and declined in 1997[3]. FSIs had the highest average ratio (86%) in 1991 due to large ratios of 4 out of 7 institutions.

Figure 5.6 Average loan to assets ratio, 1990-97



Note: True zero is not shown in order to enhance the clarity

Table 5.17 Loans to assets ratio for Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	0.85	0.76	-11	Tokyo	0.89	0.94	6
KTB	0.83	0.87	5	Sakura	0.91	0.81	-11
TFB	0.83	0.77	-7	Citibank	0.87	0.68	-22
SCB	0.81	0.79	-2	Deutsche	0.88	0.68	-23
AYD	0.83	0.82	-1	STCB	0.82	0.78	-5
TMB	0.84	0.78	-7	Indosuez	0.85	0.79	-7
FBC	0.85	0.91	7	HSBC	0.90	0.75	-17
SCIB	0.82	0.86	5	Chase	0.87	0.86	-1
BMB	0.81	0.98	21	America	0.83	0.81	-2
BBC	0.81	1.02	26	ABN	0.76	0.59	-22
BOA	0.82	0.86	5	Bharat	0.79	0.54	-32
TDB	0.84	0.89	6	ICBC	0.77	0.73	-5
NKB	0.84	0.81	-4	Sime	0.70	0.65	-7
UBB	0.81	0.79	-2	OCBC	0.78	0.91	17
LTB	0.76	0.81	7				

[3] These changes were due to two banks (Indosuez, HSBC) in 1991 and 1992 and three banks (Tokyo, Deutsche, Indosuez) in 1995 and 1996 had the loans to assets ratio of more than 90%, while the ratio of 4 banks (Citibank, Deutsche, ABN, Bharat) dropped by more than 20% in 1997.

Table 5.17 shows a possible impact of the financial crisis on individual banks. There was a large increase in ratio for BMB (21%), BBC (26%) and OCBC (17%) in 1997 relative to their 1990-96 averages. This suggests an increased liquidity risk, which may have been the effects of the financial crisis. On the other hand, four foreign banks (Citibank, Deutsche, ABN and Bharat) had around 20% less liquidity risk in 1997 compared to their 1990-96 averages.

Next, we examine the ratio of customer deposits to total assets. The higher this ratio, the better a bank's liquidity position *ceteris paribus* since customer deposits are generally a more stable source of deposit funding.

Table 5.18 Average customer deposits to assets ratio, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
Mean	0.78	0.79	0.79	0.77	0.73	0.73	0.73	0.63	0.76	0.74
STDEV	0.06	0.05	0.05	0.05	0.05	0.05	0.06	0.12	0.05	0.06
CV	0.08	0.06	0.06	0.07	0.07	0.06	0.08	0.19	0.07	0.08
Foreign bank branches										
Mean	*0.38*	*0.35*	*0.32*	*0.32*	*0.23*	*0.21*	*0.19*	*0.26**	0.29	0.27
STDEV	0.10	0.16	0.14	0.17	0.19	0.21	0.15	0.18*	0.16	0.16
CV	0.26	0.44	0.43	0.53	0.84	0.97	0.82	0.70*	0.61	0.66
Finance and specialised institutions (FSIs)										
Mean	n.a.	0.20	0.23	0.27	0.33	0.32	0.31	0.37	0.28	0.29
STDEV	n.a.	0.34	0.31	0.29	0.33	0.31	0.31	0.29	0.32	0.31
CV	n.a.	1.66	1.39	1.08	1.00	0.99	0.99	0.77	1.19	1.13

Notes: STDEV= standard deviation, CV= coefficient of variation. * The values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average = 0.19 with STDEV = 0.18 in 1997.

Table 5.18 shows that the average deposits to assets ratio of Thai and foreign banks decreased while those for FSIs increased during 1990-97. The relatively low ratio for foreign banks and FSIs suggests that they had raised funds from other sources rather than customer deposits. This was due mainly to their limited number of branches. A 24% decrease in the average ratio for Thai banks in 1997 relative to 1996 suggests the possible effects of the financial crisis. On the other hand, a decreased ratio of foreign banks in 1997 was due to an entry of 6 new banks that had relatively small deposit bases.

Figure 5.7 clearly shows that average deposits to assets ratio of Thai banks was higher than that of foreign banks and the FSIs. There was a downward trend of the average ratio for Thai and foreign banks, which indicates an increased liquidity risk during 1990-97. In contrast, the average deposits to assets ratio of FSIs was relatively low, but improved over time.

Figure 5.7 Average bank deposits to assets ratio, 1990-97

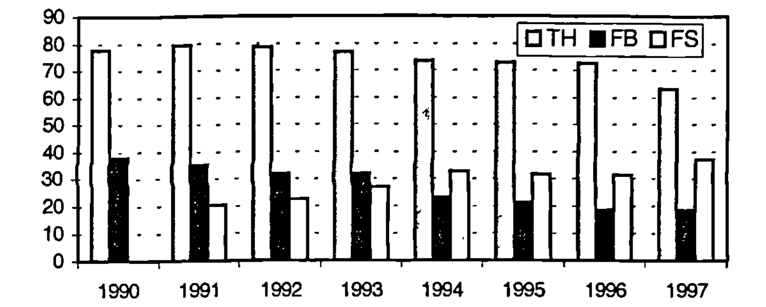


Table 5.19 Customer deposits to assets ratio of Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	0.74	0.67	-9	Tokyo	0.27	0.14	-48
KTB	0.83	0.73	-12	Sakura	0.18	0.13	-28
TFB	0.80	0.74	-8	Citibank	0.31	0.35	13
SCB	0.77	0.78	1	Deutsche	0.23	0.27	17
AYD	0.83	0.79	-5	STCB	0.33	0.34	3
TMB	0.79	0.66	-16	Indosuez	0.18	0.22	22
FBC	0.72	0.42	-42	HSBC	0.36	0.24	-33
SCIB	0.74	0.58	-22	Chase	0.21	0.05	-76
BMB	0.73	0.42	-42	America	0.16	0.16	0
BBC	0.74	0.69	-7	ABN	0.11	0.14	27
BOA	0.69	0.51	-26	Bharat	0.71	0.76	7
TDB	0.75	0.69	-8	ICBC	0.37	0.44	19
NKB	0.75	0.63	-16	Sime	0.35	0.20	-43
UBB	0.73	0.66	-10	OCBC	0.24	0.13	-46
LTB	0.77	0.51	-34				

Table 5.19 shows that the deposits to assets ratio of Thai banks, except for SCB, in 1997 were less than their 1990-96 averages. Also, there was a large reduction of ratio for 14 out of 29 banks in 1997. The results suggest an increased liquidity risk, which may have resulted from the financial crisis.

Next, we examine the loan to deposit ratio of banks. This ratio indicates how much deposits are invested in loans. The higher this ratio, the greater the proportion of deposits invested in loans, which indicates more liquidity risk (i.e. smaller relative holdings of liquidity assets).

Table 5.20 Average loans to deposits ratio, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
Mean	1.0	1.0	1.1	1.1	1.1	1.1	1.2	1.4	1.1	1.1
STDEV	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.4	0.1	0.1
CV	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.1	0.1
Foreign bank branches										
Mean	2.2	2.9	3.3	3.4	7.0	7.4	6.8	4.6*	4.7	9.8
STDEV	0.6	1.3	2.1	1.9	7.6	5.1	4.2	3.8*	3.2	19.5
CV	0.3	0.5	0.6	0.6	1.1	0.7	0.6	0.8*	0.6	0.9
Finance and specialised institutions (FSIs)										
Mean	n.a.	121	55	20	98	476	194	103	161	152
STDEV	n.a.	163	62	25	163	1771	313	282	416	397
CV	n.a.	1.4	1.1	1.2	1.7	3.7	1.6	2.7	1.8	1.9

Notes: STDEV= standard deviation, CV= coefficient of variation. * The values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average = 46 with STDEV = 134 in 1997 and the average = 10.1with STDEV = 12.9 in 1997, if the ratio for DKB and BNP (2 out of 6 new banks) was removed.

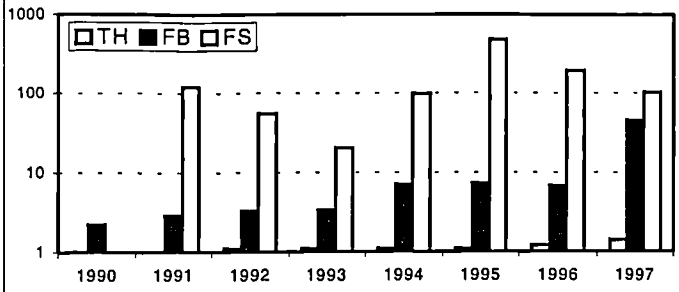
Table 5.20 shows that the average ratios for foreign banks and FSIs were much larger than Thai banks. This indicates the fact that they have used other liabilities more than customer deposits to invest in loans. The average ratio for foreign banks started to rise from 1994, following the introduction of BIBF in 1993, suggesting that banks had taken advantage of deregulation in order to mobilise funds for investment[4]. Table 5.20 also shows the largest average ratio for FSIs in 1995, which is due to the high ratio of 5 finance companies[5]. An increase in the average, variability and relative dispersion of data for Thai banks in 1997 reflects the possible impact of financial crisis, while foreign banks' data were affected by an inclusion of 6 new banks whose ratios were relatively high. On the other hand, the large variability and relative dispersions for FSIs was due to the differences in the number of DMUs.

Figure 5.8 shows that the average loans to deposits ratio of FSIs was much higher than those of Thai and foreign banks. There was an upward trend of the average ratios for Thai and foreign banks that was relatively high in 1997. The results reflect an increased liquidity risk following deregulation.

[4] The ratio of five banks (Citibank, Indosuez, Chase, ABN, OCBC rose rapidly (more than 3 times) during 1994-96 compared with 1993.

[5] These are EXIM Bank (8910), CMIC finance & securities (667), Dhana Siam finance & securities (449), Multi-Credit Corporation (455), and Wall Street finance & securities (882). These institutions their funds from domestic short-term borrowings. After excluding these institutions, FSIs had the average = 27 and STDEV = 84 in 1995.

Figure 5.8 Average loans to deposits ratio, 1990-97



Note: The graph is shown in log scale in order to enhance the clarity.

Table 5.21 Loans to deposits ratio for Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	1.14	1.14	0	**Tokyo**	3.67	6.59	80
KTB	1.00	1.19	19	**Sakura**	5.58	6.41	15
TFB	1.04	1.04	0	Citibank	3.32	1.94	-42
SCB	1.06	1.02	-4	Deutsche	4.55	2.51	-45
AYD	1.00	1.04	4	STCB	2.75	2.31	-16
TMB	1.07	1.18	10	Indosuez	5.93	3.66	-38
FBC	1.18	2.19	86	HSBC	3.19	3.11	-3
SCIB	1.11	1.48	33	**Chase**	6.08	16.21	167
BMB	1.12	2.33	108	America	7.98	5.17	-35
BBC	1.10	1.48	35	ABN	12.72	4.19	-67
BOA	1.20	1.68	40	Bharat	1.14	0.70	-39
TDB	1.13	1.29	14	ICBC	2.11	1.64	-22
NKB	1.13	1.28	13	**Sime**	2.19	3.28	50
UBB	1.11	1.19	7	**OCBC**	4.72	6.84	45
LTB	1.00	1.59	59				

Table 5.21 shows an increase in liquidity risk as a possible result of the financial crisis. We see that BMB and Chase Manhattan Bank had a much larger ratio in 1997 than their 1990-96 averages. An increased ratio in 1997 relative to the 1990-96 average is also shown for another 8 Thai and 4 foreign banks. The similar results to those in Table 5.19 are that Chase Manhattan Bank had the largest increase in liquidity risk and SCB is the only Thai bank that reduced the liquidity risk in 1997 compared to the 1990-96 average. Overall, the results suggest that more Thai banks had increased liquidity risk in 1997 relative to the 1990-96 average.

Next, we examine the ratio of cash and due from banks to total assets. This ratio indicates a bank's source of funds that is ready to meet short-term liquidity needs. A higher ratio indicates a greater supply of liquid reserves and corresponding lower liquidity risk.

Table 5.22 Average cash and due from banks to assets ratio, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
Mean	0.06	0.06	0.06	0.10	0.08	0.07	0.06	0.07	0.07	0.07
STDEV	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.04	0.02	0.02
CV	0.30	0.31	0.32	0.34	0.29	0.32	0.34	0.53	0.32	0.34
Foreign bank branches										
Mean	0.07	0.07	0.07	0.13	0.13	0.16	0.12	0.10*	0.11	0.11
STDEV	0.07	0.06	0.06	0.08	0.09	0.11	0.07	0.06*	0.08	0.08
CV	0.97	0.79	0.84	0.64	0.75	0.69	0.61	0.60*	0.76	0.76
Finance and specialised institutions (FSIs)										
Mean	n.a.	0.03	0.08	0.06	0.06	0.09	0.06	0.05	0.06	0.06
STDEV	n.a.	0.03	0.12	0.06	0.06	0.14	0.09	0.06	0.08	0.08
CV	n.a.	1.01	1.57	1.00	1.07	1.51	1.39	1.31	1.26	1.26

Notes: STDEV= Standard deviation, CV= Coefficient of variation. * The values are exclusive of 6 new foreign banks. Foreign banks, including 6 new banks had the average = 0.16 with STDEV = 0.13 in 1997.

Table 5.22 shows that foreign banks had highest average cash and due from banks to assets ratio during 1990-97, implying a relatively low liquidity risk. The average ratio for Thai banks was hardly changed, while the average for FSIs reduced by 44% from 1995 to 1997. Table 5.22 shows that FSIs had the largest dispersion of the ratio from its respective mean which was partly due to the differences in the number of DMUs. An increase in the average, variability and relative dispersion for foreign banks' data in 1997 was due to the entry of foreign banks, while greater variability and relative dispersion of Thai banks' data could be viewed as a possible impact of the financial crisis.

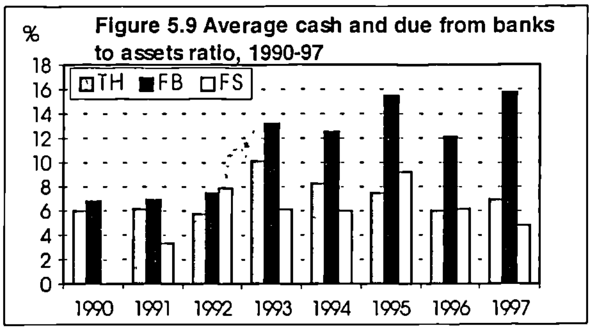


Figure 5.9 shows that average cash and due from banks to assets ratio of foreign banks, except in 1992, was higher than that of Thai banks and FSIs. During 1993-97, foreign banks' average ratio was greater than 10%. Figure 5.9 suggests that foreign banks, on average, had less liquidity risk.

Table 5.23 Cash and due from banks to assets ratio for Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	8.6	15.7	83	Tokyo	6.8	9.3	36
KTB	7.6	4.8	-37	Sakura	3.9	8.5	121
TFB	6.6	11.5	74	Citibank	8.1	20.0	146
SCB	7.1	7.8	10	Deutsche	7.7	18.1	136
AYD	6.1	7.2	18	STCB	23.4	17.5	-25
TMB	7.1	11.4	61	Indosuez	7.9	13.0	64
FBC	6.9	2.4	-65	HSBC	8.4	5.7	-33
SCIB	7.1	6.6	-7	Chase	5.8	1.3	-78
BMB	6.8	4.6	-32	America	18.0	11.6	-36
BBC	6.1	2.7	-56	ABN	12.0	4.6	-62
BOA	5.0	3.9	-22	Bharat	15.1	10.6	-30
TDB	5.4	4.6	-15	ICBC	7.7	11.9	54
NKB	8.1	8.3	2	Sime	19.4	8.5	-56
UBB	6.3	7.0	11	OCBC	4.9	1.7	-65
LTB	1.00	1.59	59				

Note: The figures are shown in percentage.

Table 5.23 shows a marked reduction in cash and due from banks to assets ratio of 15 out of 29 banks in 1997 from the 1990-96 average. Similar to Tables 5.19 and 5.21, we found that Chase Manhattan Bank had the most increased liquidity risk in 1997 relative to its 199-96 average. The results suggest a possible impact of the financial crisis.

The liquidity ratio analysis in this section suggests that foreign banks had a relatively low liquidity risk on average. There was an increase in liquidity risk for Thai banks and FSIs following the deregulation and the financial crisis may have increased the liquidity risk for banks in 1997.

5.3.5 Credit risk

Credit risk of a bank is the risk that interest or principal, or both, on securities and loans will not be paid as promised (Hempel and Simonson, 1999, p.68). Given that the majority of a bank's assets are in the form of loans, problems with loan quality are the major cause of credit risk (and a major cause of banking problems and crises). The loan quality of a bank can be estimated from the loan loss reserve (also called allowance for loan losses). The loan loss reserve comprises past due loans, and reflects the reserves need to cover future loan losses. The lower the loan loss reserves relative to total lending, the better the loan quality. This section will examine the ratio of loan loss reserves to total loans and to total assets during 1990-97.

Table 5.24 Average loan loss reserves to total loans ratio, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
Mean	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.04	0.02	0.02
STDEV	0.02	0.01	0.01	0.01	0.01	0.01	0.04	0.04	0.01	0.02
CV	1.06	0.80	0.49	0.39	0.36	0.35	1.42	0.98	0.70	0.73
Foreign bank branches										
Mean	0.06	0.06	0.06	0.10	0.09	0.14	0.12	0.11*	0.09	0.10
STDEV	0.15	0.09	0.08	0.10	0.09	0.13	0.09	0.07*	0.10	0.11
CV	2.46	1.35	1.20	0.94	0.95	0.92	0.71	0.64*	1.22	1.17
Finance and specialised institutions (FSIs)										
Mean	n.a.	0.01	0.02	0.01	0.01	0.01	0.01	0.05	0.01	0.02
STDEV	n.a.	0.01	0.03	0.01	0.01	0.01	0.01	0.04	0.01	0.02
CV	n.a.	0.49	1.70	0.86	0.66	0.62	0.68	0.80	0.83	0.83

Notes: STDEV= standard deviation, CV= coefficient of variation. * The values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average = 0.16 with STDEV = 0.13 in 1997.

Table 5.24 shows that average loan loss reserve to total loans ratio of foreign banks was relatively higher than Thai banks and FSIs from 1990 to 1997. This is possibly due to the differences in provisioning rules between Thai and foreign financial institutions. It is likely that foreign banks followed the guidelines given by their parent companies whose provisioning standards were better than Thai banks and FSIs. From Table 5.24, we see that the average loan loss reserve to total loans for foreign banks started to rise in 1995. This was due to the large ratios of 4 banks (Citibank, America, ABN and Sime), while an increase in the 1997 average was due to the large ratios of 6 new banks. On the other hand, an increase in the average and variability for Thai banks' data in 1996 was due to a large ratio of BBC (0.17) and the increases in 1997 were due to large ratios of 0.13 for FBC and BMB, while two finance companies (S.G. Asia and Phatra Thanakit) had a comparatively high ratio (0.12) in 1997. Overall, the results suggest that there was an increased credit risk of banks in 1997.

Figure 5.10 shows a relatively higher loan loss reserve to total loans of foreign banks. An increase in average ratio for all three groups of banks was apparent in 1997, suggesting that banks had become more exposed to credit risk.

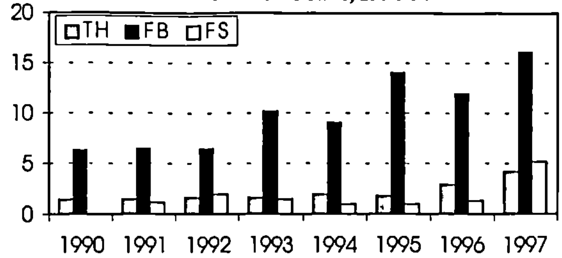


Figure 5.10 Average loan loss reserves to total loans ratio, 1990-97

Table 5.25 Loan loss reserves to total loans ratio for Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	2.71	2.64	-3	**Tokyo**	3.53	8.37	137
KTB	2.12	2.76	30	**Sakura**	2.73	7.20	164
TFB	1.32	2.76	109	Citibank	7.27	13.42	85
SCB	1.47	2.04	39	**Deutsche**	5.55	15.33	176
AYD	0.83	1.74	110	STCB	20.74	26.78	29
TMB	2.20	1.16	-47	**Indosuez**	6.83	19.21	181
FBC	1.02	13.40	1214	HSBC	9.54	10.75	13
SCIB	2.03	7.56	272	Chase	3.13	2.02	-35
BMB	1.78	13.22	643	America	11.67	16.25	39
BBC	3.22	6.48	101	ABN	13.45	10.61	-21
BOA	1.53	1.25	-18	Bharat	6.92	11.24	62
TDB	1.27	1.93	52	ICBC	4.02	4.65	16
NKB	1.20	1.75	46	Sime	32.49	9.85	-70
UBB	1.15	5.14	347	**OCBC**	0.67	1.92	187
LTB	3.44	0.25	-93				

Note: The figures are shown in percentage.

Table 5.25 shows a large increase in loan loss reserve to total loans ratio for 7 Thai and 5 foreign banks in 1997 relative to their 1990-96 averages. This increased credit risk reflect the impact of the financial crisis in 1997. On the other hand, credit risks of TMB, BOA, LTB, Chase, ABN and Sime in 1997 were much less than their 1990-96 averages.

Next, we examine the loan loss reserves to assets ratios of banks during 1990-97. The higher this ratio, the poorer the quality of bank assets. If banks have similar loans to assets ratios, the loan loss reserves to assets ratios will present a similar picture to that shown by the previously examined ratio, loan loss reserves to total loans.

Table 5.26 Average loan loss reserves to assets ratio, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
Mean	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.04	0.02	0.02
STDEV	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.04	0.01	0.01
CV	1.05	0.77	0.47	0.39	0.37	0.36	1.43	1.06	0.69	0.74
Foreign bank branches										
Mean	0.05	0.05	0.05	0.08	0.07	0.11	0.10	0.08*	0.07	0.08
STDEV	0.12	0.07	0.06	0.07	0.07	0.09	0.07	0.05*	0.08	0.08
CV	2.47	1.28	1.18	0.89	0.91	0.81	0.68	0.62*	1.17	1.14
Finance and specialised institutions (FSIs)										
Mean	n.a.	0.01	0.01	0.02	0.01	0.01	0.01	0.04	0.01	0.02
STDEV	n.a.	0.01	0.01	0.02	0.02	0.02	0.01	0.04	0.01	0.02
CV	n.a.	0.58	0.98	1.12	1.18	1.32	0.76	0.84	0.99	0.97

Notes: STDEV= standard deviation, CV= coefficient of variation. * The values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average = 0.13 and STDEV = 0.12 in 1997.

Table 5.26 shows similar results to those in Table 5.24. There was an increase in average and variability of loan loss reserves to assets ratio for the three groups of banks in 1997. The increases for foreign banks' data were due to an entry of 6 new banks, while those for Thai banks and FSIs could be viewed as an impact of the financial crisis.

Figure 5.11 Average loan loss reserves to assets ratio, 1990-97

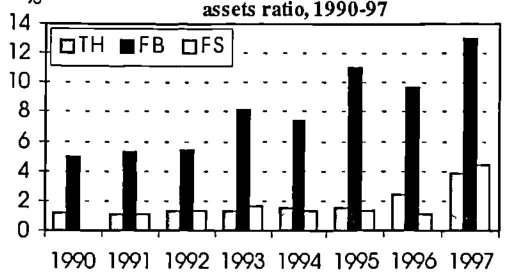


Figure 5.11 shows a similar picture to that in Figure 5.10. Foreign banks had higher ratios than Thai banks and FSIs, and that may be due to the differences in standards used to define loan loss. Average loan loss reserve to total assets for the three groups of banks was relatively high in 1997.

Table 5.27 Loan loss reserve to assets ratio for Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	2.31	2.02	-13	**Tokyo**	3.25	7.84	141
KTB	1.77	2.39	35	**Sakura**	2.53	5.85	131
TFB	1.10	2.11	92	Citibank	6.34	9.17	45
SCB	1.20	1.62	35	**Deutsche**	4.82	10.39	116
AYD	0.69	1.43	107	STCB	17.06	20.96	23
TMB	1.86	0.90	-52	**Indosuez**	6.02	15.18	152
FBC	0.87	12.21	1303	HSBC	8.75	8.02	-8
SCIB	1.68	6.49	286	Chase	2.76	1.73	-37
BMB	1.46	13.02	792	America	9.71	13.19	36
BBC	2.70	6.60	144	ABN	10.59	6.27	-41
BOA	1.28	1.07	-16	Bharat	5.51	6.05	10
TDB	1.07	1.72	61	ICBC	3.12	3.40	9
NKB	1.00	1.43	43	Sime	22.94	6.40	-72
UBB	0.94	4.04	330	**OCBC**	0.53	1.75	230
LTB	2.62	0.21	-92				

Note: The figures are shown in percentage.

Table 5.27 shows similar results to those in Table 5.25. FBC had the largest increase in the 1997 ratio compared to its 1990-96 average. Similarly, 6 other Thai and 5 foreign banks had a large loan loss reserve to assets ratio in 1997 relative to their averages. The results confirm an increased credit risk in 1997.

The analysis in this section suggests that foreign banks may have used different criteria to define loan loss reserves. There was an increased credit risk of banks in 1997 and that could be viewed as the impact of the financial crisis.

5.4 An exploratory analysis of financial ratios of bank efficiency

Financial ratio analysis of bank efficiency provides useful supplemental information to return and risk measures (Hempel and Simonson, 1999, p.77). It reflects the competitive advantage of a bank i.e. it indicates the cost of transforming bank liabilities and assets into earning assets. Sinkey (1998) asserts that the minimisation of production costs is a necessary condition of shareholders' wealth maximisation.

Efficiency can be measured in several ways. A comprehensive measure is non-interest expenses to net interest income plus non-interest income. Other popular measures include earnings power, non-interest expenses to total assets, net non-interest expenses to total assets, interest margin, yield on earning assets, cost rate on total funds, cost rate on interest bearing funds, and spread.

This section examines five efficiency ratios: non-interest expenses to total assets, total expenses to total assets, total expenses to earning assets, earnings power, and cost rate on interest earning funds.

Table 5.28 Average non-interest expenses to assets ratio, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
Mean	0.018	0.019	0.020	0.019	0.019	0.019	0.019	0.024	0.019	0.020
STDEV	0.003	0.003	0.004	0.004	0.004	0.004	0.003	0.008	0.004	0.004
CV	0.155	0.163	0.204	0.193	0.210	0.207	0.173	0.338	0.186	0.205
Foreign bank branches										
Mean	0.038	0.031	0.030	0.027	0.023	0.022	0.023	0.039*	0.028	0.028
STDEV	0.020	0.013	0.011	0.011	0.012	0.012	0.013	0.023*	0.013	0.014
CV	0.520	0.409	0.351	0.425	0.536	0.552	0.553	0.590*	0.478	0.510
Finance and specialised institutions (FSIs)										
Mean	n.a.	0.028	0.027	0.026	0.030	0.029	0.022	0.016	0.027	0.026
STDEV	n.a.	0.019	0.025	0.021	0.030	0.030	0.023	0.010	0.025	0.023
CV	n.a.	0.679	0.925	0.789	1.022	1.025	1.040	0.620	0.914	0.872

Notes: STDEV= standard deviation, CV= coefficient of variation. * The values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average = 0.033, STDEV = 0.024 and CV = 0.733 in 1997.

Table 5.28 shows that the Thai banks had the lowest average non-interest expenses to assets ratio during 1990-96, suggesting greater efficiency in overhead spending. There was small variability of the data for the three groups of banks, but relative dispersions for the ratio from its respective mean were quite large over the period studied. The increased average and variability for Thai and foreign banks' data in 1997 suggests a possible impact of the financial crisis. On the other hand, the decreased ratio of FSIs from 1996 to 1997 was partly due to the differences in the number of DMUs.

Figure 5.12 shows a downward trend of average non-interest expenses to assets ratio for foreign banks during 1990-95. There was an increase in the average ratio for Thai and foreign banks in 1997, which may have been the effects of the financial crisis. Figure 5.12 suggests that Thai banks were better at keeping down their non-interest expenses during 1990-96.

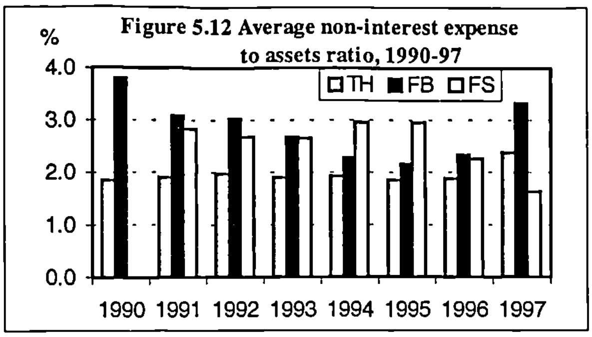


Table 5.29 Non-interest expenses to assets ratio for Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	1.81	2.14	18	Tokyo	1.05	0.47	-55
KTB	1.82	1.83	1	Sakura	0.68	0.28	-59
TFB	2.07	2.45	18	**Citibank**	4.34	7.52	73
SCB	2.05	2.09	2	**Deutsche**	2.79	4.56	63
AYD	1.87	2.01	7	**STCB**	3.52	7.68	118
TMB	1.89	1.92	2	**Indosuez**	2.73	6.38	134
FBC	1.03	1.07	4	**HSBC**	2.87	5.10	78
SCIB	1.72	2.44	42	Chase	2.76	2.05	-26
BMB	1.73	2.11	22	America	3.50	4.67	33
BBC	1.70	4.67	175	ABN	2.97	3.38	14
BOA	2.01	1.97	-2	Bharat	2.83	1.81	-36
TDB	2.17	2.52	16	ICBC	3.47	2.90	-16
NKB	1.80	2.61	45	**Sime**	3.32	5.35	61
UBB	2.52	2.45	-3	**OCBC**	1.87	3.69	97
LTB	2.25	3.34	48				

Note: The figures are shown in percentage.

Table 5.29 shows that three banks (BBC, STCB and Indosuez) had a large increase (over 100%) in non-interest expense to assets ratio in 1997 relative to their 1990-96 averages. Similarly, there was a substantial increase in the 1997 ratio for 8 banks (SCIB, NKB, LTB, Citibank, Deutsche, HSBC, Sime and OCBC). Table 5.29 also shows that four foreign banks (Tokyo, Chase, Bharat and ICBC) had a substantial reduction in 1997 relative to the 1990-96 averages.

Next, we examine total expenses to assets ratios of banks during 1990-97. The lower the ratio, the more efficient the bank is in keeping costs down. Total expenses here are the interest and non-interest expenses (including personnel expenses).

Table 5.30 Average total expense to assets ratio, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
Mean	9.33	11.29	9.08	8.34	7.46	8.97	9.19	10.60	9.10	9.28
STDEV	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
CV	0.05	0.07	0.08	0.07	0.08	0.06	0.07	0.20	0.07	0.08
Foreign bank branches										
Mean	9.06	9.59	7.98	6.31	5.47	6.42	6.83	7.68*	7.38	7.34
STDEV	0.02	0.02	0.02	0.02	0.02	0.03	0.02	0.03*	0.02	0.02
CV	0.24	0.19	0.19	0.30	0.35	0.39	0.34	0.43*	0.29	0.31
Finance and specialised institutions (FSIs)										
Mean	n.a.	12.40	9.83	8.03	7.97	9.60	9.82	9.97	9.61	9.66
STDEV	n.a.	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0.02	0.02
CV	n.a.	0.16	0.23	0.14	0.24	0.21	0.21	0.35	0.20	0.22

Notes: The averages are shown in percentage. STDEV= standard deviation, CV= coefficient of variation. * The values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average = 7.03%, STDEV = 0.03 and CV = 0.46.

Table 5.30 shows that foreign banks had lower total expense to assets ratio, but relative dispersions for the ratio from its respective mean during 1990-97 were large. In general, there was a decline in the averages for the three groups of banks from 1991 to 1994, but there was an increasing the later years preceding the financial crisis. Overall results suggest that foreign banks were relatively more efficient in reducing their total expenses, although an entry of 6 new banks had slightly lowered the average in 1997.

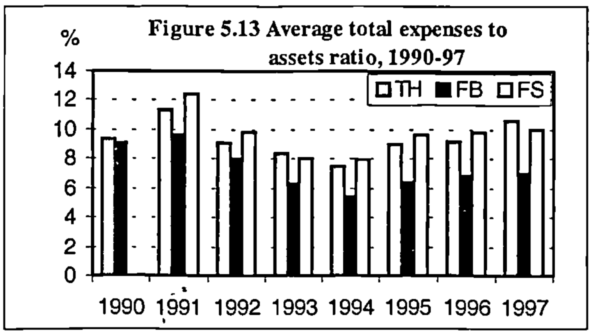


Figure 5.13 Average total expenses to assets ratio, 1990-97

Figure 5.13 shows the highest average ratio of all banks in 1991. There was a downward trend in the average ratios for the three groups during 1991-94, suggesting that banks were becoming more efficient in keeping down their total expenses. The increased ratio during 1995-97, however, indicates an increased bank expense leading up to the financial crisis in 1997. Figure 5.13 suggests that foreign banks appeared generally better at lowering their total expenses.

Table 5.31 Total expense to assets ratio for Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	8.29	8.36	1	Tokyo	5.70	4.63	-19
KTB	8.71	8.39	-4	Sakura	5.84	1.52	-74
TFB	8.86	9.03	2	**Citibank**	10.18	12.34	21
SCB	8.54	8.26	-3	Deutsche	8.37	9.36	12
AYD	9.33	9.71	4	**STCB**	8.73	14.04	61
TMB	8.99	9.88	10	**Indosuez**	7.26	9.03	24
FBC	8.59	9.67	13	**HSBC**	7.62	10.00	31
SCIB	8.70	10.80	24	Chase	6.06	3.95	-35
BMB	9.16	13.20	44	America	6.79	7.65	13
BBC	9.66	15.86	64	ABN	6.18	6.28	2
BOA	9.19	9.62	5	Bharat	9.66	5.37	-44
TDB	9.27	11.22	21	ICBC	7.69	7.16	-7
NKB	9.19	10.91	19	Sime	6.89	7.87	14
UBB	9.95	11.77	18	**OCBC**	6.36	8.32	31
LTB	9.99	12.32	23				

Note: The figures are shown in percentage.

Table 5.31 shows similar results to those in Table 5.29. BBC had a large increase in total expense to assets ratio in 1997 relative to its 1990-96 average. Similarly, there was a substantial rise in the 1997 ratio for 10 other banks (SCIB, BMB, TDB, NKB, UBB, LTB, Citibank, STCB, Indosuez, and HSBC) compared to the 1990-96 averages. The results suggest a lower efficiency in minimising total expenses of banks, which may have been the effects of the financial crisis.

Next, we examine the total expenses to earning assets of banks during 1990-97. This ratio reflects how efficient is the bank in controlling costs as a proportion of earning assets: the smaller the ratio, the more efficient the bank. Earning assets here are defined as the aggregate of net total loans and total securities[6]. If banks have similar proportions of earning assets to total assets, this ratio will present a similar picture to the previous examined ratio, total expenses to total assets.

Table 5.32 shows similar results to Table 5.30. Foreign banks had lower average total expense to earning assets ratio, which highly dispersed from its respective mean during 1990-97. An entry of 6 new banks did not seem to affect the average and variability for foreign banks' data in 1997. There was a decline in the averages for the three groups of banks from 1991 to 1994, but that increased in the later years. Overall, the results suggest that foreign banks were generally more efficient in keeping down their total expenses.

[6] Net total loans are the sum of total loans and accrued interest receivable minus loan loss reserves. Total securities are the sum of investment in Government and other securities.

Table 5.32 Average total expenses to earning assets ratio, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
Mean	10.59	12.81	10.22	9.86	8.67	10.27	10.39	12.17	10.40	10.62
STDEV	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
CV	0.06	0.08	0.10	0.10	0.12	0.07	0.07	0.16	0.09	0.10
Foreign bank branches										
Mean	10.53	10.69	8.96	7.65	6.58	8.13	8.14	10.92*	8.67	8.88
STDEV	0.03	0.02	0.02	0.03	0.03	0.03	0.03	0.05*	0.03	0.03
CV	0.25	0.19	0.21	0.34	0.42	0.42	0.39	0.50*	0.32	0.34
Finance and specialised institutions (FSIs)										
Mean	n.a.	13.25	11.47	8.84	8.68	10.47	10.61	11.50	10.56	10.69
STDEV	n.a.	0.02	0.05	0.01	0.02	0.02	0.02	0.04	0.02	0.03
CV	n.a.	0.17	0.45	0.13	0.24	0.21	0.19	0.34	0.23	0.25

Notes: The average values are shown in percentage. STDEV= standard deviation, CV= coefficient of variation. * The values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average = 10.36%, STDEV =0.05, CV = 0.52 in 1997.

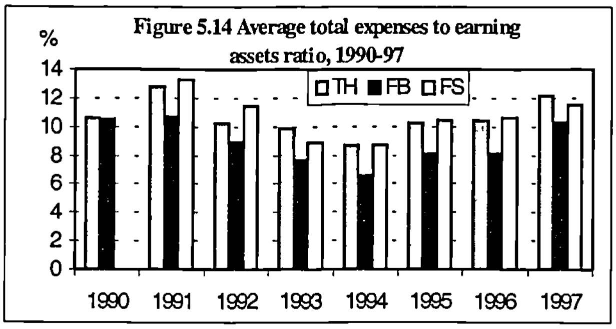


Figure 5.14 shows a downward trend in the average ratio for the three groups of banks during 1991-94, similar to Figure 5.13. It is clear that foreign banks had lowest average ratio, suggesting a better reduction in total expenses.

Table 5.33 shows a possible impact of the financial crisis. There was an apparent increase in the ratio in 1997 relative to the 1990-96 average for 15 out of 29 banks. The largest increase was for STCB (82%), followed by Deutsche (68%) and Citibank (67%). The results are similar to those in Tables 6.29 and 6.31, suggesting a lower efficiency of banks in minimising their expenses, which may have been the effects of the financial crisis.

Table 5.33 Total expenses to earning assets ratio for Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	9.43	10.76	14	Tokyo	6.18	5.26	-15
KTB	10.08	9.57	-5	Sakura	6.12	1.89	-69
TFB	9.86	11.41	16	Citibank	11.58	19.38	67
SCB	9.91	9.90	0	Deutsche	9.11	15.28	68
AYD	10.47	11.41	9	STCB	12.11	22.04	82
TMB	10.27	12.29	20	Indosuez	8.51	12.89	51
FBC	9.66	10.35	7	HSBC	8.67	13.90	60
SCIB	9.97	12.09	21	Chase	6.73	4.53	-33
BMB	10.60	14.84	40	America	8.13	10.62	31
BBC	10.72	17.00	59	ABN	7.74	10.33	33
BOA	10.08	10.57	5	Bharat	11.69	9.85	-16
TDB	10.39	12.39	19	ICBC	8.69	8.70	0
NKB	10.67	12.81	20	Sime	9.25	9.64	4
UBB	11.43	13.43	17	OCBC	6.86	8.63	26
LTB	12.51	13.72	10				

Note: The figures are shown in percentage.

Next, we examine the earnings power of banks during 1990-97. Earnings power indicates how fully a bank invests in interest-yielding assets (Hempel and Simonson, 1999, p.86). It is calculated by dividing earning assets by total assets. *Ceteris paribus*, the higher the ratio, the more efficient the bank's investment.

Table 5.34 Average earnings power, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-96	Average 1990-97
Thai banks										
Mean	0.88	0.88	0.89	0.85	0.86	0.87	0.88	0.87	0.88	0.87
STDEV	0.03	0.03	0.03	0.04	0.04	0.03	0.03	0.05	0.03	0.03
CV	0.03	0.03	0.03	0.05	0.05	0.04	0.03	0.06	0.04	0.04
Foreign bank branches										
Mean	0.87	0.90	0.90	0.84	0.85	0.81	0.85	0.74*	0.86	0.84
STDEV	0.10	0.05	0.06	0.10	0.09	0.13	0.09	0.13*	0.09	0.09
CV	0.11	0.06	0.07	0.11	0.11	0.16	0.10	0.18*	0.10	0.11
Finance and specialised institutions (FSIs)										
Mean	n.a.	0.94	0.90	0.91	0.92	0.92	0.93	0.87	0.92	0.91
STDEV	n.a.	0.02	0.10	0.04	0.05	0.07	0.07	0.10	0.06	0.07
CV	n.a.	0.03	0.11	0.04	0.06	0.08	0.08	0.12	0.07	0.07

Notes: STDEV= standard deviation, CV= coefficient of variation. * The values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average = 0.72 with STDEV = 0.13 in 1997 and their average in 1997 reduced by 15% from 1996.

Table 5.34 shows that FSIs had the highest earnings power during 1990-97. Thai banks had a low variability and relative dispersion for ratio and their averages hardly changed. On the other hand, foreign banks had a large variability and relative dispersions of data over the period studied. In 1997, earnings power of foreign banks and FSIs reduced respectively by 16% and 6.5% from 1996, while variability and relative dispersions of data for the three groups increased. The results suggest a possible impact of the financial crisis.

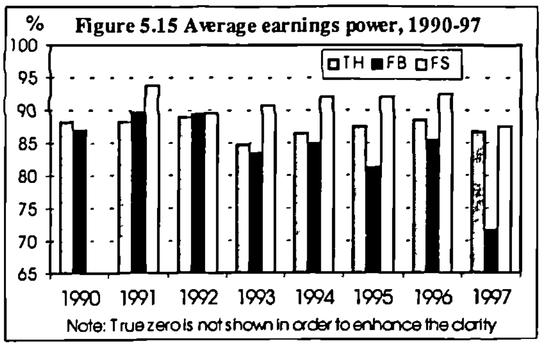


Figure 5.15 shows that the average earnings power of foreign banks was relatively low. There was an apparent decrease in earnings power for the three groups of banks in 1997, which may have been the effects of the financial crisis.

Table 5.35 Earnings power of Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	0.88	0.78	-11	Tokyo	0.92	0.88	-4
KTB	0.86	0.88	2	Sakura	0.95	0.81	-15
TFB	0.90	0.79	-12	Citibank	0.88	0.64	-27
SCB	0.86	0.83	-3	Deutsche	0.91	0.61	-33
AYD	0.89	0.85	-4	STCB	0.73	0.64	-12
TMB	0.87	0.80	-8	Indosuez	0.86	0.70	-19
FBC	0.89	0.93	4	HSBC	0.88	0.72	-18
SCIB	0.87	0.89	2	Chase	0.90	0.87	-3
BMB	0.86	0.89	3	America	0.78	0.72	-8
BBC	0.90	0.93	3	ABN	0.80	0.61	-24
BOA	0.91	0.91	0	Bharat	0.83	0.55	-34
TDB	0.89	0.91	2	ICBC	0.89	0.82	-8
NKB	0.86	0.85	-1	Sime	0.76	0.82	8
UBB	0.87	0.88	1	OCBC	0.93	0.96	3
LTB	0.80	0.90	13				

Table 5.35 examines a possible impact of the financial crisis. We found that 2 Thai banks and 8 foreign banks had a large decrease (more than 10%) in earnings power in 1997 relative to their 1990-96 averages. The results suggest a decreased earnings power that may have been the effects of the financial crisis. Table 5.35 also shows a large increase in earnings power of LTB (13%) in 1997 compared to its 1990-96 average.

Overall, the results in this section suggest that Thai banks made the most efficient use of overhead. Foreign banks were the most effective in minimising total expenses as a percentage of total assets and earning assets, while Thai banks and FSIs had relatively high earnings power. The results also suggest that bank efficiency ratios may have been adversely affected by the financial crisis.

5.5 Overall financial performance of banks during 1990-97 financial deregulation

Financial deregulation should provide new opportunities that may help to improve bank operating performance (see Chapter 3). This section synthesises the overall performance of banks during the 1990-97 period of financial deregulation.

Table 5.36 Key financial ratios of bank returns, risk and efficiency, 1990-96 and 1997

	Thai banks		Foreign banks		FSIs	
	1990-96	1997	1990-96	1997	1990-96	1997
Returns						
- Return on equity (%)	14	-28	12	2	19	-76
- Return on assets (%)	1.0	-2.8	2.5	1.9	1.9	-3.2
- Equity multiplier (EM)	14	17	5	3	10	23
Risk						
- Risk index	18	0.4	20	50	16	1
- Variability of ROE	0.06	0.55	0.07	0.05	0.08	1.74
- Variability of ROA	0.00	0.05	0.02	0.01	0.01	0.04
- Variability of EM	2.8	3.5	3.0	4.2	3.2	20
- equity/assets (%)	7	5	29	52	11	7
- equity/deposits	0.10	0.08	2	51	32	8
- loan/assets (%)	82	85	83	78	80	82
- deposit/assets(%)	76	63	29	19	28	37
- loan/deposit	1.1	1.4	5	46	161	103
- C&D/assets (%)	7	7	11	16	6	5
- LLR/total loan (%)	2	4	9	16	1	5
- LLR/assets (%)	2	4	7	13	1	4
Efficiency						
- NIE/assets (%)	1.9	2.4	2.7	3.3	2.7	1.6
- TTE/assets (%)	9.1	10.6	7.4	7.0	9.6	10.0
- TTE/earning assets (%)	10.4	12.2	8.7	10.4	10.6	11.5
- earnings power	0.88	0.87	0.86	0.72	0.92	0.87

Notes: FSIs= finance and specialised institutions. C&D = cash and due from banks, LLR= loan loss reserve, NIE= non-interest expense, TTE= total expense.

Table 5.36 shows that the average returns for FSIs and Thai banks were higher than foreign banks during 1990-96. The high profitability measures were accompanied by large financial leverage, while foreign banks had the highest ROAs. As a result, FSIs and Thai banks experienced large losses in 1997 that could be the effects of the financial crisis.

Table 5.36 shows that foreign banks had the highest average risk index and equity ratio, suggesting greater financial strength, although the ratios of deposits to assets, loans to deposits and loan loss reserves to total loans and to total assets were relatively high. The lower risk of foreign banks is also indicated by less earnings risk (as measured by variability of ROE and ROA) and liquidity risk (as measured by the ratios of total loans and cash and due from banks to total assets) in 1997. In addition, foreign banks were more efficient in minimising total expenses. The results suggest a better performance of foreign banks during 1990-97, reflected in lower risk and total expenses.

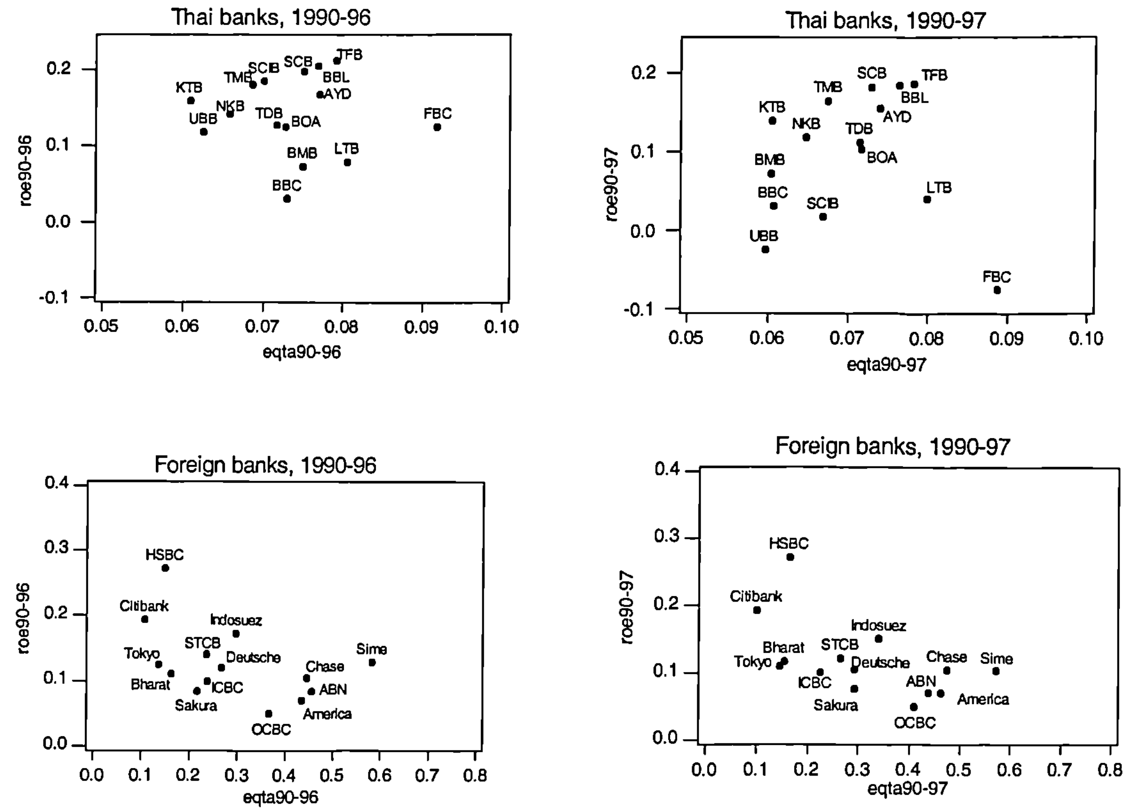
Next, we examine the relationship between risk and returns of Thai and foreign banks by using ROE and equity to assets ratio during 1990-96 and 1990-97. Table 5.37 shows negative and significant parametric and nonparametric correlations between risk index and ROE for foreign banks during both 1990-96 and 1990-97. We also found a negative and significant parametric correlation for Thai banks during 1990-97, but the relationship was not significant during 1990-96. However, the rank correlation suggests that risk and returns for Thai banks during 1990-97 was positive and significantly related, while this relationship was not significant during 1990-96. This is contradicted in the risk-return relationships outlined in Section 5.2: they suggest that Thai banks took on greater risk but did not obtain higher returns.

Table 5.37 Correlation analysis between risk and returns of Thai and foreign banks

	1990-96	1990-97
Pearson correlation		
Thai banks	-0.096	-0.463**
Foreign banks	-0.569**	-0.618**
Spearman rank correlation		
Thai banks	0.183	0.210*
Foreign banks	-0.673**	-0.717**

Notes: (**) and (*) indicates correlation is statistically significant at 1% and 5% levels.

Figure 5.16 The relationship between risk and returns of Thai and foreign banks



Notes: ROE = returns on assets, EQTA = equity to assets ratio

Figure 5.16 confirms that there is a positive relationship between risk and returns of Thai banks during 1990-97, and there seems to be no correlation during 1990-96. The plots of foreign banks during 1990-97 are not much different from those during 1990-96, indicating their negative relationship. The position of BBL, TFB and SCB hardly changed, while equity to assets ratio and ROE of 12 Thai banks noticeably decreased during 1990-97 compared to 1990-96. HSBC had the highest average ROE of almost 30%. OCBC had relatively high equity to assets ratio but low ROE (about 5%) during 1990-96 and 1990-97. Overall, we concluded that the relationship between risk and returns of Thai and foreign banks are apparently different.

5.6 The relationship between bank size and returns, risk and efficiency

This section examines whether there is a relationship between bank size and the return measures. Bank sizes are measured by total assets. Small bank refers to the group of banks that have total assets less than 10,000 million baht; medium-size bank denotes the group of banks that have total assets range of 10,000-100,000 million baht; while large bank is the group of banks that have total assets more than 100,000 million baht.

First, we examine the relationship between bank returns and asset size. The return measures used are return on equity (ROE), return on assets (ROA) and equity multiplier (EM).

Table 5.38 Correlation analysis between bank size and return measures

Category	ROE	ROA	EM
Pearson correlation			
Thai banks	0.135	0.151	-0.113
Foreign banks	-0.255*	-0.341**	0.020
FSIs	0.043	-0.059	0.309**
All banks	0.036	-0.113*	0.292**
Rank correlation			
Thai banks	0.442**	0.423**	-0.147
Foreign banks	-0.192	-0.468**	0.075
FSIs	-0.026	-0.074	0.054
All banks	0.075	-0.356**	0.535**
Mean of ratio by bank size			
Large bank	0.123	0.006	14.496
Medium bank	0.081	0.012	10.384
Small bank	0.135	0.027	5.459

Notes: (**) and (*) indicate correlation is statistically significant respectively at 1% and 5% levels. FSIs = Finance and specialised institutions

Table 5.38 shows that there is a negative and significant relationship between ROE and ROA and asset size of foreign banks, while Thai banks had positive and significant rank correlations. We found no significant relationship between ROE and asset size for all banks combined. Meanwhile, ROA and asset size for all banks are negatively related and the means of the ratios for each size group confirm that smaller banks have higher average ROA. The plots of ROE and ROA against total assets suggest a weak relationship between bank size and profitability measures (see Appendix III). There seems to be two distinct underlying relationships: negative for foreign banks and positive for Thai banks. There is no statistically significant relationship for FSIs.

Table 5.38 also shows a positive relationship between equity multiplier (EM) and total assets of all banks. The means for the three size groups show that larger banks have higher average EM. The plots of EM against total assets show a wide dispersion for Thai and foreign banks and FSIs, which implies that there is no strong relationship between EM and bank size (see Appendix III).

Next, we investigate the relationship between bank risk and asset size. Three measures of risk are used as indicators of capital adequacy risk, liquidity risk and credit risk: these are respectively the ratios of equity to assets, loans to assets and loan loss reserves to total loans.

Table 5.39 Correlation analysis between bank size and risk measures

Category	Equity to assets	Loan to assets	Loan loss reserves to total loans
Pearson correlation			
Thai banks	0.088	0.153	0.073
Foreign banks	0.131	0.355**	0.103
FSIs	-0.205*	-0.412**	-0.087
All banks	-0.220**	0.050	-0.125*
Rank correlation			
Thai banks	0.147	0.341**	0.297**
Foreign banks	-0.176	0.546**	0.176
FSIs	-0.053	-0.092	-0.033
All banks	-0.535**	0.141**	-0.113*
Mean of ratio by bank size			
Large bank	0.088	0.812	0.027
Medium bank	0.158	0.820	0.042
Small bank	0.272	0.793	0.071

Notes: (**) and (*) indicate correlation is statistically significant respectively at 1% and 5% levels

Table 5.39 provides some evidence that risk measures of Thai and foreign banks are positively related to asset size, while risk and asset size of FSIs are negatively correlated. However, the results for all banks and the means of the size groups imply weak and negative relationships between equity to assets and loan loss reserves to total loans ratios and bank size. There is a positive rank correlation between asset size and the ratio of loans to assets for all banks, but the means of the size groups indicate no relationship.

The plots of risk measures against total assets show that there is a wide dispersion of equity to assets and loan loss reserve to total loans ratios for all sizes of foreign banks (see Appendix III). A few DMUs of foreign banks and FSIs had relatively low liquidity ratios, while risk measures of Thai banks are similar for all asset size. The plots for all banks indicate an L-shaped relationship between the ratios of equity to assets and loan loss reserve to total loans and asset size, while the liquidity ratio for all bank sizes are not much different. We conclude that there are weak relationships between capital adequacy risk, liquidity risk and credit risk and bank size, but these relationships are sometimes different or stronger.

Finally, we examine the relationships between financial ratios of bank efficiency and bank size. We use the ratios of non-interest expenses and total expenses to total assets and cost rate of interest bearing funds to reflect the efficiency of banks in minimising expenses.

Table 5.40 Correlation analysis between bank size and efficiency ratio

Category	NIE/TA	TTE/TA	EA/TA
Pearson correlation			
Thai banks	-0.107	-0.345**	-0.104
Foreign banks	-0.302**	-0.317**	-0.099
FSIs	0.016	0.068	-0.376**
All banks	-0.139**	-0.041	-0.052
Rank correlation			
Thai banks	-0.232*	-0.387**	0.032
Foreign banks	-0.301**	-0.226*	-0.057
FSIs	0.279**	0.441**	-0.055
All banks	-0.214**	0.219**	-0.084
Mean of ratio by bank size			
Large bank	0.017	0.086	0.866
Medium bank	0.026	0.114	0.886
Small bank	0.028	0.075	0.862

Notes: (**) and (*) indicate correlation is statistically significant respectively at 1% and 5% levels. NIE/TA = the ratio of non-interest expense to total assets, TTE/TA = total expense to total assets.

Table 5.40 shows some evidence of negative correlation between the ratios of non-interest expenses and total expenses to assets, and size of Thai and foreign banks. However, the negative relationships are weak. For FSIs, there is some evidence of positive relationships. We also found a negative and significant relationship between earnings power and size for FSIs. The correlations and means of the size groups suggest a weak and negative relationship between non-interest expenses to assets ratio and size of all banks. Overall, the results are mixed and none of the correlations are strong.

The plots of efficiency ratios against total assets (see Appendix III) show that there is a wide dispersion of non-interest expenses to assets of foreign banks and FSIs, total expenses to assets of FSIs and earnings power of foreign banks. Meanwhile, efficiency ratios for all sizes of Thai banks do not differ greatly. The plots for all banks' efficiency ratios and total assets exhibit an L-shaped relationship. We conclude that there is a weak relationship between bank efficiency ratio and bank size, and there are slightly stronger relationships if Thai banks, foreign banks and FSIs are considered separately.

Next, we further investigate the relationship between bank size and financial ratios of bank returns, risk and efficiency using the classification of Thai and foreign banks by Leightner and Lovell (1998). Table 5.41 shows that Thai large banks had the highest average returns, followed by foreign small and tiny banks. The results show that high returns of Thai banks were linked with high financial leverage, while foreign banks were better at generating returns on assets. As a result, Thai medium and small banks were severely affected by the financial crisis in 1997.

Table 5.41 Means of financial ratios of Thai and foreign banks by size

Returns	Return on equity (%)			Return on assets (%)			Equity multiplier		
	90-94	90-96	1997	90-94	90-96	1997	90-94	90-96	1997
Thai large	19	19	3	1	1	0.2	15	14	16
Thai medium	15	16	-63	1	1	-4	13	13	18
Thai small	10	10	-27	1	1	-4	16	15	17
Foreign small	16	14	0.3	2	2	0.2	8	6	4
Foreign tiny	10	9	5	3	3	0.1	4	4	5
Risk	**Equity/assets (%)**			**Loan/assets (%)**			**LLR/loans (%)**		
	90-94	90-96	1997	90-94	90-96	1997	90-94	90-96	1997
Thai large	7	7	7	82	83	80	2	2	3
Thai medium	8	8	6	83	84	84	1	2	6
Thai small	7	7	6	81	81	88	2	2	4
Foreign small	18	25	47	86	87	79	6	8	13
Foreign tiny	32	36	35	77	76	68	11	12	8
Efficiency	**NIE/assets (%)**			**TTE/assets (%)**			**Earnings power (%)**		
	90-94	90-96	1997	90-94	90-96	1997	90-94	90-96	1997
Thai large	2	2	2	9	9	9	88	88	82
Thai medium	2	2	2	9	9	10	88	88	87
Thai small	2	2	3	10	9	12	87	87	89
Foreign small	3	3	4	8	7	8	88	87	73
Foreign tiny	3	3	3	7	7	7	85	84	75

Note: LLR =loan loss reserve, NIE = non-interest expense, TTE = total expense.

Table 5.41 shows that foreign banks had higher proportions of equity in total assets, implying greater financial strength, although loan loss reserves of foreign small and tiny banks were relatively high. The results suggest that foreign banks are more efficient in minimising the ratio of total expense to assets. On the other hand, Thai small banks became more exposed to liquidity risk as their investment in interest-yielding assets and total expenses increased in 1997 and this may have been the effects of the financial crisis.

5.7 Conclusion

This chapter examined the returns, risk and efficiency of banks during the 1990-97 financial deregulation. We use various financial ratios to examine whether performance of banks has improved since the beginning of financial deregulation in 1990.

The results indicate general improvement of bank returns during 1990-93, but there was a downward trend in the following years. The analysis shows that the risk and returns of Thai banks and FSIs may have been adversely affected by the financial crisis in 1997. Meanwhile, foreign banks had a better performance because of greater financial strength and relatively low expenses as a percentage of total assets.

We also found some weak correlations between bank sizes and financial ratios of returns, risk and efficiency of banks. More detailed analysis suggests that Thai (large) banks took on high risk to maximise the shareholders' wealth, while foreign banks were more cautious having substantially higher ratios of equity to assets.

Chapter 6 Data and Methodology

INTRODUCTION

This chapter presents the data and methodology of the two-stage approach used to examine the impact of financial deregulation on bank efficiency and productivity. In the first-stage, we use Data Envelopment Analysis (DEA) to estimate technical, allocative and cost efficiencies of 379 DMUs of Thai and foreign banks and FSIs (finance and specialised institutions). Also, Malmquist productivity indices are calculated for Thai and foreign banks between 1990 and 1997. In the second-stage, regression analyses are used to assess the effects of financial deregulation.

This chapter is organised as follows. The first section discusses the choice of bank inputs and outputs used to calculate relative efficiencies and productivity, and contains exploratory data analysis of the sample from 1990 to 1997. Section 2 examines the operating efficiency of banks. Section 3 outlines the first-stage analysis using the DEA approach to estimate relative efficiencies and productivity of banks. Section 4 specifies the variables and econometric models used to analyse the effects of financial deregulation during 1990-97. Section 5 concludes this chapter.

An overall improvement or deterioration of inputs, outputs and operating efficiency of banks is indicated by the respective change in ratio for Thai and foreign banks and the FSIs. The variability of bank inputs, outputs and operating efficiency is measured by their standard deviation, while the coefficient of variation is a measure of their relative dispersions. We attempt to identify the effects of the financial crisis in 1997 using two criteria. First, if there is a pronounced upward trend in 1990 to 1996, then we examine the difference between the actual 1997 value and the forecast from a simple regression against time for each bank separately. Second, if data shows no trend, then we compare the average 1990-96 with the actual values in 1997. We expect a substantial decrease of inputs, outputs and operating ratios and a sudden rise of input prices (because of excessive spending), if the bank has been affected by the financial crisis.

6.1 Data

The aim of this section is to define and examine bank inputs and outputs used to estimate technical, allocative and cost efficiency, and to calculate changes in productivity. First, the rationale for choosing specific inputs and outputs is discussed. Second, the results of exploratory analysis of the sample of bank inputs and outputs are presented. Finally, we examine the inputs of Thai banks in more detail and compare our findings with those of Okuda and Mieno (1999).

6.1.1 Measurement of bank inputs and outputs

This study adopts the intermediation approach to define inputs and outputs of banks. Banks are considered as financial intermediaries, which utilize labour, capital and purchased funds to produce returns from loans and other earning assets. The intermediation approach is preferable for a number of reasons.

1) It is important that deposits should be treated as inputs because banks use deposits as well as other funds to make loans and investment. As supported by Elyasiani and Mehdian (1990b): deposits are demanded by the financial firm and supplied by the public and therefore, banks buy rather than sell deposits. Similarly, Berger and Mester (1997) specified financial assets as outputs and financial liabilities and physical factors as inputs.

2) It is important that the units of bank inputs and outputs are measured in terms of monetary volume. This is because when banks compete for market share, the standard they measure is the monetary volume, not the number of accounts.

3) There are some bank services that cannot be measured in number of accounts. For instance, investment in securities cannot be counted as the number of accounts.

4) The intermediation approach is inclusive of interest expenses on deposits and other purchased funds, which comprise the majority of banking costs. Mester (1996) states that the intermediation approach is the most commonly used in the conventional cost function literature, which focuses on cost efficiencies, since interest paid is a major component of bank cost.

5) The review of specification for bank inputs and outputs in chapter four suggests that the intermediation approach has been the most widely used in bank efficiency studies.

Following the intermediation approach, this study uses three inputs: number of employees, and balance sheet levels of fixed assets and purchased funds. The two outputs are defined as net total loans and other earning assets. These inputs and outputs have been employed by, for example, Berger and Mester (1997), Altunbas and Molyneux (1997) and Casu and Girardone (1998).

6.1.2 Exploratory analysis of bank inputs and outputs

This section presents summary statistics of the three inputs (number of employees, purchased funds and fixed assets), the two outputs (net total loans and other earning assets) and the respective input prices which are the prices of labour, purchased funds and physical capital. Financial data of inputs and outputs are converted into 100's of 1990 baht using the GDP deflator[1]. Finally, three size categories of Thai banks are used to compare our input price results, and labour to capital ratios, with Okuda and Mieno (1999).

[1] GDP deflator is derived by dividing GDP at current prices by GDP at constant prices. The deflator is expressed in index form with the base 1990=100. Current price GDP is line 99b and constant price GDP is line 99b.p in the International Financial Statistics Yearbook 1996 and 1998, published by the *IMF*.

Table 6.1 Average net total loans, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-97
Thai banks									
Mean	99730	115151	131490	145709	168523	190699	210891	228310	161313
DMUs	15	15	15	15	15	15	15	15	
Foreign bank branches									
Mean	5372	6644	7273	9865	13301	16707	20563	32318	14603*
DMUs	14	14	14	14	14	14	14	14	
Finance and specialised institutions (FSIs)									
Mean	n.a.	13622	17254	21064	23259	27097	37837	65310	29349
DMUs	1	7	14	22	29	30	27	11	

Notes: The figures are shown in million baht. DMUs = decision making units. * The average value is inclusive of 6 new banks. Foreign banks, including 6 new banks, had the average of 37103 million baht in 1997, increased by 80% from 1996.

Net total loans are measured by the sum of total loans and the accrued interest receivable minus loan loss reserves. Table 6.1 shows that average net total loans of Thai banks increased by about 130%, while those of foreign banks increased by almost 600% from 1990 to 1997. The largest increase of average net total loans for foreign banks was during 1996-97 (80%), which was partly due to 6 bank entries. The average net total loans of FSIs also increased, but this is partly due to the differences in the number of DMUs in each year (see also, Section 5.1 and Appendix II).

Figure 6.1 Average and variation for net total loans, 1990-97

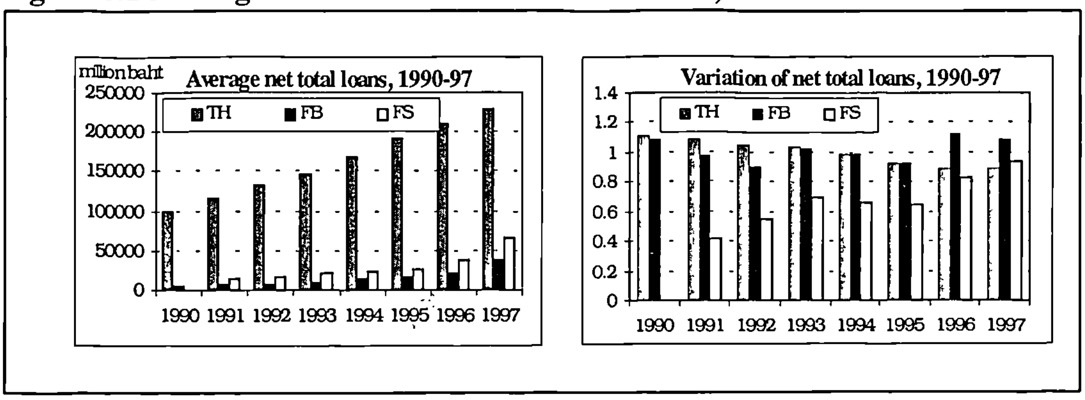


Figure 6.1 shows a steady upward trend, indicating an increase in the average net total loans for the three groups of banks. Thai banks had the highest average partly because they had branches throughout the country. Net total loans of foreign banks and FSIs became more dispersed in 1996 and 1997, while the relative dispersions of those for Thai banks decreased.

Table 6.2 Net total loans of Thai and foreign banks, 1997

Bank	Actual	Forecast	% differ	R-square adjusted (%)
BBL	735708	736604	-0.1	99.8
KTB	480006	483041	-0.6	98.6
TFB	423215	442853	-4.6	97.0
SCB	401157	370995	7.5	94.4
AYD	288826	288097	0.3	97.0
TMB	215066	219727	-2.2	98.6
FBC	206206	190280	7.7	96.6
SCIB	168184	158371	5.8	97.6
BMB	119177	125836	-5.6	97.1
BBC	91763	113226	-23.4	70.0
BOA	95770	88025	8.1	93.2
TDB	82151	78098	4.9	93.7
NKB	42603	42707	-0.2	99.4
UBB	42451	40538	4.5	91.4
LTB	32371	28308	12.6	91.1
Tokyo	133823	97421	27.2	70.2
Sakura	87112	71839	17.5	86.2
Citibank	51450	44384	13.7	90.9
Deutsche	21058	20527	2.5	90.4
STCB	22618	17072	24.5	65.4
Indosuez	15420	16511	-7.1	83.5
HSBC	41448	36788	11.2	93.8
Chase	30923	21766	29.6	67.7
America	21296	19356	9.1	91.9
ABN	14959	9657	35.4	55.6
Bharat	1214	939.2	22.6	0.0
ICBC	3887	3258	16.2	85.3
Sime	930	713.8	23.3	24.7
OCBC	6315	4983	21.1	79.3

Notes: 1) The actual and forecast values are shown in million baht.
2) F-test for each of the regressions is significant at 5% level, except for Sime and Bharat.
3) Forecasts are obtained from simple regression of net total loans against time for each bank.

Table 6.2 shows the difference between the actual and the forecast of net total loans in 1997. Most of the foreign banks had greater actual loans than forecasts, except for Indosuez that had actual value 7% less than its forecast. Similarly, actual loans of six Thai banks were slightly less than forecasts. Table 6.2 shows that BBC had the largest shortfall of 23% between the forecast and actual value in 1997, and this suggests that its net total loans were affected by the financial crisis.

Table 6.3 Average other earning assets, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-97
Thai banks									
Mean	12509	11731	11145	16623	18886	22197	21850	35277	18777
DMUs	15	15	15	15	15	15	15	15	
Foreign bank branches									
Mean	754	834	962	1698	2552	3583	4158	6313	3009*
DMUs	14	14	14	14	14	14	14	14	
Finance and specialised institutions (FSIs)									
Mean	n.a.	1546	3998	4001	7625	9147	9771	12886	6996
DMUs	1	7	14	22	29	30	27	11	

Note: The figures are shown in million baht. DMUs = decision making units. * The average value is inclusive of 6 new banks. Foreign banks, including 6 new banks, had the average of 9,530 million baht in 1997, increased by 130% from 1996.

Other earning assets comprises due from banks (interest bearing) and net total investment in securities (trading securities plus investment securities minus reserve for unrealised losses). Table 6.3 shows that Thai banks had the highest average other earning assets, which increased by about 180% from 1990 to 1997. There was a large increase in average other earning assets of foreign banks of 130% during 1996-97, which was mainly due to the entry of 6 new banks. The changes in average other earning assets of FSIs were partly due to the differences in the number of DMUs in each year.

Figure 6.2 Average and variation for other earning assets, 1990-97

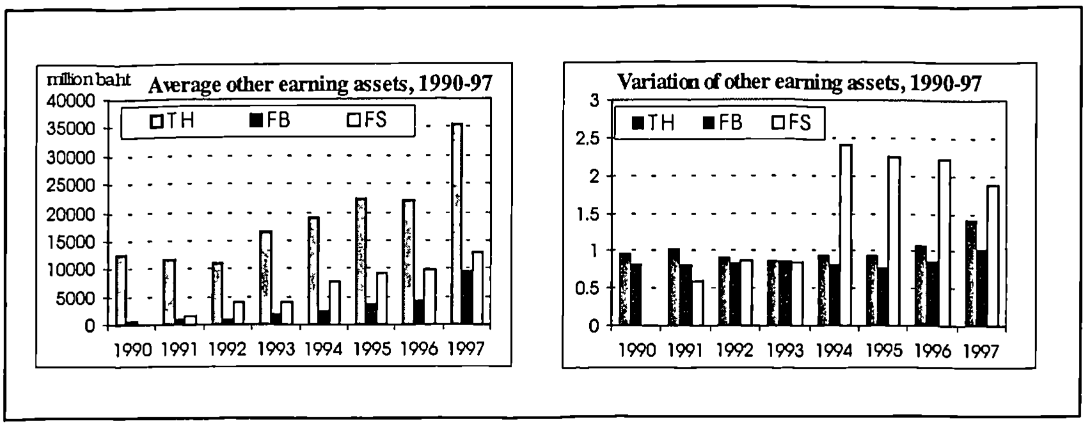


Figure 6.2 shows similar upward trends to those in Figure 6.1, indicating an increase in the average other earning assets for the three groups of banks during 1990-97. The increases in the average and relative dispersions for Thai banks' data in 1997 were due to large increases in other earning assets of four banks (BBL, TFB, SCB and TMB). A greater dispersion of data for FSIs during 1994-97 is due to the fact that the sample contained large specialised banks (GHB and GSB) in those years, and not in the earlier years.

Table 6.4 Other earning assets of Thai and foreign banks, 1997

Bank	Actual	Forecast	%differ	R-square adjusted (%)	F-test
BBL	194944	140472	27.9	66.2	14.7*
KTB	39454	41935	-6.3	49.1	7.7*
TFB	86598	55280	36.2	30.3	4.0
SCB	62108	49563	20.2	74.6	21.5*
AYD	34997	26477	24.3	55.8	9.8*
TMB	37501	28174	24.9	63.2	13.0*
FBC	10125	13565	-34.0	5.9	1.4
SCIB	16707	20191	-20.9	67.7	15.6*
BMB	7791	9034	-16.0	12.1	1.9
BBC	7777	16725	-115.1	7.6	1.5
BOA	9668	10507	-8.7	45.0	6.7*
TDB	5938	7046	-18.7	74.1	21.1*
NKB	6272	6518	-3.9	89.1	58.4*
UBB	6712	6278	6.5	83.4	36.2*
LTB	2568	3260	-26.9	43.0	6.3*
Tokyo	16191	12374	23.6	72.2	19.2*
Sakura	14415	9678	32.9	61.3	12.1*
Citibank	20206	14067	30.4	71.3	18.4*
Deutsche	7705	4814	37.5	47.5	7.3*
STCB	8377	9276	-10.7	92.9	92.8*
Indosuez	4388	4047	7.8	67.8	15.7*
HSBC	5988	5944	0.7	94.6	122.8*
Chase	1134	1559	-37.5	26.3	3.5
America	4200	6433	-53.2	53.4	9.0*
ABN	3124	3433	-9.9	76.4	23.7*
Bharat	432	356.4	17.5	9.5	1.7
ICBC	1225	938	23.4	64	13.4*
Sime	473	. 490.2	-3.6	0.0	0.01
OCBC	531	563.2	-6.1	73.1	20.0*

Notes: The actual and forecast values are in million baht. Forecasts are obtained from simple regression of other earning assets against time for each bank. (*) indicates a statistically significant at 5% level.

Table 6.4 shows that there was a large and significant shortfall in the actual compared to the simple forecast of other earning assets for SCIB, TDB, LTB and Bank of America, which suggests that these banks may have been affected by the financial crisis. Also, FBC, BBC and Chase Manhattan Bank had a large decrease, but those regressions are not significant. Overall, the actual earning assets of 10 out of 29 banks were greater than the simple trend forecasts, which suggests that the financial crisis had not yet adversely impacted on these banks.

Table 6.5 shows the average number of employees of Thai and foreign banks and the FSIs during 1990-97. Note that the number of employees for the FSIs were estimated from the average number of employees of Thai and foreign banks due to the lack of availability of data. That is, the average prices of labour of Thai and foreign banks in each year are calculated and then combined with the personnel expenses for the FSIs to estimate the numbers of employees. The sensitivity analysis provided in Appendix IV suggests that there is no difference in the number of DMUs which are efficient, using lower quartile, or mean, or upper quartile of labour price for the estimates of the FSIs' numbers of employees.

Table 6.5 Average number of employees, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-97
Thai banks									
Mean	6514	6923	7288	7679	7871	8199	8254	8174	7613
DMUs	15	15	15	15	15	15	15	15	
Foreign bank branches									
Mean	167	177	158	179	223	219	239	272	197*
DMUs	14	14	14	14	14	14	14	14	
Finance and specialised institutions (FSIs)									
Mean	n.a.	386	508	686	767	708	745	1085	698
DMUs	1	7	14	22	29	30	27	11	

Note: The average figures are shown in persons. DMUs = decision making units. * The average value is inclusive of 6 new banks. Foreign banks, including 6 new banks, had the average of 212 persons in 1997, decreased by 11% from 1996.

Table 6.5 shows that Thai banks had the highest average number of employees, about a 25% increase from 1990 to 1997. This is because Thai banks had a large number of branches, while foreign banks only had one branch each. The average number of employees of foreign banks decreased in 1997, but this was due to the inclusion of 6 new small banks.

Figure 6.3 Average and variation for number of employees, 1990-97

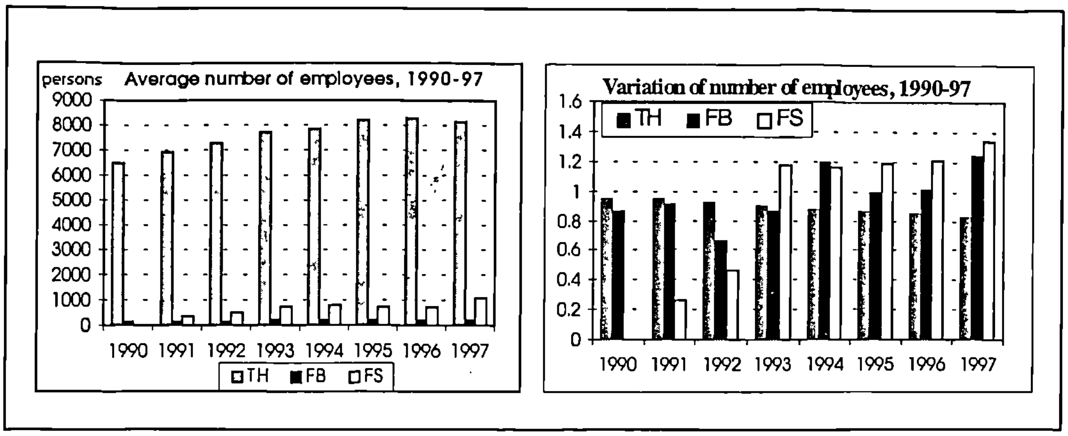


Figure 6.3 shows that the average number of employees for Thai banks slowly increased from 1990 to 1997, with the relative dispersions almost unchanged. On the other hand,

foreign banks had the smallest average number of employees with noticeable changes in relative dispersions. Meanwhile, the large increase in relative dispersion for FSIs' data during 1993-97 was partly due to the differences in the number of DMUs, and especially the inclusion of two very large FSIs, GHB and GSB.

Table 6.6 Number of employees for Thai and foreign banks, 1997

Bank	Actual	Forecast	% differ	R-square adjusted (%)	F-test
BBL	25000	26335	-5.3	67.4	15.4*
KTB	16252	16821	-3.5	43.0	6.3*
TFB	15370	16099	-4.7	15.0	2.2
SCB	12679	13484	-6.3	77.6	25.2*
AYD	12322	12159	1.3	97.4	265.6*
TMB	8149	8765	-7.6	66.5	14.9*
FBC	3778	3793	-0.4	99.2	879.5*
SCIB	6130	6325	-3.2	98.4	432.1*
BMB	5760	6077	-5.5	91.1	72.2*
BBC	5390	5439	-0.9	92.4	86.5*
BOA	2319	2523	-8.8	21.7	2.9
TDB	3410	3627	-6.4	95.9	163.7*
NKB	2149	2156	-0.3	99.7	2231.2*
UBB	2721	2711	0.4	0.0	0.05
LTB	1177	1130	4.0	95.2	140.5*
Tokyo	353	324	8.3	78.9	27.2*
Sakura	241	253	-5.1	85.0	40.7*
Citibank	1097	1099	-0.2	57.3	10.4*
Deutsche	202	204	-0.8	95.8	162.4*
STCB	466	430	7.8	54.0	9.2*
Indosuez	195	201	-3.1	95.1	137.4*
HSBC	650	563	13.3	81.7	32.3*
Chase	106	44	58.5	12.4	1.9
America	172	180	-4.5	73.7	20.6*
ABN	108	83	23.6	0.0	0.3
Bharat	51	50	1.5	61.2	12.0*
ICBC	67	65	3.5	0.0	0.02
Sime	49	53	-8.3	12.9	2.0
OCBC	52	52	-0.4	33.2	4.5

Notes: The actual and forecast figures are in persons. Forecasts are obtained from simple regressions of number of employees against time for each bank. (*) indicates a statistically significant at 5% level.

Table 6.6 shows that the actual number of employees for 6 banks (BBL, SCB, TMB, BMB, TDB and Sakura) were 5% less than the forecasts in 1997. This may have been the impact of the financial crisis. Other banks such as BOA, Chase, ABN and Sime also had a large difference from the forecasts, but the regressions on which these are based are not statistically significant.

Purchased funds are the sum of total deposits, due to banks (interest bearing) and borrowings. Table 6.7 shows that Thai banks had the largest average purchased funds, which increased by 135% from 1990 to 1997. There was a substantial increase in average for foreign banks during 1996-97 (almost 60%) that resulted from the increased purchased funds of 10 out of 14 existing banks in 1997. An increase in average for FSIs was partly due to the differences in the number of DMUs that included large specialised institutions (Government Savings and Housing Banks) in the last three years.

Table 6.7 Average purchased funds, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-97
Thai banks									
Mean	110037	124146	137971	159616	182430	205559	222833	258727	175165
DMUs	15	15	15	15	15	15	15	15	
Foreign bank branches									
Mean	5206	6390	7090	10084	12532	13169	14487	24378	11495*
DMUs	14	14	14	14	14	14	14	14	
Finance and specialised institutions (FSIs)									
Mean	n.a.	13778	18676	22461	27612	31799	40576	69004	31987
DMUs	1	7	14	22	29	30	27	11	

Note: The figures are shown in million baht. DMUs = decision making units. * The average value is inclusive of 6 new banks. Foreign banks, including 6 new banks, had the average of 23,000 million baht in 1997, increased by 59% from 1996.

Figure 6.4 Average and variation for purchased funds, 1990-97

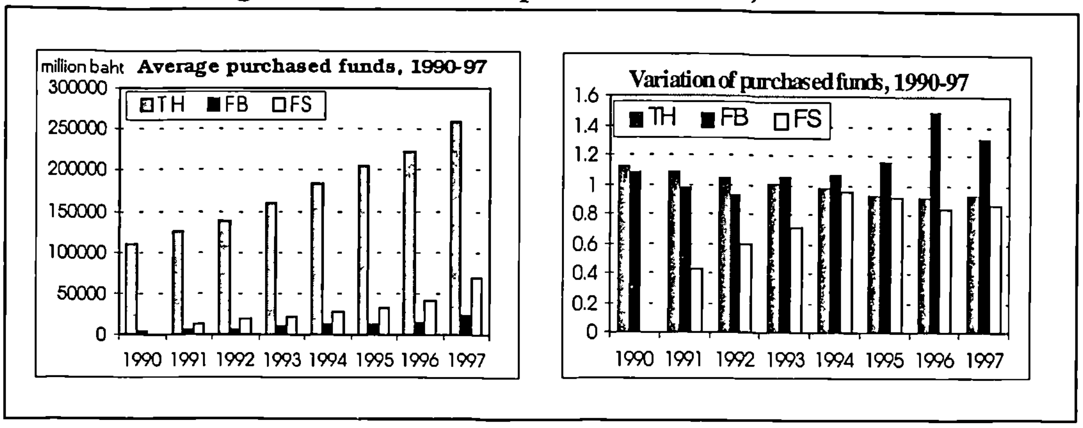


Figure 6.4 shows an upward trend of average purchased funds for the three groups of banks. Thai banks had the largest average of purchased funds, but the relative dispersions did not increase during 1990-97. Purchased funds of foreign banks, on the other hand, were highly dispersed especially in 1996 due to large increases of over 100% for two banks (Chase and ABN) and over 50% decreases for three banks (Sakura, Indosuez and Sime) compared to those in 1995. Figure 6.4 also shows an increased dispersion for FSIs' data, which was partly due to the differences in the number of DMUs.

Table 6.8 Purchased funds of Thai and foreign banks, 1997

Bank	Actual	Forecast	% differ	R-square adjusted (%)	F-test
BBL	890552	841943	5.5	96.1	173.0*
KTB	511704	512307	-0.1	97.9	323.7*
TFB	510339	484227	5.1	97.3	250.8*
SCB	462757	413418	10.7	92.4	85.9*
AYD	319883	312761	2.2	95.2	138.8*
TMB	252904	245728	2.8	98.9	636.7*
FBC	200323	186226	7.0	96.8	211.3*
SCIB	181359	174713	3.7	98.0	346.7*
BMB	138128	137283	0.6	97.9	335.2*
BBC	102542	122008	-19.0	60.4	11.7*
BOA	97966	91796	6.3	93.0	93.6*
TDB	84953	81435	4.1	96.1	174.2*
NKB	47944	47737	0.4	99.2	896.9*
UBB	47061	45307	3.7	94.7	124.9*
LTB	32484	30481	6.2	97.5	271.5*
Tokyo	121554	91462	24.8	72.4	19.4*
Sakura	15711	25225	-60.6	0.0	0.05
Citibank	71404	55155	22.8	79.3	27.8*
Deutsche	16528	12209	26.1	2.2	1.16
STCB	18376	15151	17.6	48.7	7.6*
Indosuez	8064	8803	-9.2	1.1	1.08
HSBC	43181	36714	15.0	91.6	77.3*
Chase	9698	6867	29.2	12.4	1.99
America	10183	8856	13.0	61.0	11.9*
ABN	17128	9361	45.3	38.2	5.32
Bharat	2236	1405.6	37.1	0.0	0.84
ICBC	4566	3523	22.8	76.1	23.3*
Sime	753	602.4	20.0	3.9	1.28
OCBC	1912	1975	-3.3	62.3	12.6*

Notes: The actual and forecast figures are shown in million baht. Forecasts are obtained from simple regressions of purchased funds against time for each bank. (*) indicates a statistically significant at 5% level.

Table 6.8 shows that Sakura Bank seems to be the most affected by the financial crisis, but the difference between its actual purchased funds and a forecast in 1997 is not statistically significant. Meanwhile, we found a large (19%) and significant shortfall for BBC, suggesting the possible impact of the financial crisis. Overall, the actual purchased funds for most of the banks were significantly greater than the forecasts in 1997, which suggest that the financial crisis had not yet affected the banking system's ability to raise funds.

Fixed assets are measured by the book value of land, premises, equipment and properties foreclosed. Table 6.9 shows that there was a substantial increase of average fixed assets for Thai banks of almost 20% from 1993 to 1994, and about 230% for foreign banks during 1995-96[2]. An increase in the average fixed assets of the FSIs in the

[2] The increase in average for foreign banks was due to a huge increase in fixed assets of Citibank in 1996 and 1997 (respectively 40 and 68 billion baht). The averages after excluding these outliers were 105 and 103 million baht respectively in 1996 and 1997.

last four years were mainly due to the inclusion of the large Government banks (GHB, GSB and BAAC)[3].

Table 6.9 Average fixed assets, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-97
Thai banks									
Mean	2023	2500	2976	4821	5721	6602	7353	7929	4991
DMUs	15	15	15	15	15	15	15	15	
Foreign bank branches									
Mean	35	38	43	74	99	126	2978	4991	862*
DMUs	14	14	14	14	14	14	14	14	
Finance and specialised institutions (FSIs)									
Mean	n.a.	192	296	387	501	506	659	1202	535
DMUs	1	7	14	22	29	30	27	11	

Note: The figures are shown in million baht. DMUs = decision making units. * The average value is inclusive of 6 new banks. Foreign banks, including 6 new banks, had the average of 3,506 million baht in 1997, increased by 18% from 1996.

Figure 6.5 Average and variation for fixed assets, 1990-97

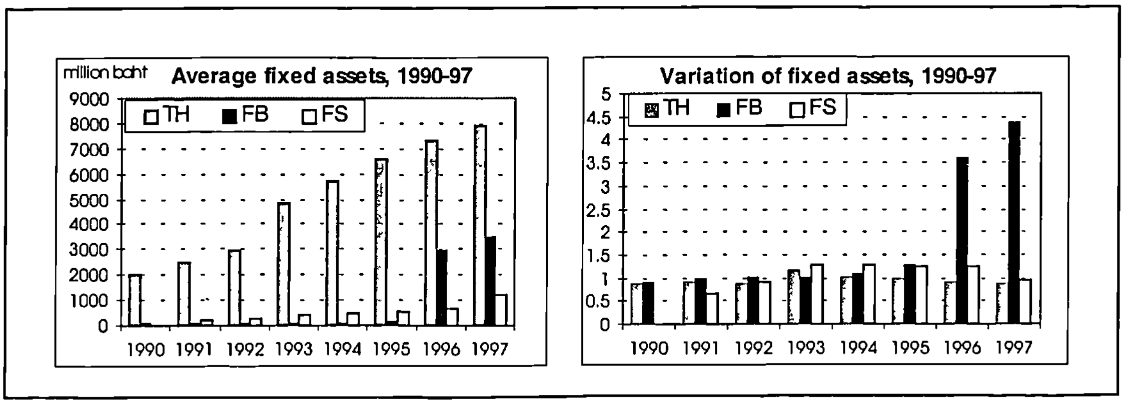


Figure 6.5 shows an upward trend of the average fixed assets for Thai banks, which considerably increased during 1993-97 compared with those during 1990-92. Similarly, the average for FSIs was highest in 1997 but this was due to the difference in the number of DMUs. Also, there was a marked increase in the average, and greater dispersion of fixed assets for foreign banks in 1996 and 1997 due to the big increase for Citibank.

[3] The averages after excluding these 3 banks were 364, 372, 419 and 624 million baht respectively from 1994 to 1997, and the 1990-97 average would be 379 million baht.

Table 6.10 Fixed assets of Thai and foreign banks, 1997

Bank	Actual	forecast	% differ	R-square adjusted (%)	F-test
BBL	26072	28405	-8.9	85.0	40.7*
KTB	12029	12789	-6.3	91.1	72.6*
TFB	15765	16808	-6.6	95.8	160.3*
SCB	15623	17316	-10.8	89.4	60.2*
AYD	9857	10095	-2.4	95.8	160.4*
TMB	9800	10163	-3.7	98.3	409.8*
FBC	6192	3848	37.9	55.0	9.5*
SCIB	6689	6562	1.9	88.1	52.9*
BMB	4577	4371	4.5	90.2	65.7*
BBC	2094	2187	-4.4	92.2	83.5*
BOA	1522	1690	-11.0	52.3	8.7*
TDB	2520	3055	-21.3	72.5	19.5*
NKB	2456	2129	13.3	91.4	75.1*
UBB	2048	2008	2.0	89.5	60.8*
LTB	1696	1800	-6.1	80.9	30.6*
Tokyo	136	151.9	-11.6	73.9	20.8*
Sakura	113	117.9	-4.1	79.0	27.4*
Citibank	68540	42223	38.4	50.6	8.2*
Deutsche	57	64	-11.0	58.1	10.7*
STCB	239	239	0.1	88.1	52.9*
Indosuez	199	182	8.6	55.3	9.6*
HSBC	213	247	-15.9	70.9	18.1*
Chase	133	176	-32.9	41.2	5.9*
America	82	98	-20.3	0.0	0.08
ABN	39	40	-1.1	49.3	7.8*
Bharat	7	6	19.7	48.7	7.6*
ICBC	34	50	-45.1	20.6	2.8
Sime	12	16	-29.7	46.6	7.1*
OCBC	75	40	46.7	25.2	3.3

Notes: The actual and forecast figures are shown in million baht. Forecasts are obtained from simple regressions of fixed assets against time for each bank. (*) indicates a statistically significant at 5% level.

Table 6.10 shows that Chase Manhattan Bank seems to be badly affected by the financial crisis as its actual fixed assets was over 30% significantly less than the trend forecast in 1997. Two other foreign banks (ICBC and America) also had a large decrease from the forecasts, but their trend regressions were not statistically significant. Table 6.10 also shows a shortfall in the actual fixed assets from the estimates of over 20% for two banks (TDB and Sime) and over 10% for five banks (TFB, BOA, Tokyo, Deutsche and HSBC), which may have been the effects of the financial crisis.

The price of labour equals personnel expenses divided by number of employees. Table 6.11 shows that average prices of labour for foreign banks were higher than Thai banks. This suggests a higher quality of employees for foreign banks on average[4]. From 1993 to 1997, the average labour price of Thai and foreign banks increased by 143% and 124%, respectively. Note that the BIBF (Bangkok International Banking Facilities) was initiated and bond holding requirements for new Thai bank branches were abolished in 1993, therefore financial expertise and more employees were needed. This

[4] In general, foreign banks in Thailand employ bilingual employees with higher degrees. Their terms of employment are sometimes based on contract, while Thai banks tend to have permanent employees.

means an increased average price of labour for both Thai and foreign banks. Their average prices were highest in 1997 although the average number of employees decreased (see, Table 6.5), and the entry of 6 new banks slightly lowered the average price for foreign banks in 1997. The FSIs' data are not shown here because we estimated their number of employees (see, Table 6.5 and Appendix IV), using synthetic prices of labour, as described earlier in this chapter.

Table 6.11 Average price of labour, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-97
Thai banks									
Mean	0.14	0.16	0.19	0.21	0.25	0.28	0.31	0.34	0.23
DMUs	15	15	15	15	15	15	15	15	
Foreign bank branches									
Mean	0.38	0.44	0.48	0.53	0.59	0.74	0.83	0.97	0.61*
DMUs	14	14	14	14	14	14	14	14	

Note: The figures are shown in million baht. DMUs = decision making units. The average for the FSIs is not shown here because they are synthetic. * The average value is inclusive of 6 new banks. Foreign banks, including 6 new banks, had the average of 0.85 million baht in 1997, increased by 2.5% from 1996.

Figure 6.6 Average and variation for price of labour, 1990-97

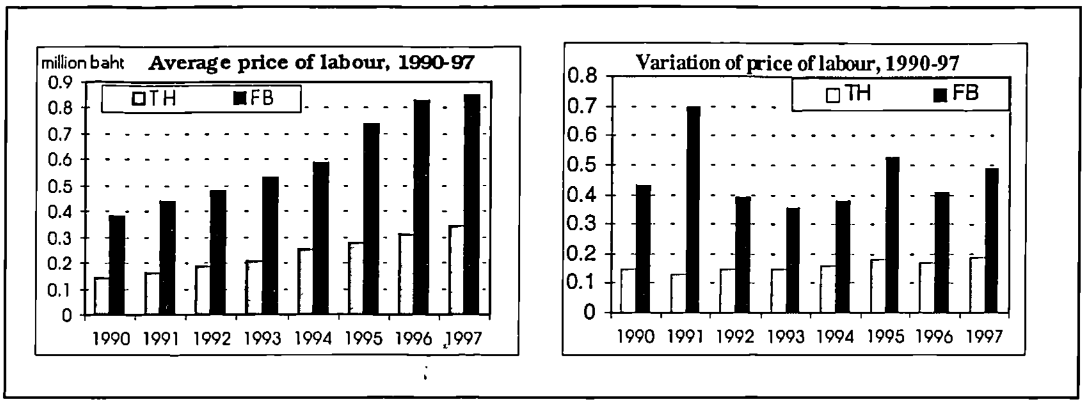


Figure 6.6 shows an upward trend of the average price of labour for both Thai and foreign banks. The average and relative dispersions for foreign banks' were higher than for Thai banks. Foreign banks had a relatively large dispersion of data in 1991, which was due to a sharply increased price (about 300%) of Citibank from 1990 to 1991. Figure 6.6 suggests a substantial difference of foreign banks' price of labour during 1990-97.

Table 6.12 Price of labour of Thai and foreign banks, 1997

Bank	Actual	Forecast	% differ	R-square adjusted (%)
BBL	0.42	0.42	0.5	98.6
KTB	0.37	0.37	0.3	97.1
TFB	0.42	0.44	-3.9	94.3
SCB	0.44	0.39	13.0	87.5
AYD	0.32	0.33	-3.8	99.1
TMB	0.30	0.30	0.4	98.2
FBC	0.25	0.26	-3.9	97.6
SCIB	0.32	0.32	-0.4	98.8
BMB	0.24	0.24	-1.1	99.2
BBC	0.37	0.30	19.0	76.8
BOA	0.40	0.39	3.5	96.7
TDB	0.30	0.32	-5.9	93.7
NKB	0.32	0.32	1.5	97.6
UBB	0.25	0.28	-11.4	91.8
LTB	0.34	0.35	-5.8	96.1
Tokyo	0.69	0.66	4.2	90.9
Sakura	0.56	0.46	17.1	1.7
Citibank	1.04	0.88	15.1	0.0
Deutsche	1.29	1.15	11.1	81.8
STCB	1.12	1.03	8.6	87.8
Indosuez	1.78	1.44	19.3	79.4
HSBC	0.66	0.68	-2.5	95.9
Chase	1.28	1.59	-23.8	68.4
America	0.95	1.02	-7.0	84.0
ABN	1.63	1.86	-14.3	94.7
Bharat	0.37	0.37	0.4	84.6
ICBC	1.07	0.97	10.2	87.5
Sime	0.59	0.53	11.2	86.6
OCBC	0.46	0.44	3.7	96.1

Notes: The actual and forecast values are shown in million baht. Forecasts are obtained from simple regressions of price of labour against time for each bank. Each of the regression is significant at 5% level, except for Sakura and Citibank.

Table 6.12 shows that the actual prices of labour for BBC and Banque Indosuez were 19% significantly greater than their trend forecasts in 1997. Similarly, there was a 10% price increase from the simple forecasts for the four banks (SCB, Deutsche, ICBC and Sime). This may be due to either or both of the following reasons: the banks needed to hire more expertise and/or due to the financial crisis the banks were forced into making a large number of costly redundancies. We have seen from Table 6.6 that the numbers of employees for these banks (except for ICBC) were less than the forecasts in 1997. Table 6.12 also shows large increases of the actual price from the estimates of Sakura and Citibank, but the underlying regressions are not statistically significant.

The price of purchased funds equals total interest expenses divided by purchased funds. Table 6.13 shows the average prices and spreads for the three groups of banks. We calculate the spread for Thai banks from the difference between average price and interest rate on deposits. This is because the majority of their funds were customer deposits (see, Chapter 5, Section 5.3.4). Meanwhile, the spreads for foreign banks and

FSIs are calculated as the difference between their average prices and interest rates in the money market since the majority of their funds were from other sources.

Table 6.13 Average price of purchased funds, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-97
Thai banks									
Mean	8.60	10.73	8.07	7.27	6.28	8.13	8.47	9.01	8.32
Spread (1)	5.40	-0.23	0.43	-0.27	2.97	2.12	0.03	2.49	
Foreign bank branches									
Mean	7.44	8.90	6.64	5.20	5.01	8.78	10.93	7.90	9.11*
Spread (2)	6.92	5.06	3.07	3.89	4.38	4.61	0.49	13.83	
Finance and specialised institutions (FSIs)									
Mean	n.a.	11.51	9.55	7.25	6.99	9.24	9.78	9.90	9.18
Spread (2)	n.a.	2.45	0.16	1.84	2.40	4.15	1.64	11.83	
Average interest rates on deposits and other purchased funds									
Deposit	14.00	10.50	8.50	7.00	9.25	10.25	8.50	11.50	9.94
Money market	14.36	13.96	9.71	9.09	9.39	13.39	11.42	21.73	12.88

Notes: The figures are shown in percentage. * The average value is inclusive of 6 new banks. Foreign banks, including 6 new banks, had the average of 20% in 1997 increased by 83% from 1996. Interest rates on deposits are based on a one-year period as offered by leading commercial banks at the end of period. Money market interest rates are figured by a daily average interbank lending rate. Spread (1) = Deposit rate – Mean, Spread (2) = Money market rate – Mean.

Table 6.13 shows that the spreads for Thai and foreign banks declined over the period studied. Thai banks had a small spread in 1991, 1993 and 1996, while foreign banks experienced a fall in 1996[5]. On the other hand, FSIs had a large spread in 1997 due to the inclusion of 3 specialised banks (GSB, BAAC and EXIM) whose price of funds were relatively low. Table 6.13 shows that the average price of purchased funds for foreign banks increased substantially in 1997 due to a relatively high price of purchased funds for the 6 new foreign banks[6]. The averages for the three groups of banks were relatively low during 1993-94. This was partly due to the introduction of BIBF (Bangkok International Banking Facilities) in 1993, which allowed banks to increase funds more cheaply from overseas, and the low interest rates during 1993-94. On average, Thai banks had the lowest price of purchased funds during 1990-97.

[5] For Thai banks, the prices of purchased funds for four banks (AYD, NKB, UBB and LTB) were greater than 11% in 1991, while two banks (FBC and LTB) had price greater than 8% in 1993 and 7 out of 15 banks had price greater than 9% in 1996. Similarly, four foreign banks (Sakura, Deutsche, Indosuez and OCBC) had price greater than 15% in 1996.

[6] Banque Nationale de Paris had extraordinary high price at 219%, followed by Bank of China and Industrial Bank of Japan respectively at 26% and 22%.

Figure 6.7 Average and variation for price of purchased funds, 1990-97

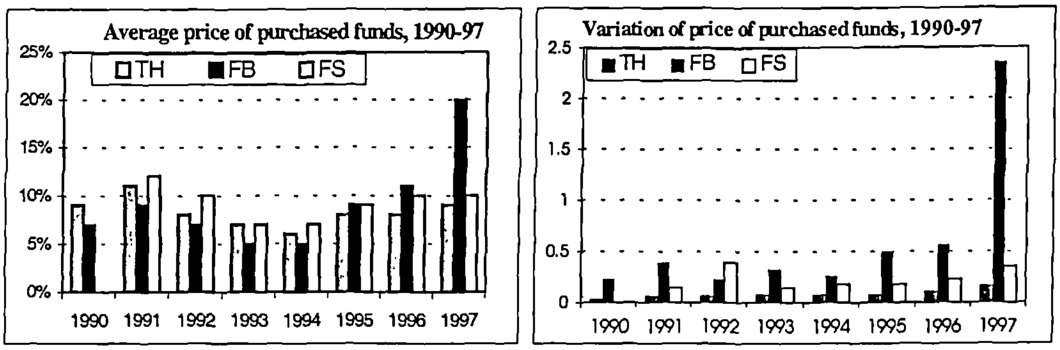


Figure 6.7 shows that average price of purchased funds for foreign banks during 1990-94 was lower than those of Thai banks and the FSIs. An increase in the average in later years was due to an increased price for 8 out of 14 existing banks and the entry of 6 new banks that also heightened the relative dispersion in 1997 A small dispersion of Thai banks' data suggests that their prices were not much different.

Table 6.14 Spread of price of purchased funds for Thai and foreign banks, 1990-96 and 1997

Thai banks			Foreign banks		
Bank	Average 1990-96	1997	Bank	Average 1990-96	1997
BBL	2.39	4.45	Tokyo	6.08	16.45
KTB	1.96	4.22	Sakura	3.43	12.70
TFB	1.98	4.15	Citibank	4.63	15.94
SCB	2.13	4.65	Deutsche	1.47	11.19
AYD	1.23	2.98	STCB	3.78	8.53
TMB	1.58	2.71	Indosuez	3.29	13.92
FBC	0.92	1.77	HSBC	5.59	14.79
SCIB	1.64	2.51	Chase	5.62	14.63
BMB	1.11	0.54	America	5.57	12.70
BBC	0.70	0.08	ABN	3.64	17.05
BOA	1.51	2.73	Bharat	2.98	17.69
TDB	1.75	1.94	ICBC	5.82	16.58
NKB	1.34	2.34	Sime	1.64	16.50
UBB	1.25	1.09	OCBC	3.37	4.83
LTB	0.86	1.21			

Notes: The figures are shown in percentage. The 1990-96 average deposit and market rates were 9.71 and 11.62, respectively.

Table 6.14 shows the spread of price of purchased funds during 1990-96 and in 1997. In general, foreign banks had larger spread than Thai banks and hence obtained cheaper funds than the average money market rate. Most of the banks had larger spread in 1997 relative to the 1990-96 average, except for BMB, BBC and UBB. This indicates that banks had not yet been affected by the financial crisis. The huge reduction for BMB and BBC suggests a greater difficulty in obtaining funds, as they were insolvent at the end of 1997

Table 6.15 Average price of physical capital, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-97
Thai banks									
Mean	0.58	0.57	0.54	0.45	0.39	0.39	0.41	0.58	0.49
DMUs	15	15	15	15	15	15	15	15	
Foreign bank branches									
Mean	4.96	5.24	5.15	5.04	2.59	2.57	2.32	8.54	4.77*
DMUs	14	14	14	14	14	14	14	14	
Finance and specialised institutions (FSIs)									
Mean	n.a.	1.39	1.30	1.30	1.46	1.50	1.41	0.93	1.33
DMUs	1	7	14	22	29	30	27	11	

Note: The figures are shown in million baht. DMUs = decision making units. * The average value is inclusive of 6 new banks. Foreign banks, including 6 new banks, had the average of 10.32 million baht in 1997 increased by 345% from 1996.

The price of physical capital equals other non-interest expenses (non-interest expenses minus personnel expenses) divided by fixed assets. Table 6.15 shows that foreign banks had the highest average price of physical capital, followed by FSIs and Thai banks. The high average price for foreign banks in 1997 was due to an increased price for 4 banks (Deutsche, America, STCB and ABN). The high price of foreign banks may suggest that they were investing more in new technology than the Thai banks and FSIs.

Figure 6.8 Average and variation for price of physical capital, 1990-97

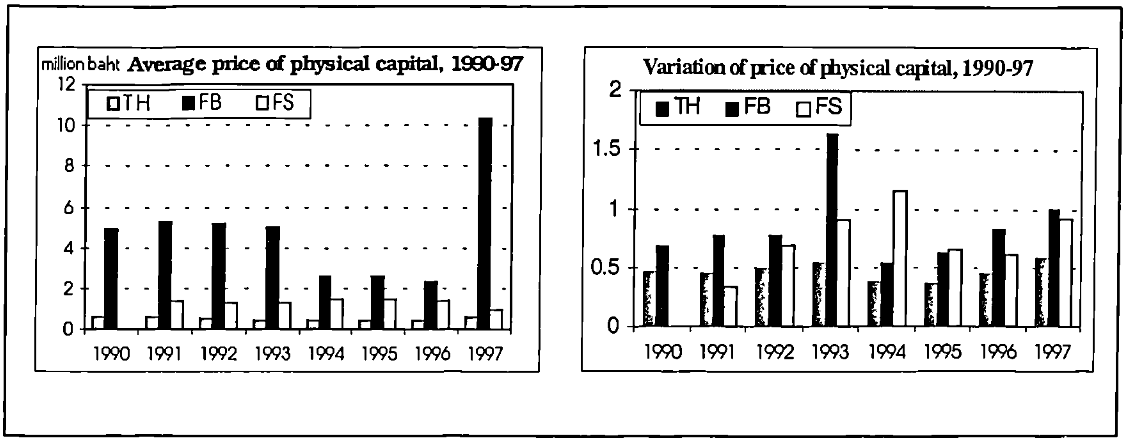


Figure 6.8 shows a relatively high average price of physical capital for foreign banks. This was due to high prices of five banks (Tokyo, Sakura, Deutsche, Sime and ICBC) during 1990-93 and four existing banks (Deutsche, America, STCB, and ABN) and three new banks (Dresdner, BNP and IBJ) in 1997. Figure 6.8 also shows that Thai banks had a steady average price and small relative dispersions, while foreign banks' data was highly dispersed in 1993 which suggests more price differences. An increase in relative dispersions of FSIs' data, however, is partly due to the differences in the number of DMUs.

Table 6.16 Price of physical capital for Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	0.49	0.54	10.2	Tokyo	5.51	4.03	-26.9
KTB	0.80	0.50	-37.5	Sakura	5.12	1.94	-62.1
TFB	0.48	0.59	22.9	**Citibank**	2.11	5.91	112.4
SCB	0.41	0.43	4.9	**Deutsche**	6.49	25.59	294.3
AYD	0.37	0.44	18.9	**STCB**	2.65	10.69	303.4
TMB	0.34	0.36	5.9	**Indosuez**	2.49	6.40	157.0
FBC	0.92	0.28	-69.6	**HSBC**	2.43	13.23	444.4
SCIB	0.45	0.50	11.1	Chase	4.52	4.86	7.5
BMB	0.44	0.42	-4.5	**America**	1.64	16.22	889.0
BBC	0.62	1.65	166.1	**ABN**	3.95	20.55	420.3
BOA	0.56	1.01	80.4	Bharat	3.25	4.50	38.5
TDB	0.31	0.64	106.5	ICBC	3.87	3.15	-18.6
NKB	0.30	0.36	20.0	Sime	9.73	5.18	-46.8
UBB	0.39	0.39	0.0	OCBC	1.60	3.19	99.4
LTB	0.26	0.57	119.2				

Notes: The figures are shown in million baht.

Table 6.16 shows that three Thai banks (BBC, TDB and LTB) and seven foreign banks (Citibank, Deutsche, STCB, Indosuez, HSBC, America and ABN) had a large price increase in 1997 compared to their 1990-96 averages. This was due to a greater increase in other non-interest expenses, which may have been the impact of the financial crisis. On the other hand, a large price fall of KTB, FBC, Sakura and Sime was due to a higher book value of land, premises and equipment in 1997 relative to the 1990-96 average.

Table 6.17 Average input prices of Thai banks, 1990-97

Bank	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-94	Average 1990-97
Price of labour										
Large bank	0.16	0.17	0.21	0.24	0.28	0.33	0.35	0.40	0.21	0.27
Medium bank	0.13	0.14	0.17	0.19	0.21	0.24	0.25	0.30	0.17	0.20
Small bank	0.14	0.16	0.20	0.22	0.26	0.28	0.31	0.32	0.20	0.24
Price of purchased funds										
Large bank	0.08	0.10	0.08	0.07	0.06	0.08	0.08	0.07	0.08	0.08
Medium bank	0.09	0.11	0.08	0.08	0.07	0.09	0.09	0.10	0.09	0.09
Small bank	0.09	0.11	0.08	0.07	0.06	0.08	0.08	0.10	0.08	0.09
Price of physical capital										
Large bank	0.74	0.67	0.60	0.45	0.36	0.37	0.38	0.50	0.56	0.51
Medium bank	0.58	0.61	0.65	0.58	0.51	0.47	0.49	0.64	0.59	0.57
Small bank	0.41	0.43	0.39	0.32	0.30	0.34	0.37	0.59	0.37	0.39

Note: The figures are shown in million baht

Table 6.17 reports the calculated values of the average input prices of each bank size. We classify 15 Thai banks as in Okuda and Mieno (1999) and compare the results during 1990-94[7].

We found similar results to those of Okuda and Mieno (1999). Price of labour increased, while price of physical capital was declining from 1990 to 1994. This reflects the rapid growth in the Thai economy and technological progress (Okuda and Mieno, 1999). However, we found an increased price of physical capital from 1995 to 1997, which related to the higher average fixed assets for Thai banks (see Table 6.9 and Figure 6.5). The higher average prices for Thai large banks suggest that they may have a better quality of employees. Thai large banks also had lower average cost of funds, which reflects their strong ability to mobilise savings in the forms of deposits using well-developed branch networks (Okuda and Mieno, 1999). The small and medium-sized banks, on the other hand, may have covered the shortages by borrowing at higher costs.

We further examined the relationship between input prices and bank size (see, Appendix V) and found a weak correlation for Thai and foreign banks and FSIs. An L-shaped relationship is exhibited for each price when all banks are considered together. Overall results are mixed and none of the correlations are strong.

Following Okuda and Mieno (1999) we investigate next the labour to capital (employees to fixed assets) ratio. Table 6.18 shows that the average labour to capital

[7] Following Okuda and Mieno (1999), Thai large banks are BBL, KTB, TFB, SCB and AYD. Thai medium banks are TMB, SCIB, FBC, BMB and BBC and Thai small banks are BOA, UBB, TDB, NKB and LTB.

ratio of foreign banks was higher than those for FSIs and Thai banks during 1990-97. The average and variability of the ratio for the three groups declined over the period studied. This suggests that production of banks became more capital intensive and less different in the labour to capital ratio. The high variability and relative dispersion of foreign banks' data in 1993 was due to the high ratio of Sime Bank Berhad[8]. Meanwhile, the variability for FSIs' ratio was partly due to the difference in the number of DMUs.

Table 6.18 Average labour to capital ratio, 1990-97

Bank	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-97
Thai banks									
Mean	3.2	2.8	2.6	2.0	1.6	1.4	1.3	1.2	2.0
STDEV	1.3	1.1	1.1	1.0	0.6	0.5	0.5	0.5	0.8
CV	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4
Foreign bank branches									
Mean	7.5	10.6	7.6	8.4	4.7	3.2	2.4	2.4	5.9
STDEV	5.8	13.0	8.5	16.6	6.1	3.0	2.0	1.7	7.1
CV	0.8	1.2	1.1	2.0	1.3	1.0	0.8	0.7	1.1
Finance and specialised institutions (FSIs)									
Mean	n.a.	2.6	2.9	3.2	3.2	2.4	1.8	1.0	2.4
STDEV	n.a.	0.6	3.6	4.7	5.5	1.8	1.2	0.8	2.6
CV	n.a.	0.2	1.2	1.5	1.7	0.7	0.7	0.7	1.0

Note: The value of fixed assets is deflated to the 1990 price. STDEV = standard deviation, CV = coefficient of variation. After including 6 new banks, the average, STDEV and CV for foreign banks in 1997 do not differ.

Figure 6.9 Average employees to fixed assets ratio, 1990-97

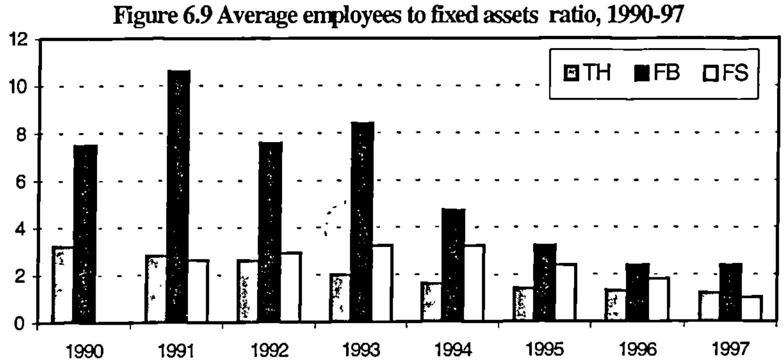


Figure 6.9 shows that foreign banks were more labour intensive, while Thai banks had more capital intensive production. There was a downward trend of the ratio for each

[8] After removing this outlier, foreign banks had the average ratio = 4.0, STDEV = 2.9.

group from 1993 to 1997, which suggests that the banks had become more capital intensive.

Table 6.19 Average labour to capital ratio of Thai banks, 1990-97

Bank	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-94	Average 1990-97
Large bank	3.54	2.98	2.66	1.89	1.36	1.21	1.10	1.07	2.49	1.98
Medium bank	3.56	3.24	3.08	2.64	2.09	1.81	1.47	1.24	2.92	2.39
Small bank	2.39	2.14	1.92	1.49	1.27	1.30	1.28	1.15	1.84	1.62

Table 6.19 reports the labour to capital ratio of Thai banks using Okuda and Mieno (1999)'s size classification. We found similar results to those reported by Okuda and Mieno (1999), that the speed of reduction in the ratio differs between different-sized banks during 1990-94 and up until 1997. The large and small-sized banks were more capital intensive and the medium-sized had more labour intensive production. However, there was a downward trend for each bank size, which suggests that Thai banks' production had become more capital intensive. These results correspond to an upward trend in price of labour (see, Table 6.11), which leads to the substitution of physical capital for labour (Okuda and Mieno, 1999).

We further investigated the relationship between labour to capital ratio and bank size (see, Appendix VII) and found a very weak correlation for Thai and foreign banks and FSIs. An L-shaped relationship is exhibited for each ratio when all banks are considered together. Overall results are mixed and none of the correlations are strong.

The analysis in this section showed that there was an increase in average inputs and outputs of banks during 1990-97. Also, there was an increase in relative dispersion of foreign banks' data in 1997, which was partly due to the entry of 6 new banks. Thai banks had relatively higher average because they had more branches while foreign bank branches were restricted. Overall, the dominating feature is the huge expansion in lending which for the Thai banks more than doubled over the period, while for the foreign banks lending increased by a factor of six. Inputs also increased, in parallel, but generally not as quickly as loans. This suggests that, in simple terms, productivity of the Thai banking system did increase over the period studied.

6.1.3 Inputs and outputs per branch of Thai banks

The analysis in the previous section showed that Thai banks had highest inputs and outputs throughout 1990-97 because they had extensive branch networks. This section explores the mean inputs and outputs of Thai banks per branch.

Table 6.20 Branch effects of input and output for Thai banks

	1990	1991	1992	1993	1994	1995	1996	1997	Mean 1990-97
As per bank branch									
Employees	40	40	39	39	38	38	37	35	38
Purchased funds	653	686	732	808	871	946	977	1077	844
Fixed assets	15	16	18	24	29	30	31	34	25
Net total loans	594	640	694	730	799	875	935	987	782
Other earning assets	80	66	63	97	99	110	97	120	92
Branches*	152	165	174	183	193	202	214	223	188

Note: Number of branches is the average of 15 banks. Funds, fixed assets, net total loans, and other earning assets are in million baht of the 1990 price. Number of employees are in persons.

Table 6.20 shows that the average number of Thai bank branches increased by 46% from 1990 to 1997. At the same time, the average funds and fixed assets per branch increased by 65% and 126%, respectively, while the average employees per branches decreased by 12.5%. This confirms the results shown in Tables 6.18 and 6.19 that Thai banks had become more capital intensive in production. Table 6.20 also shows that the average total loans and other earning assets increased respectively by 66% and 50% from 1990 to 1997. The results suggest the increased bank inputs (except for number of employees) and outputs per branch of Thai banks following financial deregulation.

Next, we follow Okuda and Mieno (1999) and examine the expenses on physical capital for each Thai bank branch.

Table 6.21 Average other non-interest expenses per branch of Thai banks, 1990-97

Bank	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-94	Average 1990-97
Large bank	9.76	10.08	10.09	10.59	11.38	12.88	14.01	18.65	10.38	12.18
Medium bank	6.14	6.91	7.69	8.35	9.25	9.90	11.80	17.29	7.67	9.66
Small bank	6.80	7.68	8.01	8.18	8.97	9.33	9.52	16.40	7.93	9.36
All banks	7.57	8.22	8.59	9.04	9.87	10.70	11.78	17.45	8.66	10.40

Note: Other non-interest expense = non-interest expense – personnel expense. We use the 1990 price of other non-interest expenses. Okuda and Mieno (1999) used the ratio of equipment expenses to number of branches.

Table 6.21 shows the average other non-interest expenses per branch and compares the 1990-94 results with (Okuda and Mieno, 1999) by using their size classifications of Thai banks. We found similar results to those reported by Okuda and Mieno (1999) that the average expenses on physical capital per branch increased for all bank sizes during 1990-94 (and up until 1997). Thai large banks had the highest, while medium banks had the lowest average during 1990-94, but small banks had the lowest average during 1990-97. Okuda and Mieno (1999) suggested that the high average expenditure on physical capital of Thai large banks reflects their active investment for modernisation and expansion of business operations.

6.2 Operating efficiency

Operating efficiency in the production of banking system can be defined as employed inputs per unit of output (Molyneux *et al.*, 1996, p.73). It is important to examine the bank's operating efficiency because it closely corresponds to the concept of productivity, which is the centre of our study. This section examines operating efficiency of Thai and foreign banks and FSIs during 1990-97 by exploring the ratios of output to number of employees, purchased funds and fixed assets, and the cost to income ratio. The results for Thai banks are also compared with Okuda and Mieno (1999).

The definition of bank output used here is an aggregate of net total loans and other earning assets. Following Sinkey (1998) bank income is defined as interest received plus non-interest income and we use three major components of total costs: interest expense, provision for loan losses and non-interest expenses. *Ceteris Paribus* the higher the ratio of bank output to input and the lower the cost to income ratio, the greater the bank's operating efficiency.

Table 6.22 The ratio of output to number of employees, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-97
Thai banks									
Mean	16	17	19	20	23	25	28	31	22
STDEV	4.2	4.5	5.9	6.4	6.7	6.8	7.0	10.3	6.5
CV	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Foreign bank branches									
Mean	38	47	47	60	76	98	108	156*	102
STDEV	35	40	32	49	56	63	85	133*	99
CV	0.9	0.8	0.7	0.8	0.7	0.6	0.8	0.9*	0.9
Finance and specialised institutions (FSIs)									
Mean	n.a.	42	42	42	45	58	75	102	58
STDEV	n.a.	21	17	15	17	21	38	65	28
CV	n.a.	0.5	0.4	0.4	0.4	0.4	0.5	0.6	0.4

Notes: STDEV= standard deviation, CV= coefficient of variation. * The values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average = 343, STDEV = 432 and CV = 1.3 in 1997.

Table 6.22 shows that foreign banks had substantially higher average output to employees ratios than FSIs and Thai banks. There was a huge increase in average for foreign banks in 1997, which was partly due to the entry of 6 new banks. Table 6.22 also shows that variability of the ratio for the three groups of banks increased in 1997. This suggests the increased differences of bank operating efficiency.

Figure 6.10 Average output to employees, 1990-97

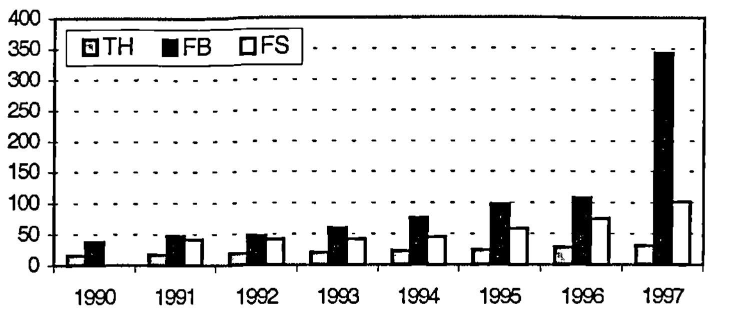


Figure 6.10 shows an upward trend of average output to employees ratio for the three groups of banks. It confirms that foreign banks had the highest average ratios, especially in 1997. Figure 6.10 shows that the average ratios for each group were increasingly divergent over the period studied. Notably, Thai bank employees were the least productive; foreign bank employees produced twice as much output per person in 1990, and five times as much in 1997 (excluding the new banks).

Table 6.23 The ratio of output to employees for Thai and foreign banks, 1997

Bank	Actual	Forecast	% differ	R-square adjusted (%)
BBL	37	34	8.6	87.3
KTB	32	32	1.5	96.3
TFB	33	31	5.0	94.1
SCB	37	32	13.6	81.7
AYD	26	26	-1.7	95.0
TMB	31	29	6.4	94.3
FBC	57	55	3.5	96.3
SCIB	30	29	3.5	96.4
BMB	22	23	-3.2	94.5
BBC	18	24	-34.7	47.8
BOA	45	39	12.4	86.8
TDB	26	24	6.8	84.5
NKB	23	23	-1.5	93.2
UBB	18	17	3.8	88.3
LTB	30	29	3.1	94.5
Tokyo	425	338	20.5	77.2
Sakura	421	335	20.4	75.2
Citibank	65	51	21.3	0.0
Deutsche	142	128	9.8	71.4
STCB	67	62	6.9	95.6
Indosuez	102	106	-4.1	73.1
HSBC	73	81	-10.7	90.7
Chase	302	248	17.9	84.7
America	148	150	-1.6	88.2
ABN	167	144	14.0	87.2
Bharat	32	26	19.3	0.0
ICBC	76	64	15.6	84.4
Sime	29	23	20.3	21.0
OCBC	132	105	20.2	80.9

Notes: Forecasts are obtained from simple regression of output to employees ratios against time for each bank. The F-test for each of the regression is statistically significant at 5% level, except for Citibank, Bharat and Sime.

Table 6.23 shows that the actual output to employees ratio in 1997 for 6 out of 29 banks was significantly less than the simple trend forecasts. BBC had the largest shortfall from its forecast (-35%), followed by HSBC (-10%), suggesting their output to employees ratios may have been affected by the financial crisis.

Table 6.24 shows similar results to Table 6.22 in the sense that foreign banks had higher average output to funds ratio than FSIs and Thai banks. There was a substantial increase in average ratio for foreign banks, which more than doubled, in 1997 due to the high ratio of 8 banks in 1997[9]. On the other hand, the average ratio for Thai banks decreased by 2.8% from 1996 to 1997 partly due to a 23% decrease in BBC's ratio. Similarly, FSIs had a decrease in average ratio in 1997 but that was partly due to the differences in the number of DMUs.

[9] The ratio for each of these 8 banks, which included 5 out of 6 new banks, was greater than 2.5. BNP had the lowest ratio (2.4), while Dresdner bank had the highest ratio (60.1).

Table 6.24 The ratio of output to purchased funds, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-97
Thai banks									
Mean	1.03	1.03	1.03	1.02	1.03	1.04	1.05	1.02	1.03
STDEV	0.03	0.03	0.03	0.03	0.03	0.03	0.06	0.04	0.03
CV	0.03	0.03	0.03	0.03	0.03	0.02	0.06	0.04	0.03
Foreign bank branches									
Mean	1.34	1.31	1.32	1.38	1.82	2.27	2.53	2.13*	2.17
STDEV	0.44	0.40	0.32	0.43	1.16	1.43	1.35	1.52*	2.31
CV	0.33	0.30	0.24	0.31	0.64	0.63	0.53	0.71*	0.68
Finance and specialised institutions (FSIs)									
Mean	n.a.	1.10	1.16	1.13	1.15	1.17	1.17	1.11	1.14
STDEV	n.a.	0.04	0.09	0.08	0.10	0.12	0.18	0.20	0.12
CV	n.a.	0.04	0.08	0.07	0.09	0.10	0.15	0.18	0.10

Notes: STDEV= standard deviation, CV= coefficient of variation. * The average values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average = 5.36, STDEV = 12.98 and CV = 2.42 in 1997.

Figure 6.11 Average output to funds, 1990-97

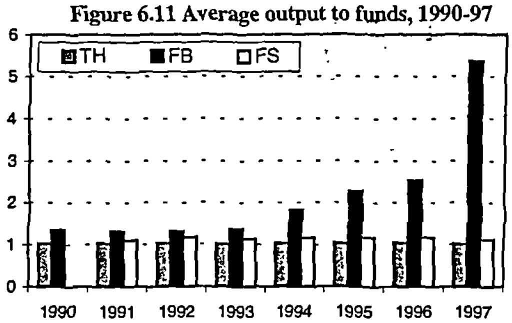


Figure 6.11 shows that foreign banks had a relatively high average output to funds ratio, although the high average in 1997 was due to the inclusion of 6 new banks. It indicates that foreign banks were generating more output per unit of funds throughout the period, and this became especially marked from 1994 onwards. On the other hand, the average ratio for Thai banks is similar to FSIs, which hardly increased during 1990-97. Figure 6.11 suggests that foreign banks produced twice as much output per fund from 1995 to 1997 (excluding the new banks).

Table 6.25 shows that BMB and BBC had a relatively large shortfall of ratio in 1997 compared to their 1990-96 averages and the other Thai banks, which may have been the impact of the financial crisis. Similarly, four foreign banks (ABN, Bharat, ICBC and Sime) had a substantial decrease in output to purchased funds ratio in 1997, but this was due to the change in the source of funding from long-term borrowing to customer deposits and interbank borrowing. On the other hand, there was a huge increase in the ratio for Sakura Bank and OCBC, which suggests that these banks may have used other kinds of funding input to produce loans and other earning assets.

Table 6.25 The ratio of output to purchased funds of Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	1.02	1.05	2.9	Tokyo	1.15	1.23	2.5
KTB	1.01	1.02	1.0	Sakura	1.69	6.46	280.0
TFB	1.04	1.00	-3.8	Citibank	1.13	1.00	-9.1
SCB	1.03	1.00	-2.9	Deutsche	1.78	1.74	-3.3
AYD	1.03	1.01	-1.9	STCB	1.39	1.69	20.7
TMB	1.03	1.00	-2.9	Indosuez	1.71	2.46	44.7
FBC	1.08	1.08	0.0	HSBC	1.19	1.10	-8.3
SCIB	1.05	1.02	-2.9	Chase	2.49	3.31	32.4
BMB	1.03	0.92	-10.7	America	2.21	2.50	13.6
BBC	1.05	0.97	-7.6	ABN	2.39	1.06	-55.8
BOA	1.06	1.08	1.9	Bharat	1.22	0.74	-38.3
TDB	1.02	1.04	2.0	ICBC	1.29	1.12	-13.8
NKB	1.04	1.02	-1.9	Sime	2.61	1.86	-28.5
UBB	1.02	1.05	2.9	OCBC	1.71	3.58	110.6
LTB	1.00	1.08	8.0				

Table 6.26 The ratio of output to fixed assets, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-97
Thai banks									
Mean	53	51	51	44	37	38	36	34	43
STDEV	30	33	41	35	23	22	18	12	27
CV	0.6	0.6	0.8	0.8	0.6	0.6	0.5	0.4	0.6
Foreign bank branches									
Mean	285	340	331	322	255	230	214	325*	354
STDEV	329	351	337	449	237	155	187	320*	435
CV	1.2	1	1	1.4	0.9	0.7	0.9	1.0*	1.1
Finance and specialised institutions (FSIs)									
Mean	n.a.	94	108	113	141	136	129	83	115
STDEV	n.a.	49	103	133	230	115	120	49	114
CV	n.a.	0.52	0.96	1.17	1.63	0.84	0.92	0.59	0.95

Notes: STDEV= standard deviation, CV= coefficient of variation. * The average values are exclusive of 6 new banks. Foreign banks, including 6 new banks, had the average = 854, STDEV = 1437 and CV = 1.7 in 1997.

Table 6.26 shows similar results to Tables 6.22 and 6.24 in that foreign banks had higher average output to fixed assets ratios than FSIs and Thai banks. The highest average and variability for foreign banks in 1997 was mainly due to the high ratios of 6 new banks. There was a gradual decline in the average ratio for Thai banks during 1990-97, which suggests a decrease in their operating efficiency. Also, there was a decline in the average ratio for FSIs during 1995-97 that was partly due to the differences in the number of DMUs.

Figure 6.12 shows that the foreign banks made the best use of their fixed assets throughout the 1990-97 period, compared to the two other groups. However, their average ratios declined in 1994 to 1996, going back to the 1993 average in 1997 (excluding the new banks). Similarly, Thai banks and FSIs had a lower average ratio in 1997. This was partly due to a large increase in their fixed assets in 1997 (see Table 6.9). Overall results suggest that Thai banks produced the least output per fixed asset during 1990-97.

Figure 6.12 Average output to fixed assets, 1990-

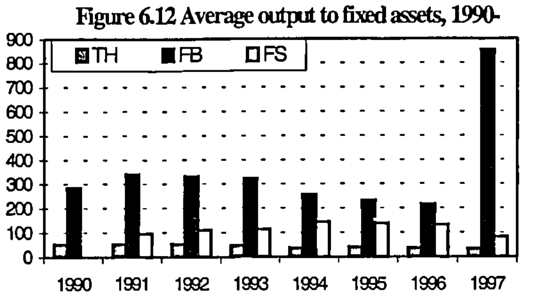


Table 6.27 The ratio of output to fixed assets of Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	47	36	-23.4	Tokyo	658	1102	67.5
KTB	72	43	-40.3	Sakura	969	897	-7.4
TFB	39	32	-17.9	Citibank	90	75	-16.6
SCB	29	30	3.4	Deutsche	307	502	63.5
AYD	31	33	6.5	STCB	127	130	2.4
TMB	30	26	-13.3	Indosuez	150	99	-34.0
FBC	129	35	-72.9	HSBC	140	223	59.3
SCIB	44	28	-36.4	Chase	241	242	0.4
BMB	40	28	-30.0	**America**	114	312	173.7
BBC	58	48	-17.2	**ABN**	189	459	142.9
BOA	47	69	46.8	Bharat	152	230	51.3
TDB	25	35	40.0	ICBC	193	149	-22.8
NKB	29	20	-31.0	**Sime**	432	115	-73.4
UBB	27	24	-11.1	**OCBC**	198	91	-54.0
LTB	17	21	23.5				

Table 6.27 shows that there was a large decrease in the 1997 ratio (of more than 10%) compared to the 1990-96 average for 10 out of 15 Thai banks and 6 out of 14 foreign banks. The large falls were mainly due to a greater increase in the book value of land, premises and equipment, especially for OCBC, Sime and FBC. On the other hand, there

was a large increase in the 1997 ratio for Bank of America and ABN, which was due to a greater increase in their output in 1997 relative to the 1990-96 averages.

Next, we investigate the ratio of cost to income. The lower this ratio, the better the operating efficiency of a bank *ceteris paribus*. The results for foreign banks are not shown here because of data unavailability.

Table 6.28 The ratio of cost to income, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-97
Thai banks*									
Mean	0.91	0.93	0.87	0.84	0.81	0.84	0.96	1.22	0.92
STDEV	0.05	0.04	0.05	0.06	0.06	0.05	0.42	0.37	0.14
CV	0.05	0.04	0.06	0.07	0.08	0.06	0.44	0.30	0.14
Finance and specialised institutions (FSIs)**									
Mean	n.a.	0.85	0.74	0.73	0.73	0.84	0.87	1.22	0.85
STDEV	n.a.	0.04	0.07	0.08	0.10	0.09	0.08	0.37	0.12
CV	n.a.	0.05	0.09	0.10	0.14	0.11	0.09	0.30	0.13

Notes: STDEV= standard deviation, CV= coefficient of variation. (*) After excluding BBC, the average was 0.85 in 1996 and 1.17 in 1997 with respective STDEV 0.06 and 0.33, and the average of 0.90 during 1990-97. (**) After excluding 3 finance companies (S.G. Asia, National Finance & Securities, and Phatra Thanakit) in 1997, the average = 1.04, STDEV = 0.21 in 1997and the 1990-97 average was 0.83 with STDEV = 0.10.

Table 6.28 shows that average cost to income ratios for Thai banks and FSIs were relatively low in 1994. This was mainly due to the introduction of BIBF, which provided banks the opportunities to access funds at lower costs. We saw in Chapter 3 (Section 3.3.1) and Table 6.13 that average interest rates were lowest in 1993. This indicates the positive effect of financial deregulation. Table 6.28 also shows that FSIs had lower average and variability for cost to income than Thai banks, despite their different numbers of DMUs in each year. This suggests their better ability in generating income at lower costs. There was a marked increase in average, variability and relative dispersion for the ratio in both groups in 1997, which may have been the effects of the financial crisis.

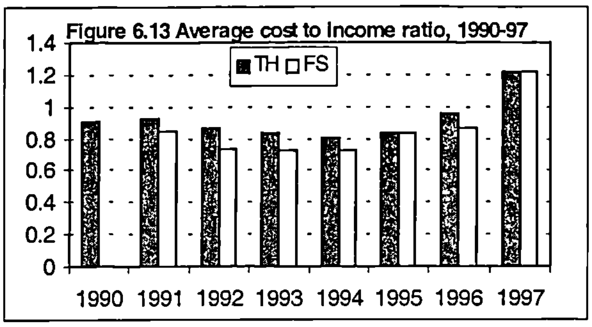


Figure 6.13 shows that there was a downward trend of average cost to income during 1991-94, suggesting an improved operating efficiency following the deregulation. It confirms that FSIs had lower average ratios than Thai banks. Figure 6.13 shows the highest average for both groups in 1997, which may have been the impact of the financial crisis.

Table 6.29 The ratio of cost to income of Thai banks, 1990-96 and 1997

Bank	Average 1990-96	1997	% change
BBL	0.79	0.95	20.3
KTB	0.85	1.00	17.6
TFB	0.80	0.99	23.8
SCB	0.81	0.93	14.8
AYD	0.84	0.96	14.3
TMB	0.84	0.96	14.3
FBC	0.85	1.84	116.5
SCIB	0.84	1.42	69.0
BMB	0.92	1.90	106.5
BBC	1.18	1.92	62.7
BOA	0.87	1.00	14.9
TDB	0.88	1.00	13.6
NKB	0.88	1.02	15.9
UBB	0.90	1.21	34.4
LTB	0.93	1.17	25.8

Table 6.29 shows an increased cost to income ratio for Thai banks in 1997 relative to the 1990-96 average. The largest increase was for FBC (116%) and BMB (106%), followed by SCIB (69%) and BBC (63%). These results suggest the possible impact of the financial crisis.

Finally, three size categories of Thai banks are used to compare our results with Okuda and Mieno (1999).

Table 6.30 Average operating efficiency of Thai banks, 1990-97

Bank	1990	1991	1992	1993	1994	1995	1996	1997	Average 1990-94	Average 1990-97
Output/employees										
Large bank	17.71	18.59	19.71	21.06	24.09	26.05	28.37	33.04	20.23	23.58
Medium bank	17.17	18.48	21.21	23.21	25.53	28.18	29.68	31.79	21.12	24.41
Small bank	14.12	15.07	15.30	17.11	19.12	22.07	24.97	28.36	16.14	19.51
Output/funds										
Large bank	1.02	1.02	1.03	1.01	1.02	1.03	1.03	1.01	1.02	1.02
Medium bank	1.05	1.04	1.04	1.03	1.04	1.04	1.08	1.00	1.04	1.04
Small bank	1.03	1.02	1.02	1.02	1.02	1.04	1.04	1.05	1.02	1.03
Output/fixed assets										
Large bank	61.74	55.65	52.22	39.02	33.00	31.55	31.22	34.75	48.33	42.39
Medium bank	64.04	64.54	73.05	66.41	54.63	52.90	44.55	32.73	64.53	56.60
Small bank	32.63	32.32	28.12	25.17	23.90	28.44	32.35	33.75	28.43	29.58
Cost/income										
Large bank	0.87	0.89	0.82	0.79	0.76	0.79	0.80	0.97	0.83	0.84
Medium bank	0.94	0.95	0.91	0.86	0.82	0.85	1.17	1.61	0.90	1.01
Small bank	0.93	0.95	0.88	0.87	0.84	0.88	0.89	1.08	0.89	0.91

Table 6.30 reports calculated values of the mean operating ratios, within each year for each bank size. We group 15 Thai banks as in Okuda and Mieno (1999) and compare the results for 1990-94.

Okuda and Mieno (1999) reported the highest average productivity of labour (as measured by the ratio of interest income to number of employees) for large bank during 1990-91 and medium banks during 1992-94. Small banks had relatively low average productivity of physical capital (as measured by the ratio of interest income to market value of physical capital), while the average for medium banks was higher than that of large banks during 1991-94. We found similar results in which the average output to employees ratio for medium banks increased and was greater than those for large and small banks during 1992-94 and up until 1997. Also, the average ratio of output to fixed assets for small banks was lowest, and medium banks had the highest average throughout 1990-97. We found similar results that the average ratio of output to fixed assets, or productivity of physical capital, of large and small banks decreased from 1990 to 1994, although their average ratios later increased in 1997.

Okuda and Mieno (1999) reported no difference in the average productivity of funds (as measured by the ratio of interest income to total amount of raised funds). Similarly, we found that the average ratio of output to purchased funds for medium banks was 2% greater than those for large and small banks during 1990-94.

Finally, we found similar results of operational costs in which Okuda and Mieno (1999) indicated that Thai large banks had the lowest average ratio of fund-raising expense to interest income. Table 6.30 shows the lowest average cost to income ratio for Thai large banks during 1990-94 (and up until 1997) and that the average for each bank size increased in 1991 and subsequently decreased during 1992-94, which is similar to the findings of Okuda and Mieno (1999). There was an increase in the average cost to income ratio for each bank size from 1995 to 1997 in which Thai medium banks had the largest averages during 1990-94 and 1990-97.

Overall, Thai medium banks seem to have higher average output to input and cost to income ratios than Thai large and small-sized banks. The high ratios, however, may have been the results of over-lending as two medium banks (BBC and BMB) were insolvent in 1997.

We further examined the relationship between operating ratios and bank sizes (see, Appendix VII) and found a very weak correlation for Thai and foreign banks and FSIs. An L-shaped relationship is exhibited for each ratio when all banks are considered. Overall results are mixed and none of the correlations are strong.

The analysis in this section shows that the average operating efficiency of foreign banks increased from 1990 to 1997, although the average in 1997 was influenced by the entry of 6 new banks. The average ratios for Thai banks and FSIs do not suggest an improvement. The results showed that there was an increased variability and greater relative dispersions of operating ratios, which may be due to the financial crisis in 1997.

6.3 Methodology: the first-stage analysis

This study uses Data Envelopment analysis (DEA) to estimate efficiency and productivity of the Thai banking sector during the 1990-97 period. The review in Chapter 4 showed that DEA has been used extensively in estimating efficiency and productivity in the banking industry: for example, Aly *et al.* (1990), Elyasiani and mehdian (1990a, 1990b), Yue (1992), Grabowski *et al.* (1994), Fukuyama (1995), Grifell-Tatjé and Lovell (1996), and Bhattacharyya *et al.* (1997). DEA can evaluate the relative efficiency and productivity change for a set of banks in their use of multiple inputs to produce multiple outputs, where the efficient frontier is generated from the actual data modeled of the bank sample under study. The strengths of DEA have been analysed in Chapter 4.

6.3.1 Efficiency analysis

This study adopts Bhattacharyya *et al.* (1997)'s approach to calculate technical, allocative and cost efficiencies of a bank. Bhattacharyya *et al.* (1997) used DEA to construct a single "grand frontier" which envelops the pooled input-output data of all banks in all years. The advantage of this approach is that it provides a single benchmark against which to evaluate performance and its change through time. That is, it is possible to compare the relative efficiency for each bank in each year and observe the change in bank performance during the period. *Ceteris paribus* if financial deregulation has caused bank performance to improve, most of the efficient observations are likely to be in more recent periods (Bhattacharyya *et al.*, 1997), and mean efficiency scores should be higher. Another benefit of using a grand frontier is that it can alleviate the problem of unbalanced panel data in this study[10].

In this study, a sample of 379 DMUs of 67 banking institutions in Thailand over the 1990-97 period will be evaluated by (i) technical efficiency, (ii) allocative efficiency and (iii) cost efficiency. The efficiency of each DMU will be estimated using the input-based orientation. As explained in Chapter 4, this measure reflects the expressed interest in the banking sector in reducing costs, that was brought about by the financial deregulation.

We use the variable returns to scale (VRS) assumption of production technology to define the best practice frontier. This is to ensure that each DMU is only compared to other DMUs of a similar size, when calculating its relative efficiency because not all DMUs are operating at the most productive scale size (Coelli *et al.*, 1998, p.150). The effects of each return to scale assumption and the benefits of VRS returns to scale were presented in Chapter 4.

[10] The number of DMUs can affect DEA analysis. For example, if a small number of DMUs is used in the model, a large proportion of the DMUs will be efficient.

Following Coelli *et al.* (1998) we assume that each of N DMUs has data on K inputs and M outputs. For the *i-th* DMU, x_i and y_i represent the column vectors of input and output respectively. For N DMUs, **X** represents the $K*N$ input matrix and **Y** is the $M*N$ output matrix. λ is an intensity vector with dimension equal to N, the number of DMUs. The VRS input-orientated technical efficiency of each DMU can be estimated by solving a linear programming problem. In this study, the problem is to minimise input quantities for a given amount of outputs. The mathematical formulation is as follows:

$$\begin{aligned} & Min_{\theta,\lambda}\ \theta, \\ \text{subject to} \quad & \mathbf{Y}\lambda - y_i \geq 0, \\ & \theta x_i - \mathbf{X}\lambda \geq 0, \\ & N1'\lambda = 1 \\ & \lambda \geq 0 \end{aligned} \qquad \text{..........................(6.1)}$$

where θ is a scalar and $N1$ is an $N*1$ vector of ones. The estimated value of θ is the efficiency score for each of the N DMUs. The estimate will satisfy the restriction $\theta \leq 1$ with a value $\theta = 1$ indicating a technically efficient bank. The problem has to be solved N times, once for each DMU, to derive a set of N technical efficiency scores.

The estimation of input-orientated technical efficiency also provides information related to the identification of which banks are the efficient ones. For a bank that is inefficient, the results shows by how much each input can be reduced to produce an efficient outcome (see, Chapter 4).

Other useful information relates to the returns to scale characteristics of the frontier banks. Holding the input mix constant, a bank's production exhibits increasing returns to scale if a small proportionate increase in all inputs produces a greater proportionate increase in outputs. On the other hand, a bank's production exhibits decreasing returns to scale (DRS) if a small increase in all inputs produces less than proportionate increases in outputs, while the constant returns to scale (CRS) depicts the most productive scale size, where a small proportionate change in all inputs produces the same proportionate change in the outputs.

Cost efficiency is defined as the ratio of the minimum possible cost to the observed cost for the i-th DMU (Coelli *et al.*, 1998). DEA cost efficiency is estimated by solving the respective linear programming problem. In this study, the problem is to choose input quantities to minimise costs holding constant input prices and output quantities. The mathematical formulation is as follows:

$$Min_{\lambda, x_i^*} w_i' x_i^*,$$

$$\text{subject to} \quad Y\lambda - y_i \geq 0,$$
$$x_i^* - X\lambda \geq 0,$$
$$N1'\lambda = 1$$
$$\lambda \geq 0 \qquad \text{.........................(6.2)}$$

where w_i is a vector of input prices for the *i-th* DMU and x_i^* is the cost-minimising vector of input quantities for the i-th DMU, given the input price (w_i) and the output quantities (y_i). Cost efficiency for DMU i is calculated as the ratio of $w_i' x_i^* / w_i' x_i$, where w_i' is the transpose of DMU i's input price vector. Thus, cost efficiency (CE) is the ratio of frontier costs of DMU i's output vector, given the set of its input prices, to its actual cost, where $0 \leq CE \leq 1$, and CE = 1 for fully efficient banks.

Cost efficiency is the product of technical and allocative efficiency. Banks can achieve cost efficiency by adopting the best practice technology (technologically efficient) and by adopting the cost minimising mix of inputs (allocatively efficient). By calculating cost and technical efficiency, allocative efficiency can be estimated using the relationship:

$$AE = CE/TE \qquad \text{.........................(6.3)}$$

The allocative efficiency (AE) is bounded by 0 and 1, with fully efficient banks having an efficiency score equal to 1. Note that a technically efficient DMU is not necessarily cost efficient, as it may be allocatively inefficient. Similarly, an allocatively efficient DMU may not be technically efficient. However, a cost efficient DMU is always both technically and allocatively efficient.

Finally, we follow Anderson and Peterson (1993) and Wilson (1995) who used DEA to calculate modified technical efficiency. The procedure can be used to identify a subset of efficient DMUs which are influential in the sense that their absence changes the efficiency scores of a large number of inefficient DMUs. Also, it can be used to compare the rankings of efficient DMUs[11]. The calculation involves removing the i-th efficient DMU from the constraint set when efficiency for the i-th DMU is computed. The modified score measures a kind of technical efficiency for the i-th DMU relative to other DMUs in the sample.

The first-stage DEA efficiency analysis will be carried out using DEAP computing software version 2.1 constructed by Coelli (1996a).

6.3.2 Productivity analysis

This study adopts Färe *et al.* (1994)'s approach to calculate Malmquist total factor productivity (TFP) indices for 232 DMUs of 29 Thai and foreign banks during 1990-97[12]. The advantage of this approach is that first, it does not require restrictive assumptions whether banks are cost minimisers or revenue maximisers. Second, it does not require price data and third, the TFP index can be decomposed into technical efficiency change and technological change components. In addition, technical efficiency change can be further decomposed into scale efficiency and pure technical efficiency components.

We focus on input-orientated productivity measures because the emphasis is on the equiproportionate reduction of inputs, within the context of a given level of output. Studies using this approach include Berg *et al.* (1992), Fukuyama (1995), Worthington (1999) and Glass and Mckillop (2000). The input-orientated Malmquist TFP index is defined and calculated in terms of input distance functions. It involves measuring how far a DMU's respective input bundles in two periods (*t* and *t+1*) are from a common frontier, with the ratio of the two measures obtained providing an index of productivity change (Glass and Mckillop, 2000). Färe *et al.* (1994) defined productivity change as

[11] Non-efficient DMUs are not affected: their modified score is the same as their original score.
[12] The FSIs cannot be included because their data are unbalanced. The 6 new foreign banks in 1997 are also excluded from the productivity analysis.

the geometric mean of productivity indices relative to the frontiers of the t and $t+1$ technology[13]. The formula is written as:

$$M_I^{t+1}(y^{t+1}, x^{t+1}, y^t, x^t) = \frac{D_I^{t+1}(y^{t+1}, x^{t+1})}{D_I^t(y^t, x^t)} \left[\frac{D_I^t(y^{t+1}, x^{t+1})}{D_I^{t+1}(y^{t+1}, x^{t+1})} \times \frac{D_I^t(y^t, x^t)}{D_I^{t+1}(y^t, x^t)} \right]^{1/2}$$

$$= E_I^{t+1} \cdot T_I^{t+1} \qquad \text{.........................(6.4)}$$

where the subscript I indicates input-orientated productivity measures of output level y that can be produced from a given level of input x. M is the productivity index of the most recent production point (x^{t+1}, y^{t+1}), using period $t+1$ technology, that is measured relative to the earlier production point (x^t, y^t), and the D_I are input distance functions. M is the product of technical efficiency change (E) and technological change (T). E, the ratio outside the square brackets, measures the change in technical efficiency between period t and $t+1$, or the catching up to the frontier. T, the two ratios in the square bracket, measures the shift in the frontier between technology $t+1$ and t which is the geometric mean evaluated relative to the two observations, (x^t, y^t) and (x^{t+1}, y^{t+1}). The calculation of T involves the calculation of two "cross-efficiencies", $D^{t(t+1)}$ and $D^{t+1(t)}$.

The Malmquist TFP change index and its components can be empirically calculated using DEA-like linear programming methods as suggested by Färe *et al.* (1994). This requires the solving of four linear programming (LP) problems. The first two LPs are where the technology and the observation to be evaluated are from the same period, and the solution value is less than or equal to unity. The second two LPs are where the production point from period $t+1$ is compared to technology in period t, and the production point from period t is compared to technology in period $t+1$.

We adopt the constant returns to scale (CRS) technology because it is suggested that there are interpretation and computational difficulties associated with TFP measures based on the variable returns to scale (VRS) technology (see, Coelli *et al.*, 1998, pp.224-8). Assuming variables are as previously defined for equations 6.1 and 6.4, the following CRS input-orientated LPs, as in Worthington (1999), are used:

[13] This means, for example, that productivity index relating to 1990/91 treats 1990 as t and 1991 as $t+1$.

$$\left[D_I^t(y_t, x_t)\right]^{-1} = \min_{\theta,\lambda} \theta$$

$$\text{subject to} \quad -y_{i,t} + \mathbf{Y}_t\lambda \geq 0$$
$$\theta x_{i,t} - \mathbf{X}_t\lambda \geq 0$$
$$\lambda \geq 0 \quad \text{.......................(6.5)}$$

$$\left[D_I^{t+1}(y_{t+1}, x_{t+1})\right]^{-1} = \min_{\theta,\lambda} \theta$$

$$\text{subject to} \quad -y_{i,t+1} + \mathbf{Y}_{t+1}\lambda \geq 0$$
$$\theta x_{i,t+1} - \mathbf{X}_{t+1}\lambda \geq 0$$
$$\lambda \geq 0 \quad \text{.......................(6.6)}$$

$$\left[D_I^{t+1}(y_t, x_t)\right]^{-1} = \min_{\theta,\lambda} \theta$$

$$\text{subject to} \quad -y_{i,t} + \mathbf{Y}_{t+1}\lambda \geq 0$$
$$\theta x_{i,t} - \mathbf{X}_{t+1}\lambda \geq 0$$
$$\lambda \geq 0 \quad \text{.......................(6.7)}$$

$$\left[D_I^t(y_{t+1}, x_{t+1})\right]^{-1} = \min_{\theta,\lambda} \theta$$

$$\text{subject to} \quad -y_{i,t+1} + \mathbf{Y}_t\lambda \geq 0$$
$$\theta x_{i,t+1} - \mathbf{X}_t\lambda \geq 0$$
$$\lambda \geq 0 \quad \text{.......................(6.8)}$$

The above LPs can be extended to decompose the technical efficiency change into scale efficiency and pure technical efficiency change components. This involves repeating LPs 6.5 and 6.6 with the convexity constraint ($N1'\lambda = 1$) added to each (i.e., technical efficiency change is calculated relative to VRS technology). These calculations will be carried out using the DEAP software version 2.1 constructed by Coelli (1996a).

An interpretation of the Malmquist TFP index is that productivity increases (decreases) if *M* is greater (less) than one. Similarly, *E* is greater (less) than one indicates technical efficiency increases (decreases), and technological progress (regress) occurs if T is greater (less) than one. The primary sources of productivity change can be indicated by comparing the values of E and T. Table 6.31 presents six possible outcomes and their interpretations.

Table 6.31 The primary sources of productivity change

Possible outcomes	Interpretations
E > T > 1	Efficiency increase is the primary source of productivity change
1 > T > E	Efficiency decrease is the primary source of productivity change
T > E > 1	Technological progress is the primary source of productivity change
1 > E > T	Technological regress is the primary source of productivity change
E > 1 > T	Productivity gains from efficiency increase are offset by technological regress
T > 1 > E	Productivity gains from technological progress are offset by efficiency decline

We adopt the Atkinson and Wilson (1995) bootstrapping methodology to construct confidence intervals for geometric means of indices in order to test for significant changes in the Malmquist TFP index and its components. The null hypothesis of no changes in productivity is rejected if the geometric mean of indices is significantly different from unity. In addition, we also use the nonparametric test of median differences for each index. Finally, we follow Worthington (1999) in using the Kruskal-Wallis (one-way nonparametric analysis of variance) test to determine whether the productivity change, the frontier shift and catching up effects for Thai and foreign banks are significantly different.

The Malmquist TFP index can be calculated alternatively by using a fixed-based period (see, Berg *et al.*, 1992; Grifell Tatjé and Lovell, 1996; and Glass and Mckillop, 2000). The advantage of this approach is that productivity change can be estimated for all the DMUs in all the years. It satisfies the circularity condition for an index[14]. The productivity change for each bank in year $t+1$ relative to year t is simply given by,

$$M_{t+1/t} = \frac{TE_{t+1}}{TE_t} \qquad \text{.........................(6.9)}$$

[14] For the fixed-base version, for example, technical change in 1995 relative to 1990 is given by

$$M_{90/95} = M_{90/91} * M_{91/92} * M_{92/93} * M_{93/94} * M_{94/95}$$

In general, this is not true for adjacent period formula, because of the cross-overs of successive years' frontiers.

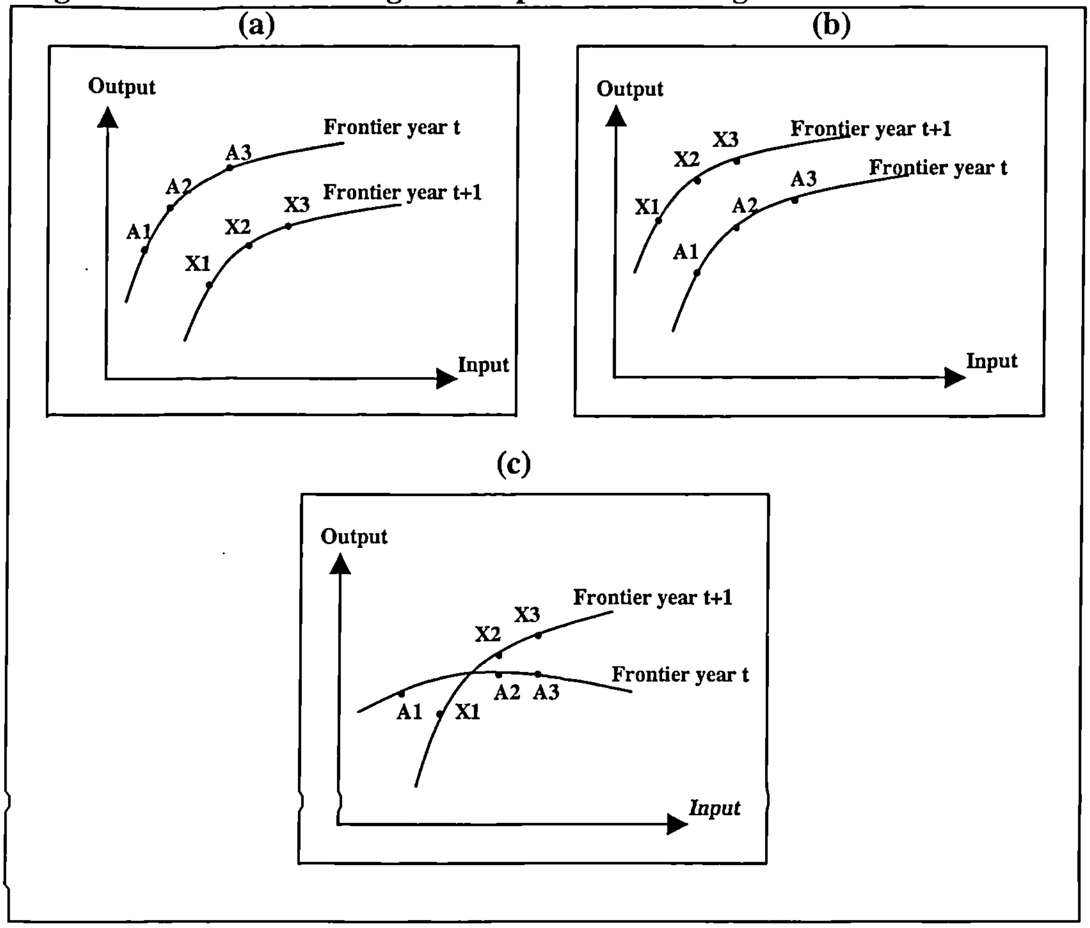
where TE = technical efficiency calculated relative to CRS (constant returns to scale) or VRS (variable returns to scale) technology.

We follow Griffell-Tatjé and Lovell (1996) in calculating the Malmquist TFP index by using the grand frontier as the fixed-base period. The advantage of this approach is that there are no problems of non-feasible solutions for some of the distance functions since all the DMUs lie within or on the grand frontier. The use of the grand frontier as the reference technology also helps to alleviate the index problem of the base year being increasingly out of line. The calculation requires one additional input distance function, $D^s(x^{i,t}, y^{i,t})$, for each DMU in each year, where the subscript s indicates that each DMU in each year is evaluated relative to technology constructed from all DMUs in all years.

It is noted that the M-index computed relative to the adjacent and fixed based period should generate the same values for the technical efficiency change (see, Grifell-Tatjé and Lovell, 1996 and Glass and McKillop, 2000). The two approaches may yield different estimates of M if the annual frontiers intersect. The intersecting of frontiers can be examined by inspecting the different cross-efficiencies of DMUs which are efficient relative to their same-period technology. The concept can be explained in Figure 6.14.

Assume that X_1, X_2 and X_3 are efficient DMUs in year $t+1$, and A_1, A_2 and A_3 are efficient DMUs in year t. Figure 6.14 shows three possible configurations, (a), (b) and (c). In (a) and (b), the frontiers do not intersect. The cross-efficiencies of A_1, A_2 and A_3 with respect to the frontier in $t+1$ are all greater than 1 in (a), since A_1, A_2 and A_3 lie outside the $t+1$ frontier, and are all less than 1 in (b), since A_1, A_2 and A_3 lie inside the $t+1$ frontier. The converse holds for X_1, X_2 and X_3. In (c), the frontiers intersect, so that A_1 has a cross-efficiency (with respect to $t+1$ frontier) which is greater than 1 because A_1 lies outside the $t+1$ frontier. In addition, A_2 and A_3 have cross-efficiencies less than 1, since they lie inside the $t+1$ frontier.

Figure 6.14 Schematic diagrams of possible crossing-over of frontiers



The recent study by Leightner and Lovell (1998) suggested that LP techniques could also be used to measure productivity change relative to the previous best practice, which they called *the Malmquist growth index.* It is defined in the same way as the Malmquist TFP index, but with variable returns to scale imposed on the production frontier. The growth relative to the previous best practice occurs if M>1, while M = 1 indicates a stagnation and M<1 indicates a decline. We adopt this approach to measure growth relative to the previous best practice of Thai and foreign banks and use the grand frontier as the base period to calculate the M-growth index.

6.4 Methodology: the second-stage regression analysis

In the first stage DEA analysis, bank productive efficiency and productivity are determined by traditional inputs and outputs, which are assumed to be under the control of management. However, efficiency and productivity of banks can also be influenced by environmental factors such as financial deregulation. The review in Chapters 3 and 4 explained the hypothesised and policy targeted efficiency and productivity effects (i.e. improvements) of a financial deregulation.

The objective of the regression analysis is to investigate the main question addressed in this study: i.e. whether financial deregulation in Thailand led to improvements in the efficiency and productivity of banks. We use the Tobit, stochastic frontier, OLS, heteroscedastic, and seemingly unrelated regressions and the fixed and random effects models, to explain efficiency and productivity differences. By using different models, it should be possible to identify which of the main findings are robust, compared with those which are more sensitive to different, underlying model assumptions. The following sections outline the choice of environmental variables and the regression models.

6.4.1 The determinants of bank efficiency

This section presents a set of environmental or explanatory variables that may explain the efficiency effects of financial deregulation. It is important to investigate whether they affect bank performance, as the managers do not have control over their changes. The general approach is to take into account both bank-specific variables and regulatory-specific variables in explaining variations in bank efficiency. These variables are commonly employed in many bank performance studies.

The candidate bank-specific variables comprise return on assets (ROA), the ratio of total costs to total assets (TCTA), the ratio of bank deposits to the total deposits (BDTD), the ratio of equity to total assets (EQTA), the ratio of loan loss reserves to total loans (LLRTL), the ratio of total loans to total assets and the natural log of total assets. The hypotheses that have been tested are as follows:

- *Return on assets* (ROA): the ratio of net income to total assets, indicating bank profitability. A positive relationship between ROA and bank efficiency is expected, all things being equal, since greater profit implies lower bank cost. The positive correlation between ROA and bank efficiency is reported by, for example, Berger and Mester (1997) and Bauer *et al.* (1998).
- *The ratio of total costs to total assets* (TCTA) captures the effect of bank expenses. A negative correlation between TCTA and efficiency is expected, since banks with higher expenses may overutilise inputs and therefore be less efficient. Studies reporting this negative correlation are, for example, Berger and Mester (1997) and Bauer *et al.* (1998).
- *The ratio of bank deposits to total deposits* (BDTD) captures aspects of market power. Miller and Noulas (1996) reported a negative relationship between BDTD and technical efficiency, suggesting that banks with more market power have lower technical efficiency.
- *The ratio of equity to assets* (EQTA) indicates capital adequacy or bank safety and soundness. The tightening of capital adequacy ratio is expected to be positively related to efficiency indexes, since a bank is exposed to lower financial risk, which in turn provides the possibility of attracting more purchased funds at a lower cost. Kaparakis *et al.* (1990 and Elyasiani *et al.* (1994) reported a positive correlation between capital adequacy ratio and efficiency. Similarly, Mester (1993) and Mester (1996) found a negative correlation between capital to assets ratio and inefficiency.
- *The ratio of loan loss reserves to total loans* (LLRTL) can be used to measure loan quality (Molyneux *et al.* 1996). The larger the ratio, the poorer the loan quality. LLRTL is expected to be negatively related to efficiency, since greater loan losses increase financial risk and reflect passive risk management, which should lead to lower efficiency.
- *The ratio of total loans to total assets* (TLTA) captures the bank's asset management. A study by Elyasiani *et al.* (1994) reported a positive relationship between the ratio of consumer loans to total assets and efficiency, suggesting that banks with higher asset management ratios tend to be more efficient. It is expected that banks with higher

proportion of loans in assets are more efficient, since their inputs are efficiently utilised to generate a given level of output.

• *The natural log of total assets* (LOGTA) is a measure of bank size. Rai (1996) and De Young *et al.* (1998) reported a negative relationship between bank size, as measured by LOGTA, and inefficiency, suggesting that cost efficiency increases with bank size. This implies that larger banks are expected to achieve higher efficiency.

The regulatory variables are time dummies and bank dummies. A recent study by Bhattacharyya *et al.* (1997) included time dummies to show how bank efficiency evolves through time relative to the base year. Time dummies can also be used to indicate the impact of changes in the regulatory environment. A positive coefficient of time dummies implies that banks became more efficient as they practically adapted to the changes in the regulatory environment. Bhattacharyya *et al.* (1997) reported a declining trend of efficiency, suggesting that banks took a cautious adjustment toward financial deregulation[15]. Finally, bank type dummies are included to test whether there is any difference in efficiency between Thai and foreign banks and the FSIs.

Table 6.32 shows the abbreviations and definitions of environmental variables used in this section and throughout this study.

Table 6.32 Definition of environmental variables

Symbol	Definition
ROA	Net income to total assets
TCTA	Total cost to total assets
BDTD	Bank deposit to total deposits
EQTA	Equity to total assets
LLRTL	Loan loss reserves to total loans
LOGTA	Natural log of total assets
TLTA	Total loans to total assets
D1	Equals 1 if the bank is Thai bank and 0 if otherwise
D2	Equals 1 if the bank is Foreign bank and 0 if otherwise
TD91-97	Equals 1 when TD91=1991, TD92=1992, TD93=1993, TD94=1994, TD95=1995, TD96=1996 and TD97= 1997; and 0 if otherwise. Base year = 1990.

[15] Bhattacharyya, Lovell and Sahay (1997) investigated technical efficiency of 70 Indian commercial banks during 1986-1991.

Choosing the appropriate explanatory variables is important. Coelli *et al.* (1998, p.171) identify statistical problems in regressing efficiency indexes upon environmental factors:

> One disadvantage of the two-stage method is that if the variables used in the first-stage are highly correlated with the second-stage variables then the results are likely to be biased.

To overcome the problem, this study will carry out the correlation analysis between bank inputs and outputs and a set of explanatory variables. The Pearson correlation coefficient has been used to investigate first, the correlation between explanatory variables and second, the correlation between explanatory variables and bank inputs and outputs.

Table 6.33 Correlation between the explanatory variables

	ROA	TCTA	EQTA	BDTD	LLRTL	LOGTA	TLTA
TCTA	-0.033						
EQTA	0.169	-0.170					
BDTD	-0.059	-0.068	-0.250				
LLRTL	0.037	-0.052	0.560	-0.156			
LOGTA	-0.274	0.087	-0.363	0.671	-0.245		
TLTA	-0.156	0.008	-0.356	0.076	-0.557	0.206	
D1	-0.248	-0.061	-0.368	0.616	-0.213	0.618	0.173
D2	0.162	-0.217	0.625	-0.309	0.517	-0.545	-0.244
TD91	0.039	0.057	-0.084	0.046	-0.051	-0.094	0.100
TD92	0.125	0.002	-0.068	0.047	-0.056	-0.080	0.066
TD93	0.164	-0.033	-0.074	-0.018	-0.026	-0.053	-0.031
TD94	0.138	-0.037	-0.032	-0.042	-0.065	-0.015	0.012
TD95	0.036	0.087	0.038	-0.045	-0.002	0.042	-0.029
TD96	-0.020	-0.003	0.064	-0.035	-0.013	0.096	0.040
TD97	-0.523	-0.050	0.194	0.001	0.243	0.167	-0.125

Table 6.33 shows the correlation coefficients between environmental variables. The results suggest that there is no strong correlation between these variables, and it is unlikely there will be problems of multicollinearity in the regression models.

Table 6.34 Correlation between the environmental variables and bank inputs and outputs

	Net total loans	Other earning assets	Number of employees	Purchased funds	Fixed assets
ROA	-0.103	-0.054	-0.088	-0.099	-0.080
TCTA	-0.042	-0.012	-0.050	-0.035	-0.024
EQTA	-0.226	-0.135	-0.271	-0.256	-0.187
BDTD	0.915	0.664	0.972	0.919	0.543
LLRTL	-0.129	-0.066	-0.160	-0.144	-0.030
LOGTA	0.727	0.594	0.707	0.720	0.478
TLTA	0.135	-0.285	0.100	0.073	-0.006
D1	0.570	0.331	0.662	0.570	0.360
D2	-0.303	-0.234	-0.341	-0.319	-0.134
TD91	-0.039	-0.075	0.019	-0.037	-0.059
TD92	-0.041	-0.083	0.002	-0.042	-0.061
TD93	-0.042	-0.057	-0.011	-0.037	-0.035
TD94	-0.031	-0.011	-0.022	-0.024	-0.026
TD95	-0.002	0.032	-0.021	0.002	-0.010
TD96	0.049	0.041	-0.009	0.040	0.072
TD97	0.130	0.180	0.021	0.119	0.156

Table 6.34 shows the Pearson correlation coefficient between bank inputs and outputs used in the first-stage DEA efficiency analysis and explanatory variables. There is a strong correlation between the ratio of bank deposits to total deposits (BDTD) and bank inputs and outputs: correlations of over 90% are found between BDTD and net total loans, number of employees, purchased funds. Table 6.34 also shows significant correlations of about 70%, between LOGTA and net total loans, number of employees and purchased funds. The results suggest that BDTD and LOGTA should not be included in the second-stage regression analysis as they could bias the estimate[16].

Since LOGTA cannot be used in the second-stage regression model, this study *has examined whether the importance* of bank size could be captured by dummy variable. Bank size is, therefore, categorised by total assets of a bank. The dummy variables, S1 is equal to 1 if total assets of a bank are less than 10,000 million baht and S2 is equal to 1 if total assets of a bank range from 10,000 to 99,999 million baht, otherwise S1 and S2 are equal to zero.

[16] A further investigation shown in Appendix VIII supports this conclusion.

Table 6.35 Correlation between the dummy variable of bank sizes and bank inputs and outputs

	Net total loans	Other earning assets	Number of employees	Purchased funds	Fixed assets
S1	-0.282	-0.247	-0.262	-0.275	-0.187
S2	-0.387	-0.298	-0.413	-0.392	-0.220

Table 6.35 shows the Pearson correlation coefficient between the dummy variables of bank sizes and bank inputs and outputs. The results suggest no strong correlation between the dummy variable of bank sizes and bank inputs and outputs. These results, however, are not conclusive because the dummy variable is categorical.

Table 6.36 Average bank inputs and outputs classified by the dummy variables of total assets

	Net total loans	Other earning assets	Number of employees	Purchased funds	Fixed assets
Small bank	3564	732	142	3263	54
Medium bank	29504	5094	977	29524	1062
Large bank	225528	30829	9900	246041	6752

Notes: Small bank refers to the group of banks that have total assets less than 10,000 million baht, medium bank indicates the group of banks that have total assets range between 10,000-100000 million baht, while large bank is the group of banks that have total assets more than 100,000 million baht.

Table 6.36 examines further the correlation between bank size dummies and bank inputs and outputs. First, bank inputs and outputs are classified according to total assets including small, medium and large sizes. Second, the average of inputs and outputs classified by bank size have been calculated.

The results shown in Table 6.36 suggest that the average bank inputs and outputs are higher as bank sizes get larger. This indicates a positive association between bank size dummies and bank inputs and outputs. It follows that including the dummy variable of bank sizes in the second-stage regression analysis may cause biased estimates of the coefficients and their standard errors.

The correlation analysis between environmental variables and bank inputs and outputs therefore suggests that the variables used in the second-stage regression should be return on assets (ROA), total cost to total assets (TCTA), equity to total assets (EQTA), loan loss reserve to total loans (LLRTL), total loan to total assets (TLTA), organisational dummies (D1 and D2) and time dummies (TD91-TD97).

6.4.2 OLS regression model

OLS regression is the model in which the estimators are derived from the least-squares principle (see, Gujarati, 1995). We use OLS regression to explain the effects of financial deregulation on the efficiency and productivity of banks. The OLS regression model is specified as:

$$Y_i = \beta_0 + \beta_k X_{ki} + u_i \qquad \text{.....................(6.10)}$$

where Y_i represents respectively technical, allocative and cost efficiencies and the Malmquist TFP indices calculated in the first-stage using DEA, X_{ki} is the vector of explanatory variables, β_k is the vector of parameters and u_i is the error term for observation *i*.

6.4.3 Tobit regression model

Tobit regression refers to a special kind of regression model in which the range of the dependent variable is constrained (see, Greene, 1997 p.962). The Tobit model has been used by a number of researchers (see, for example, Donni and Fecher, 1997; Ruggiero and Vitaliano, 1999). This is because efficiency can be considered as a censored variable that takes only bounded non-negative values and efficiency indexes belong to the interval (0,1). The Tobit regression model is specified as:

$$\begin{aligned} y_i^* &= \beta' x_i + e_i \\ y_i &= y_i^* \text{ if } y_i^* \leq 1 \text{ and } y_i^* \; \phi \; 0 \\ y_i &= 1 \text{ if } y_i^* \geq 1 \qquad \text{.....................................(6.11)} \end{aligned}$$

where $e_i \sim N(0, \delta^2)$, x_i and β are vectors of environmental variables and parameters, respectively. In the above equation, y_i represents respectively technical, allocative and cost efficiency calculated in the first-stage using DEA and y_i^* is a latent, unobservable variable. The results of Tobit regression will be obtained from the Limdep statistical software version 7.0 by Greene (1998).

6.4.4 Stochastic frontier regression model

An alternative method for modelling the effects of financial deregulation is by using the stochastic frontier regression model. The stochastic frontier regression is a linear regression model with a non-normal asymmetric disturbance (see, Greene, 1997 pp.309-10). Bhattacharyya *et al.* (1997) suggested that the use of stochastic frontier regression could provide a better explanation of the variation in efficiencies calculated using a DEA model than an OLS regression model.

The advantage of this model is that the unexplained variation in calculated efficiencies can be decomposed into systematic and random parts. The systematic part captures the effect of financial deregulation, while the random component captures the part of efficiency variation that is not associated with the explanatory variables. The stochastic frontier regression model is specified as:

$$y_i = \alpha + \beta' x_i + e_i \qquad \text{..............................(6.12)}$$

where y_i represents respectively technical, allocative and cost efficiencies calculated in the first-stage using DEA, x_i is the vector of explanatory variables, β is the vector of parameters and e_i is the error term for observation *i*. The asymmetry distribution of e_i is a central feature of this model. It is assumed that e_i is composed of two independent components:

$$e_i = v_i - |u_i| \qquad \text{....................................(6.13)}$$

where v_i is a two-sided error term representing the systematic component and u_i is a one-sided error term representing the random component. The random part of the calculated efficiency variation, u_i, can be estimated from the conditional mean of u_i

given the estimated residuals e_i, as proposed by Jondrow, Lovell, Materov and Schmidt (1982). These are given as:

$$E[u_i \mid e_i] = -\gamma e_i + \delta_A \left\{ \frac{\phi(\gamma e_i / \delta_A)}{1 - \Phi(\gamma e_i / \delta_A)} \right\} \qquad \text{.....................(6.14)}$$

where $\delta_A = \sqrt{\gamma(1-\gamma)\,\delta_s^2}$; $e_i = (y_i) - x_i\,\beta$; and $\phi(\,.\,)$ is the density function of a standard normal random variable.

Battese and Corra (1977) suggested that the asymmetry of e_i could be defined by the parameter γ, where $\gamma = \delta^2 / \delta_s^2$, which has a value between zero and one. The larger is γ, the more pronounced will be the asymmetry. Conversely, if γ equals zero, then $e_i = v_i$, which has a normal distribution, and the model is the usual OLS regression.

The estimates of β, δ_s^2 and γ are obtained by finding the maximum of the likelihood function. This study uses the computing program, FRONTIER version 4.1 constructed by Coelli (1996b) to obtain the results.

6.4.5 Seemingly unrelated regressions model

The seemingly unrelated regression (SUR) model assumes that the regression models of efficiency scores are linked by their disturbances. The parameters are estimated by using the generalised least squares. We use the SUR model to support the Tobit, stochastic frontier, OLS and heteroscedastic regression models in explaining the effects of financial deregulation on bank efficiency. The model is specified in the form:

$$\mathbf{Y}_m = \mathbf{X}_m\,\beta_m + \varepsilon_m \qquad \text{.........................(6.15)}$$

where $\mathbf{Y}_m$ represents respectively technical, allocative and cost efficiencies calculated in the first-stage using DEA, $\mathbf{X}_m$ is the vector of explanatory variables, β_m is the vector of parameters and ε_m is the error term for m equations.

6.4.6 Heteroscedastic regression model

The classical linear regression model requires that the variance of each disturbance term U_i, conditional on the chosen values of the explanatory variables, has the same variance σ^2. Heteroscedasticity occurs when the conditional variances of U_i, are not constant. We use the heteroscedastic regression to estimate the effects of financial deregulation on relative efficiencies. The method uses OLS estimation allowing for heteroscedasticity. Using the formula given in (6.14), the variance that takes into account of heteroscedasticity is expressed by:

$$\mathrm{var}(\hat{\beta}_2) = \frac{\Sigma x_i^2 \sigma_i^2}{(\Sigma x_i^2)^2} \qquad \text{.........................(6.16)}$$

if $\sigma_i^2 = \sigma^2$ for each i, then the variances of each disturbance term are equal and therefore no heteroscedasticity.

6.4.7 Fixed and random effects model

The fixed effects model assumes that differences across units can be captured in differences in the constant term (see, 1993, pp. 615-23). The differences between units can be viewed as parametric shifts of the regression function and individual effects. The model can be obtained using dummy variables in OLS regression. The fixed effects model is denoted as:

$$\mathbf{Y}_{i,t} = \alpha_i + \beta' \mathbf{X}_{i,t} + \varepsilon_{i,t} \qquad \text{......................(6.17)}$$

where α_i are (unknown) individual specific constants, $\mathbf{Y}_{i,t}$ and $\mathbf{X}_{i,t}$ are the T observations for the i-th units and $\varepsilon_{i,t}$ is the $T \times 1$ vector of disturbances with mean 0 and variance σ^2.

The random effects model assumes that individual specific constant terms are randomly distributed. The efficient estimator is generalised least squares. The model is written as:

$$\mathbf{Y}_{i,t} = \alpha + \beta \mathbf{X}_{i,t} + u_i + \varepsilon_{i,t} \qquad \text{.........................(6.18)}$$

where u_i is an individual specific disturbance and is constant through time. All disturbances have variance $\varepsilon_{i,t} + u_i$, but for a given i, the disturbances in different periods are correlated because of their common component, u_i.

Equations (6.16) and (6.17) can be extended to include the time-specific effect for each period. The two-way fixed effects model is:

$$\mathbf{Y}_{i,t} = \alpha_i + \gamma_t + \beta' \mathbf{X}_{i,t} + \varepsilon_{i,t} \qquad \text{.........................(6.19)}$$

where γ_t is the time-specific effects. The two-way random effects model is:

$$\mathbf{Y}_{i,t} = \alpha + \beta \mathbf{X}_{i,t} + u_i + \varepsilon_{i,t} + w_t \qquad \text{.........................(6.20)}$$

where w_t is the time-specific effects.

We use the fixed and random effects model to test first, the individual effects of productivity change for Thai and foreign banks and second, the time-specific effects of financial deregulation.

6.5 Conclusion

This chapter outlined the data and the two-stage approach that will be used to estimate efficiency and productivity and the effects of financial deregulation in Thailand during 1990-97.

We adopt a form of the intermediation approach to specify three inputs (employees, purchased funds and fixed assets) and two outputs (net total loans and other earning assets). The analysis of bank inputs and outputs showed that there was a huge increase in outputs each year as a result of deregulation. In parallel, we also found an increase in inputs but not as large as the average percentage change in outputs. This seems to suggest that productivity of the Thai banking system increased from 1990 to 1997, if measured in these terms. We found that Thai banks had relatively greater average inputs and outputs, while having a lower average price of labour and physical capital. However, foreign banks seem to have higher average operating efficiency. There is evident to suggest that financial deregulation led to lower average cost to income ratios. In addition, we found weak relationships between bank size and input prices, labour to capital and operating ratios.

In the first-stage analysis, we will use the DEA approach to measure technical, allocative and cost efficiency and productivity. In the second-stage regression analysis, technical, allocative and cost efficiencies and the Malmquist TFP indices are used as dependent variables in regression models, which include a set of explanatory variables whose coefficients measure the effects of financial deregulation.

Chapter 7 Productive Efficiency in Thai Banking: Empirical Results

INTRODUCTION

This chapter analyses the relative efficiencies of Thai and foreign banks and finance and specialised institutions (FSIs). We adopt the two-stage approach to explore whether changes in financial regulation during 1990-97 improved the efficiency of banks. Theoretically, financial deregulation increases competitive pressures that consequently incentivise banks to become more efficient. We also examine whether relative efficiencies are different for Thai and foreign banks and FSIs and why particular banks are efficient and others are not.

This chapter is organised as follows. Section 1 analyses the relative efficiencies of Thai and foreign banks and FSIs. Section 2 investigates input slacks and technical efficiency of Thai banks and explores adjusted technical efficiency. Section 3 explores the relationship between bank size and relative efficiencies. Section 4 discusses the characteristics of efficient DMUs and examines their maximum productive scale sizes. Section 5 analyses the impact of influential observations. Section 6 examines the consistency of relative efficiencies. Section 7 explores the results of the second stage regression analysis and section 8 concludes this chapter.

7.1 Exploratory analysis of DEA efficiency

This section examines the results of the first-stage DEA analysis of technical, allocative and cost efficiencies for banking institutions in Thailand between 1990 and 1997. The aim of this section is to consider whether technical, allocative and cost efficiencies of banks have improved during the 1990-97 financial deregulation. *A priori* it is assumed that efficiency of banks in more recent years would be relatively higher as a result of the deregulated financial environment.

Following Bhattacharyya *et al.* (1997), technical, allocative and cost efficiencies of 379 DMUs comprising 15 Thai banks, 20 foreign banks, 5 specialised institutions and 27 finance companies during 1990 to 1997 have been estimated from the DEA grand frontier. An improvement of technical, allocative and cost efficiencies is indicated by an increase in average efficiency between 1990 and 1997. The standard deviation is used to examine the variability of efficiency, while the coefficient of variation indicates the relative dispersion of efficiency from the mean value. Finally, we examine whether Thai and foreign banks had been adversely affected by the 1997 financial crisis by comparing their mean efficiencies during 1990-96 with their relative efficiencies in 1997. A large drop in 1997 compared to the 1990-96 mean values would indicate that the bank may have been affected by the financial crisis.

7.1.1 Exploratory analysis of technical efficiency

Table 7.1 Average technical efficiency, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997
Thai banks								
Mean	0.3053	0.3316	0.3635	0.3802	0.4263	0.4779	0.5157	0.5179
DMUs	15	15	15	15	15	15	15	15
Foreign bank branches								
Mean	0.5054	0.5054	0.5015	0.5114	0.5079	0.5116	0.5373	0.7076
DMUs	14	14	14	14	14	14	14	20
Finance and specialised institutions (FSIs)								
Mean	n.a.	0.1587	0.1763	0.1809	0.2130	0.2286	0.2675	0.3856
DMUs	1	7	14	22	29	30	27	11

Note: DMUs = decision making units. The Kruskal-Wallis test of the equality of medians has H-statistic of 77.65 with p-value = 0.000.

Table 7.1 shows that the average technical efficiency of Thai banks increased from about 30% in 1990 to 52% in 1997. Meanwhile, average technical efficiency of foreign banks increased by 21% over the same period: however, the 17% increase from 1996 to

1997 was due to the entry of 6 foreign banks[1]. For the FSIs, the average technical efficiency increased from 16% in 1991 to 38% in 1997. The results of the Kruskal-Wallis test support the hypothesis that there are differences in median technical efficiencies of Thai and foreign banks and FSIs.

Table 7.2 Number of technical efficient DMUs, 1990-97

Year	Thai banks	Foreign banks	Finance and specialised institutions (FSIs)	TOTAL
1990	1	1	-	2
1991	-	-	-	-
1992	1	-	-	1
1993	-	1	-	1
1994	-	2	-	2
1995	-	-	1	1
1996	1	2	1	4
1997	1	7	1	9
Total	4	13	3	20

Table 7.2 shows the composition of the efficient frontier. It shows that the majority of efficient DMUs, 13 out of 20, are foreign banks. However, 5 out of the 7 efficient foreign bank DMUs in 1997 are new banks. The number of technically efficient DMUs increased from 2 in 1990 to 9 in 1997. There were no efficient DMUs in 1991.

Figure 7.1 Average and variability of technical efficiency, 1990-97

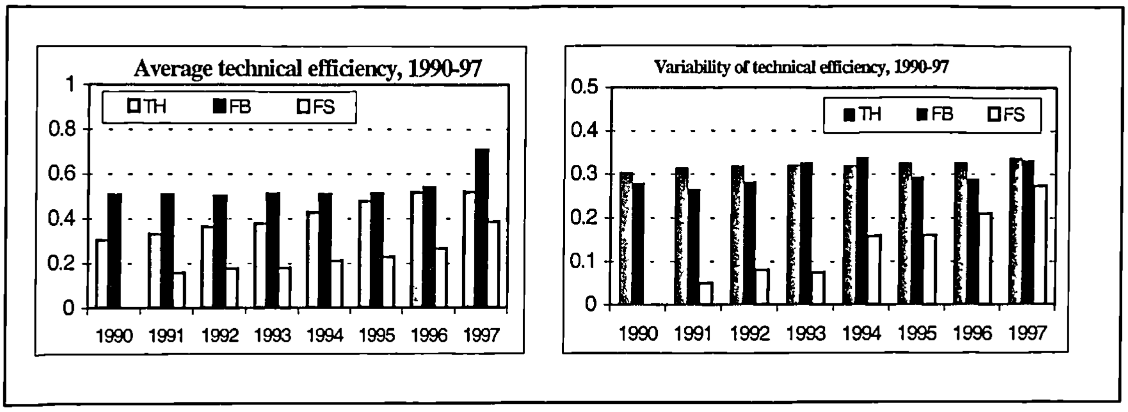


Figure 7.1 shows that the average technical efficiency of Thai and foreign banks and the FSIs increased over the period. Foreign banks, on average, achieved the highest technical efficiency, followed by Thai banks and the FSIs. The dispersions of technical

[1] A re-estimation of technical efficiency without 6 new banks reveals that mean efficiency of foreign banks increased by only 1% between 1996 and 1997.

efficiency of Thai and foreign banks shown in Figure 7.1 were relatively high, while those of the FSIs increased over the period.

Table 7.3 Technical efficiency for Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	0.993	1.000	0.7	Tokyo	0.330	1.000	203.0
KTB	0.903	0.996	10.3	Sakura	0.438	1.000	128.3
TFB	0.820	0.873	6.5	Citibank	0.177	0.168	-5.1
SCB	0.684	0.863	26.2	Deutsche	0.437	0.339	-22.4
AYD	0.517	0.778	50.5	STCB	0.200	0.191	-4.5
TMB	0.428	0.684	59.8	Indosuez	0.315	0.270	-14.3
FBC	0.359	0.674	87.7	HSBC	0.194	0.212	9.3
SCIB	0.264	0.559	111.7	Chase	0.450	0.701	55.8
BMB	0.215	0.326	51.6	America	0.334	0.386	15.6
BBC	0.239	0.195	-18.4	ABN	0.727	0.472	-35.1
BOA	0.150	0.241	60.7	Bharat	0.932	0.974	4.5
TDB	0.132	0.173	31.1	ICBC	0.752	0.679	-9.7
NKB	0.102	0.135	32.4	Sime	0.977	0.980	0.3
UBB	0.115	0.137	19.1	OCBC	0.898	0.866	-3.6
LTB	0.080	0.134	67.5				

Table 7.3 shows that technical efficiency of BBC in 1997 was 18% less than its 1990-96 mean value. Similarly, there was a large decrease in technical efficiency of Deutsche Bank (22%), Banque Indosuez (14%) and ABN (35%) in 1997 compared to their 1990-96 means. Also, we found that four other foreign banks (Citibank, STCB, ICBC and OCBC) had a slightly lower technical efficiency in 1997 than their 1990-96 means. The results suggest that these banks may have been adversely affected by the financial crisis. On the other hand, Table 7.3 shows that SCIB, Bank of Tokyo and Sakura Bank had a large improvement in 1997 compared to their mean technical efficiencies during 1990-96. Overall, technical efficiency of 14 Thai and 7 foreign banks increased in 1997 compared to their 1990-96 means

Overall, the results presented in Tables 7.1, 7.2 and 7.3 and Figure 7.1 show an improvement of mean technical efficiency during the 1990 to 1997 period, especially for the Thai banks which in 1990 had mean efficiency scores 20% less than the foreign banks. By 1997, they had almost caught up with the foreign banks (excluding the new banks). This suggests that deregulation did provide an impetus for Thai banks to improve their productive efficiency.

7.1.2 Exploratory analysis of allocative efficiency

Table 7.4 Average allocative efficiency, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997
Thai banks								
Mean	0.8528	0.8767	0.8475	0.8321	0.8307	0.8845	0.8953	0.8940
DMUs	15	15	15	15	15	15	15	15
Foreign bank branches								
Mean	0.6536	0.5945	0.6734	0.6719	0.7176	0.6839	0.6749	0.7184
DMUs	14	14	14	14	14	14	14	20
Finance and specialised institutions (FSIs)								
Mean	n.a.	0.5434	0.6569	0.6570	0.6887	0.6838	0.7129	0.6943
DMUs	1	7	14	22	29	30	27	11

Note: DMUs = decision making units. The Kruskal-Wallis test of the equality of medians has H-statistic of 72.64 with p-value = 0.000.

Table 7.4 shows that the average allocative efficiency of Thai banks increased from 85% in 1990 to 89% in 1997. Meanwhile, average allocative efficiency of foreign banks increased by 6% over the same period, but 4% of this increase is due to the addition of new foreign banks in 1997[2]. Average allocative efficiency of the FSIs increased from 54% in 1991 to 69% in 1997. The results of the Kruskal-Wallis test supports the hypothesis that the median allocative efficiencies of Thai and foreign banks and the FSIs are unequal.

Table 7.5 Number of allocative efficient DMUs, 1990-97

Year	Thai banks	Foreign banks	Finance and specialised institutions (FSIs)	TOTAL
1990	-	1	-	1
1991	-	-	-	-
1992	1	-	-	1
1993	-	1	-	1
1994	-	-	-	-
1995	-	-	1	1
1996	1	-	1	2
1997	1	5	1	7
Total	3	7	3	13

Table 7.5 gives a breakdown of the allocative efficient DMUs. It can be seen that the majority of efficient DMUs are foreign banks if new banks which enter in 1997 are

[2] A re-estimation of allocative efficiency without 6 new banks reveals that mean efficiency of foreign banks declined by 6% between 1996 and 1997.

included. The number of allocative efficient DMUs increased from 1 in 1990 to 7 in 1997. There were no efficient DMUs in 1991. Overall, the picture is similar to Table 7.2 (technical efficient DMUs). However, it is usually the case that fewer banks are allocatively efficient than are technically efficient. All banks which were allocatively efficient were also technically efficient.

Figure 7.2 Average and variability of allocative efficiency, 1990-97

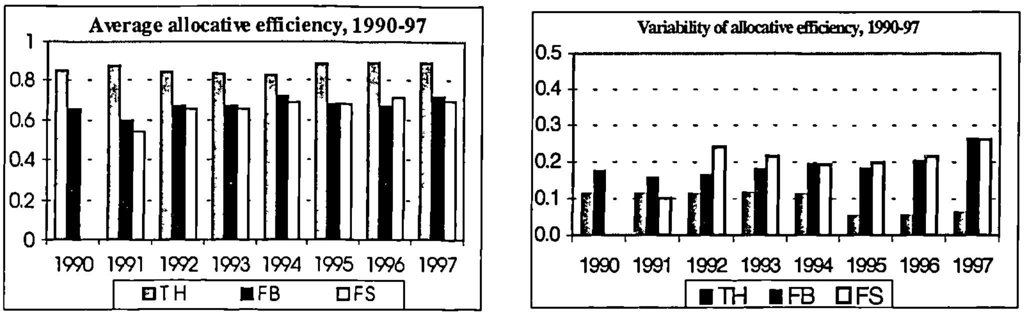


Figure 7.2 shows that the average allocative efficiency of the three bank groups slightly improved with Thai banks reporting the highest average in each year. This is in contrast to the results in Figure 7.1 where foreign banks had the highest mean technical efficiencies. Figure 7.2 shows that foreign banks and the FSIs experienced large and increased variability of allocative efficiency.

Table 7.6 Allocative efficiency for Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	0.972	1.000	2.9	Tokyo	0.813	0.848	4.3
KTB	0.901	0.964	7.0	Sakura	0.758	1.000	31.9
TFB	0.929	0.959	3.2	Citibank	0.685	0.449	-34.5
SCB	0.864	0.962	11.3	Deutsche	0.610	0.917	50.3
AYD	0.866	0.919	6.1	STCB	0.790	0.897	13.5
TMB	0.840	0.913	8.7	Indosuez	0.544	0.682	25.4
FBC	0.957	0.949	-0.8	HSBC	0.752	0.942	25.3
SCIB	0.851	0.849	-0.2	Chase	0.626	0.656	4.8
BMB	0.861	0.881	2.3	America	0.693	0.937	35.2
BBC	0.878	0.804	-8.4	ABN	0.587	0.546	-7.0
BOA	0.859	0.914	6.4	Bharat	0.462	0.370	-19.9
TDB	0.831	0.829	-0.2	ICBC	0.568	0.397	-30.1
NKB	0.880	0.817	-7.2	Sime	0.942	0.518	-45.0
UBB	0.820	0.834	1.7	OCBC	0.510	0.262	-48.6
LTB	0.590	0.816	38.3				

Table 7.6 shows that allocative efficiency of two Thai banks (BBC and NKB) decreased in 1997 compared to their 1990-96 means and the rest of Thai banks. Similarly, there was a substantial decrease in allocative efficiency of 5 foreign banks (Citibank, Bharat, ICBC, Sime, and OCBC) in 1997 compared to their means during 1990-96, while the allocative efficiency of ABN was 7% lower. The results suggest that allocative efficiency of these banks may have been adversely affected by the financial crisis. Table 7.6 also shows that the allocative efficiency of 18 out of 29 banks increased in 1997 compared to their 1990-96 means.

The results presented in Tables 7.4, 7.5 and 7.6 and Figure 7.2 suggest some improvement of mean allocative efficiency from 1990 to 1997 though for some of the years in between, mean efficiencies went down rather than up. Overall, the beneficial effects (if any) of deregulation are much less evident in these results than in the technical efficiency results. Thai banks were already more allocative efficient (on average) than the other institutions at the beginning of the period, and remained so.

7.1.3 Exploratory analysis of cost efficiency

Table 7.7 Average cost efficiency, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997
Thai banks								
Mean	0.2675	0.2968	0.3229	0.3331	0.3766	0.4348	0.4751	0.4814
DMUs	15	15	15	15	15	15	15	15
Foreign bank branches								
Mean	0.3389	0.3105	0.3339	0.3333	0.3373	0.3119	0.3568	0.5064
DMUs	14	14	14	14	14	14	14	20
Finance and specialised institutions (FSIs)								
Mean	n.a.	0.0831	0.1054	0.1131	0.1508	0.1605	0.2014	0.3007
DMUs	1	7	14	22	29	30	27	11

Note: DMUs = decision making units. The Kruskal-Wallis test of the equality of medians has H-statistic of 90.54 with p-value = 0.000.

Table 7.7 shows that average cost efficiency of Thai and foreign banks increased respectively from 27% and 34% in 1990 to 48 % and 51% in 1997. Meanwhile, the average cost efficiency of the FSIs increased from 8% in 1991 to 30% in 1997. The results of the Kruskal-Wallis test suggest that median cost efficiencies of Thai and foreign banks and FSIs are different.

Table 7.8 Number of cost efficient DMUs, 1990-97

Year	Thai banks	Foreign banks	Finance and specialised institutions (FSIs)	TOTAL
1990	-	1	-	1
1991	-	-	-	-
1992	1	-	-	1
1993	-	1	-	1
1994	-	-	-	-
1995	-	-	1	1
1996	1	-	1	2
1997	1	5	1	7
Total	3	7	3	13

Table 7.8 shows the number of efficient DMUs on the cost frontier, which increased substantially in 1997. It also shows that most of the cost-efficient DMUs are foreign banks when the new foreign banks, which entered in 1997, are included. This is in accordance with Table 7.2 which listed 20 technically efficient DMUs (13 foreign), and Table 7.5 which listed 13 allocatively efficient DMUs (7 foreign)[3]. One Thai DMU and 6 foreign DMUs are technically efficient but not cost efficient relative to the grand frontier.

Figure 7.3 Average and variability of cost efficiency, 1990-97

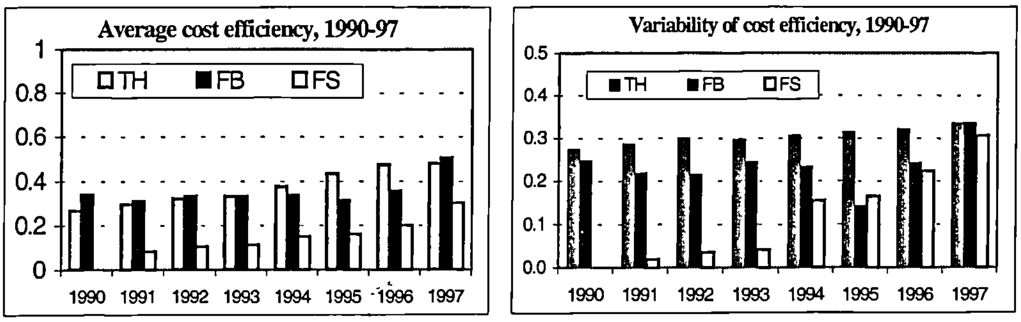


Figure 7.3 shows that average cost efficiency for each of the three groups of banks improved over the period. Figure 7.3 also shows that the variability of cost efficiency for Thai banks was relatively high, while variability for the FSIs increased by 18% from

[3] In fact, since all the allocative efficient banks were also technically efficient, Table 7.8 is identical to Table 7.5.

1993 to 1996, as more DMUs were included. The highest variability of cost efficiency, on average, was in 1997. Again, these results are qualitatively similar to those for technical efficiency.

Table 7.9 Cost efficiency for Thai and foreign banks, 1990-96 and 1997

Thai banks				Foreign banks			
Bank	Average 1990-96	1997	% change	Bank	Average 1990-96	1997	% change
BBL	0.965	1.000	3.6	Tokyo	0.270	0.848	214.1
KTB	0.814	0.961	18.1	Sakura	0.343	1.000	191.5
TFB	0.763	0.837	9.7	**Citibank**	0.110	0.076	-30.9
SCB	0.592	0.830	40.2	Deutsche	0.270	0.311	15.2
AYD	0.449	0.715	59.2	STCB	0.158	0.171	8.2
TMB	0.360	0.624	73.3	Indosuez	0.171	0.184	7.6
FBC	0.343	0.640	86.6	HSBC	0.146	0.200	37.0
SCIB	0.222	0.475	114.0	Chase	0.274	0.460	67.9
BMB	0.185	0.287	55.1	America	0.229	0.361	57.6
BBC	0.210	0.156	-25.7	**ABN**	0.429	0.258	-39.9
BOA	0.129	0.220	70.5	**Bharat**	0.433	0.361	-16.6
TDB	0.109	0.143	31.2	**ICBC**	0.435	0.270	-37.9
NKB	0.089	0.110	23.6	**Sime**	0.923	0.508	-45.0
UBB	0.094	0.114	21.3	**OCBC**	0.457	0.227	-50.3
LTB	0.048	0.109	127.1				

Table 7.9 shows similar results to those in Tables 7.3 and 7.6. Cost efficiency of BBC in 1997 was about 26% lower than its 1990-96 mean value. Meanwhile, there was a substantial decrease in cost efficiency of 6 foreign banks (Citibank, ABN, Bharat, ICBC, Sime and OCBC). The results suggest that these banks may have been adversely affected by the financial crisis. On the other hand, Table 7.9 shows a large increase in cost efficiency of SCIB, Bank of Tokyo and Sakura Bank in 1997 compared to their 1990-96 means, which was due to an increase in allocative efficiency (see, Table 7.6). Table 7.9 suggests that cost efficiency of about 90% of Thai banks and 60% of foreign banks had not been badly affected by the financial crisis.

The results shown in Tables 7.7, 7.8 and 7.9 and Figure 7.3 show that there was an increase in the mean cost efficiency of banks during the 1990-97 period, relative to the grand frontier. However, some of this increase is due to four "new" cost efficient banks which entered the database in 1997, and overall the cost efficiencies are rather low. As for technical efficiencies, the effects of deregulation are most evident for the Thai banks, which increased their average cost efficiencies steadily and substantially over the period of study.

Up to this point, it can be summarised that foreign banks had higher average technical efficiency, while Thai banks are better on allocative efficiency[4]. Most of the efficient DMUs are foreign banks and the number of efficient DMUs increased in 1996-97. There was an increased variability of efficiency scores as time went by which suggests that financial deregulation created more winners and losers. This finding is similar to Bhattacharyya *et al.* (1997), who found a greater variability of technical efficiency of 70 Indian commercial banks during 1986 to 1991. The smaller variability in performance of domestic banks is said to reflect their greater familiarity with the regulatory system.

7.1.4 Supplementary analysis of technical, allocative and cost efficiencies

This section examines the source of cost efficiency. Given that cost efficiency is the product of technical and allocative efficiencies, it is interesting to investigate which the main contributor to cost efficiency is, and whether this is different for Thai and foreign banks and the FSIs.

Figure 7.4 Schematic diagram of cost efficiency component

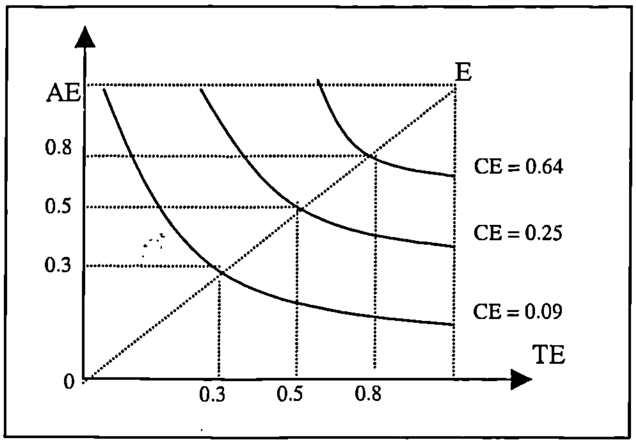


Figure 7.4 shows the schematic diagram of the relationship, where AE=TE=CE =1 at point E and iso-cost efficiency curves correspond to constant values of CE. If there are

[4] The high allocative efficiency of Thai banks is confirmed by the re-estimate from the grand frontier of Thai banks (see, Appendix IX).

more points above the 0E line when AE is plotted against TE, allocative efficiency is the main contributor to cost efficiency, while the opposite suggests otherwise.

Figure 7.5 The composition of cost efficiency

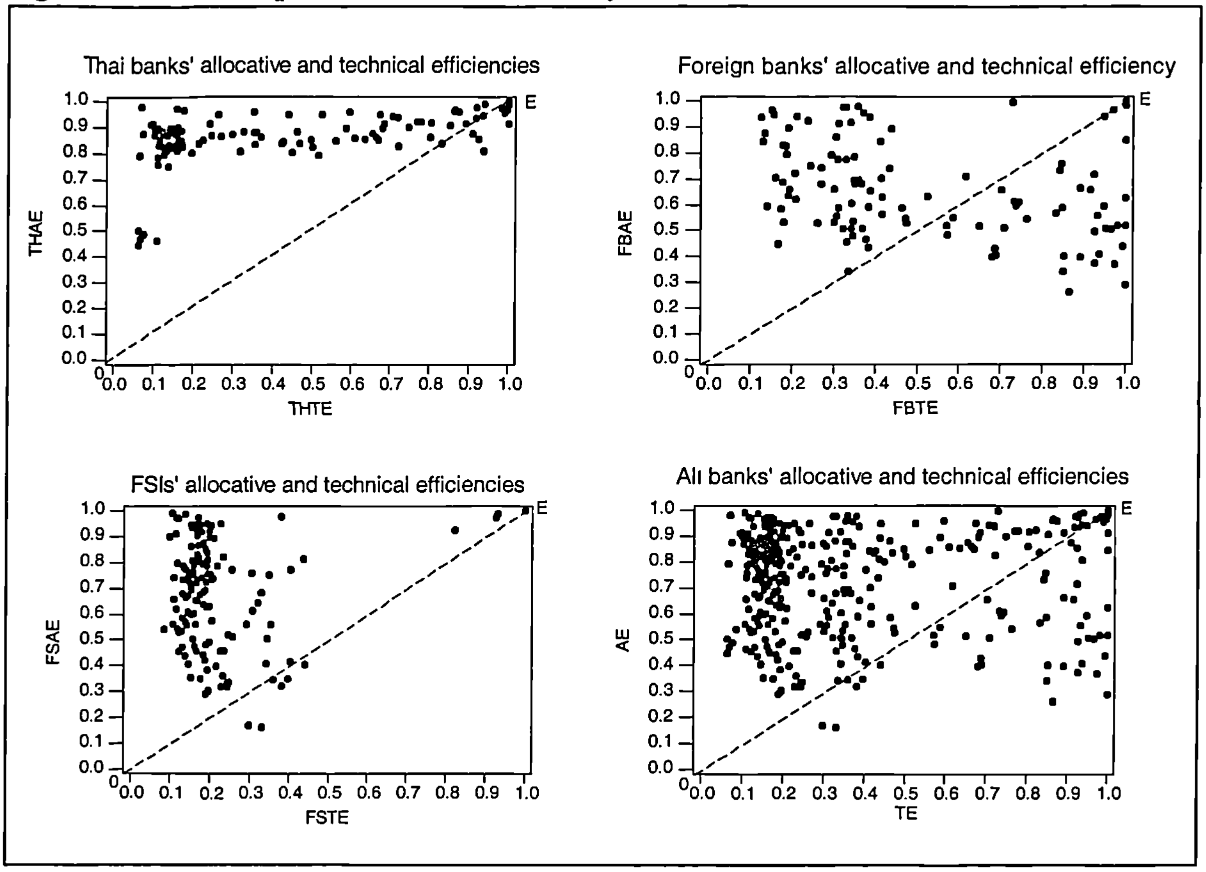
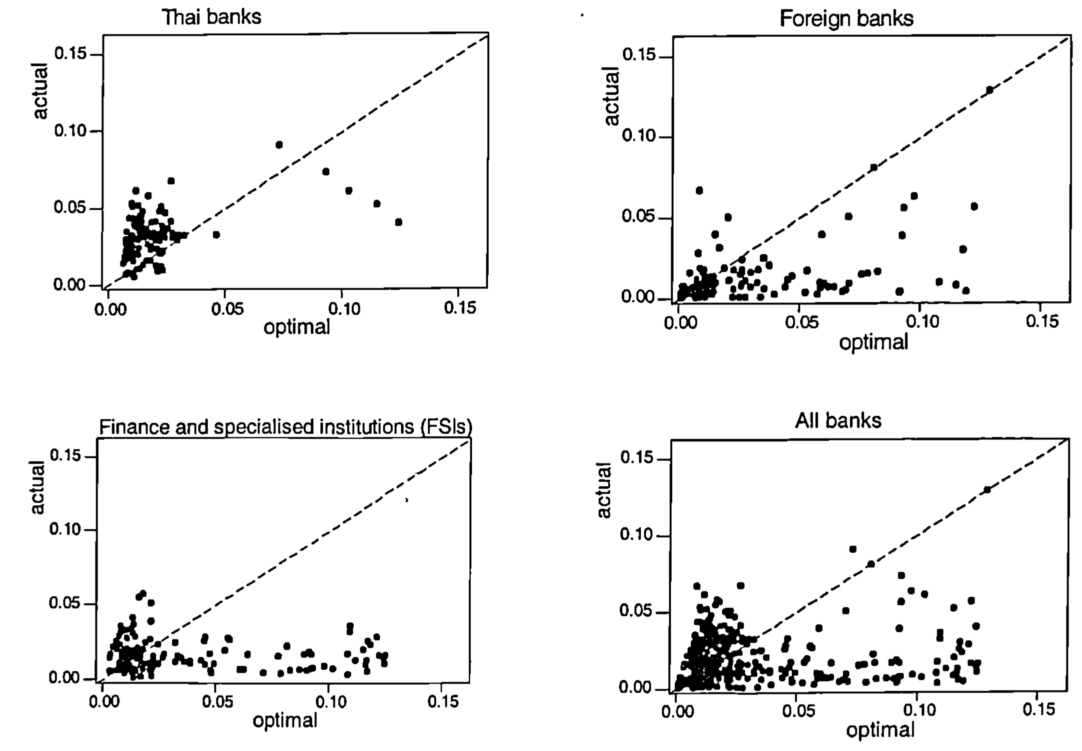


Figure 7.5 shows the scatter plots of allocative efficiency against technical efficiency. The plot for Thai banks shows that allocative efficiency was the main contributor to cost efficiency. It is clear that the vast majority of Thai banks were better at input mix than minimising input use. For the FSIs, their poor performance was due to low technical efficiency, except for DMUs of GSB and GHB (Government Savings and Housing Banks). On the other hand, the scatterplot of foreign banks shows two more or less distinct clusters; the first cluster (TE<0.5) has allocative efficiencies greater than technical efficiencies, while the opposite is true for the second cluster (TE>0.5). For all banks pooled together, the plot suggests that most of the banks were better on optimising the input mix than minimising input use.

Next, we investigate the nature of the input mix of Thai and foreign banks and the FSIs in order to identify the source of cost (allocative) disefficiency. It is assumed that efficient DMUs optimise their input uses by choosing the cost minimising input quantities.

First, we calculate the actual ratios of employees and fixed assets to purchased funds. Second, we obtain the optimal input quantities from the DEA analysis and calculate the optimal ratios of employees and fixed assets to purchased funds. The plots of actual against the optimal ratios should reveal whether banks used high or low proportion of employees and fixed assets relative to funds. The cost (allocative) efficient DMUs should lie on the diagonal line where optimal = actual ratio. DMUs below the diagonal line are said to have a relatively low proportion of employees or fixed asset to funds *ceteris paribus.*

Figure 7.6 Plots of actual against optimal ratio of fixed assets to purchased funds



Note: the plots exclude 2 DMUs of foreign banks (Citibank in 1996 and 1997) because their ratios are extraordinary high (1.07 and 0.96)

Figure 7.6 shows the plots of actual against optimal ratio of fixed assets to funds. Cost (allocative) disefficiency of Thai banks is associated with a higher proportion of fixed assets relative to funds than is optimal. In contrast, cost (allocative) disefficiency of foreign banks is associated with a lower proportion of fixed asset to funds than optimal. Two efficient DMUs with high ratio (0.08 and 0.13) are respectively Chase Manhattan Bank in 1994 and Banque Nationale de Paris in 1997. FSIs' plots show a similar picture to those for foreign banks: disefficiency is mainly associated with a low proportion of fixed assets to funds. The plot for all banks shows that cost efficient DMUs (with the exception of Chase and BNP) had the proportion of fixed assets to funds of less than 5%.

Figure 7.7 Plots of actual against optimal ratio of employees to purchased funds

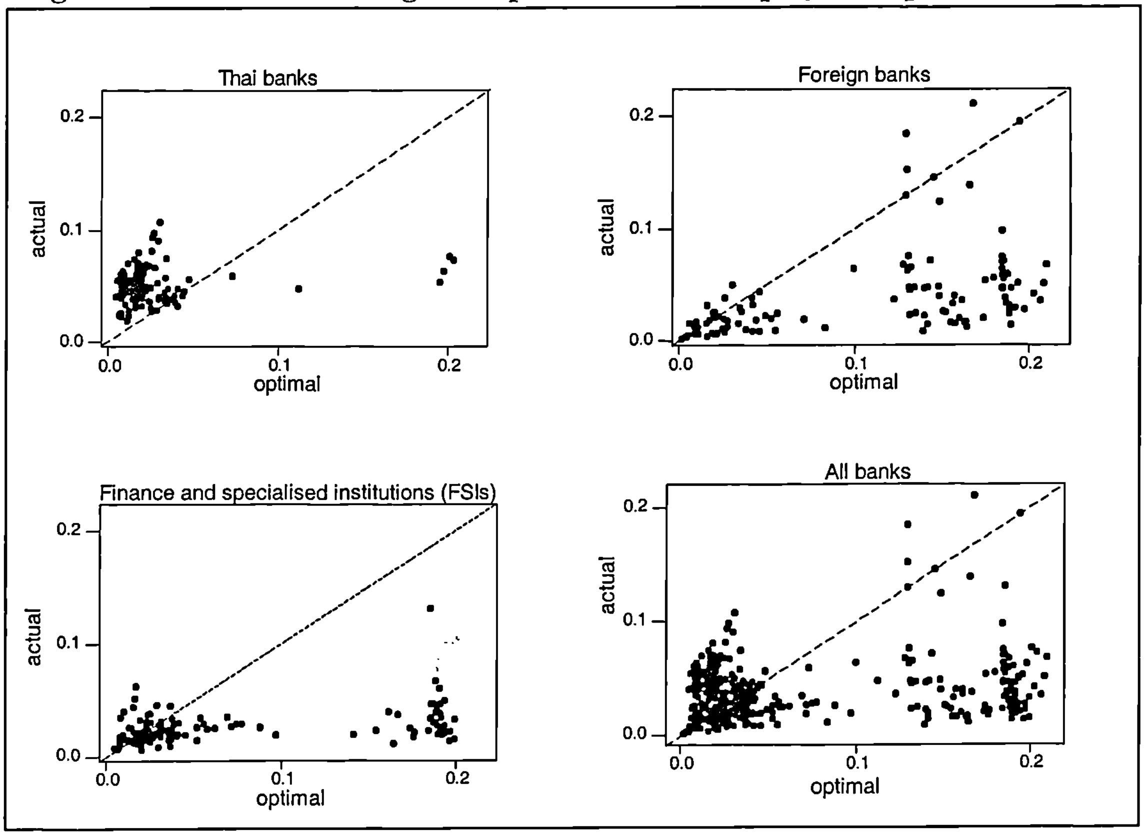
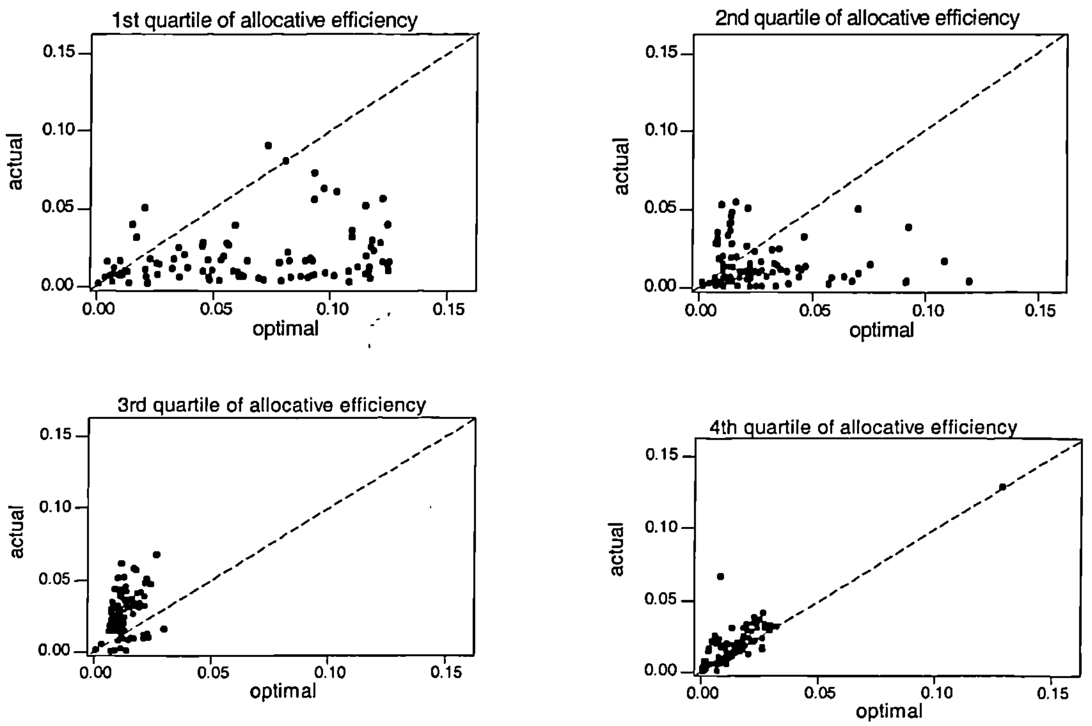


Figure 7.7 shows the plots of actual against optimal ratio of employees relative to purchased funds. These are qualitatively similar to the plots in Figure 7.6. It appears that Thai banks' cost (allocative) disefficiencies are associated with higher ratios of employees to funds than optimal. In contrast, inefficient DMUs of foreign banks

generally had low ratios of employees to funds, which are widely dispersed. Three efficient DMUs with relatively high proportions of employees to funds are Sime Bank Berhad (13%, 15%) and BNP (19%). For FSIs, the plot is similar to that for foreign banks: most of the inefficient DMUs have low ratios of employees to funds. The plots for all banks show that most of the efficient DMUs have the proportion of employees to funds of less than 10%.

It can be concluded that Thai banks' cost (allocative) disefficiency was associated with high ratios of fixed assets and employees to purchased funds. This can be explained by the increased number of branches of Thai banks during 1990-97. In other words, Thai banks had lower amounts of deposits per employee and per branch than optimal. Conversely, inefficient DMUs of foreign banks and the FSIs had lower proportions of fixed assets and employees to purchased funds than optimal. Efficient DMUs used fixed assets and employees respectively less than 5% and 10% of purchased funds to achieve the cost minimising input mix.

Figure 7.8 Plots of actual against optimal ratio of fixed assets to purchased funds by quartiles of allocative efficiency



Note: the plots exclude 2 DMUs of foreign banks (Citibank in 1996 and 1997) because their ratios are extraordinary high (1.07 and 0.96)

Figure 7.8 shows that in the first and second quartiles of allocative efficiency inefficient DMUs have low proportion of fixed assets relative to funds. In the third quartile of allocative efficiency, however, most of the ratios of fixed assets to funds are higher than optimal. For the fourth quartile where DMUs are more allocatively efficient, we found that the optimal and actual ratios of fixed assets to funds are mainly less than 0.5, except for those of BNP (Banque Nationale de Paris), which is clearly quite separate from all the other DMUs.

Figure 7.9 Plots of actual against optimal ratio of employees to purchased funds by quartiles of allocative efficiency

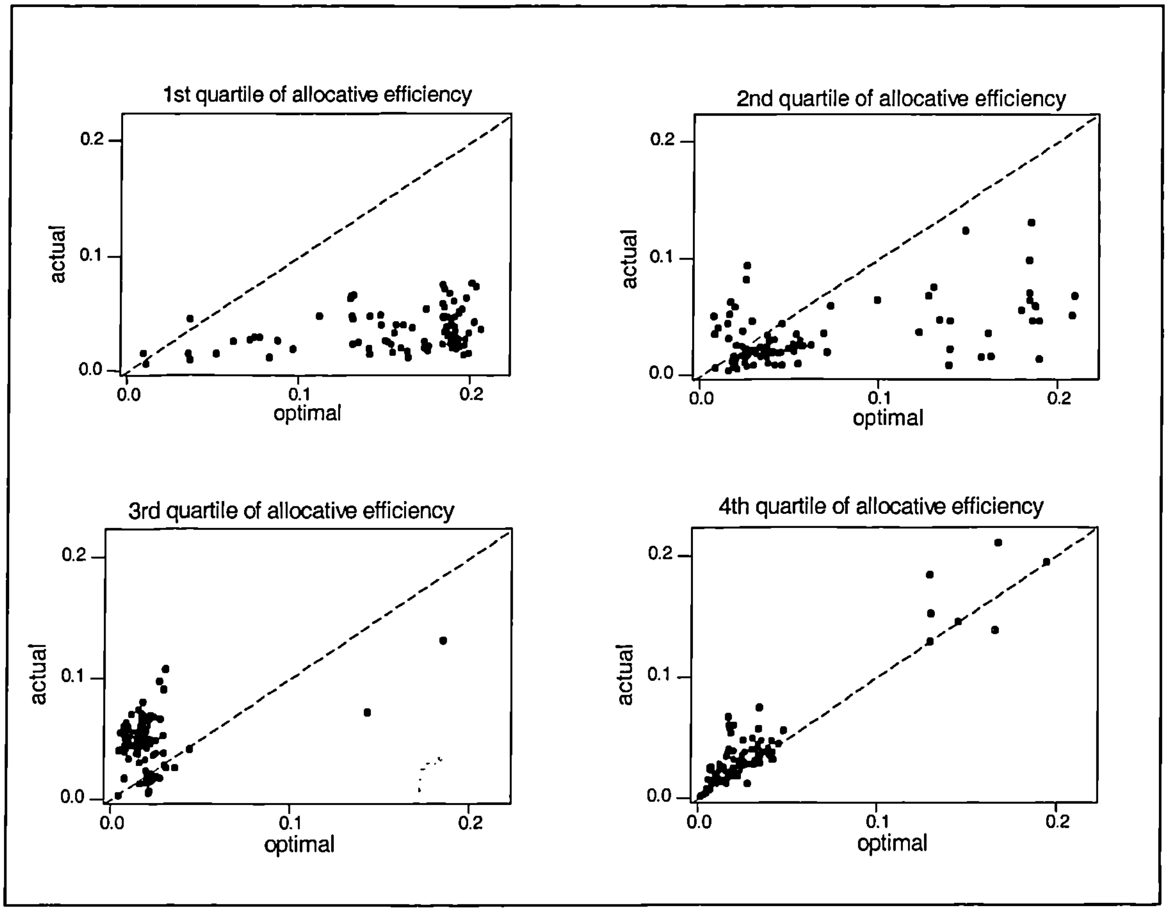


Figure 7.9 presents a qualitatively similar picture to Figure 7.8, for ratios of employees to purchased funds. It shows that inefficient DMUs mainly have low ratios of employees to funds in the first and second quartiles of allocative efficiency. In contrast, most of the ratios of employees to funds for inefficient DMUs in the third and fourth

quartiles of allocative efficiency were higher than optimal. Optimal ratios for the DMUs with allocative efficiencies above the median value were 5% or less, except for 2 DMUs in the third quartile (HSBC in 1990 and Thai Securities Company in 1995) and 7 DMUs in the fourth quartiles (6 DMUs of Sime Bank Berhad in 1990-94 and 1996 and BNP in 1997).

It can be summarised that inefficient DMUs in the first and second quartiles of allocative efficiency (0-0.7356) had lower actual ratios of fixed assets and employees to purchased funds than optimal. In contrast, most inefficient DMUs in the third quartile of allocative efficiency (0.735601-0.8950) had higher proportions of fixed assets and employees to funds than optimal.

7.2 Input slacks and estimates of technical efficiency

This section examines the amount of inputs that inefficient banks could reduce in order to achieve technically efficient production. This study assumes that banks produce net total loans and other earning assets using three inputs: number of employees, purchased funds and fixed assets. The amount of inputs that inefficient banks could reduce is the combination of radial technical inefficiency and input slacks (see discussion in Chapter 4, section 4.2.2).

Radial technical inefficiency is the amount by which all inputs could be proportionally reduced without a reduction in outputs. It is computed as one minus the value of technical efficiency score obtained from the first-stage DEA analysis. Input slacks (which may be zero) are the amounts of inputs that could be further reduced without a reduction in output if production were to achieve technical efficiency. They are obtained from the first-stage DEA analysis of input-orientated technical efficiency.

Inspection of the detailed results from the first-stage DEA analysis of input-orientated technical efficiency, using the grand frontier, shows that Thai banks experienced relatively high input slacks, which were caused by the overutilisation of employees and fixed assets. Therefore, it is important to investigate how much these banks could reduce further their input usage without a reduction in outputs.

This section explores first radial technical inefficient scores, which indicate the percentage of the three inputs a bank could reduce. Second, the percentage of input slacks is calculated to identify a further reduction of employees and fixed assets. Finally, targets of input reduction for individual banks in 1997 are examined.

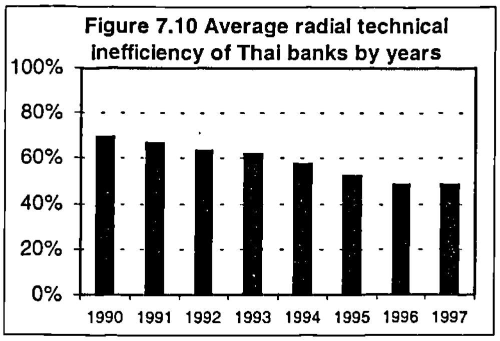


Figure 7.10 Average radial technical inefficiency of Thai banks by years

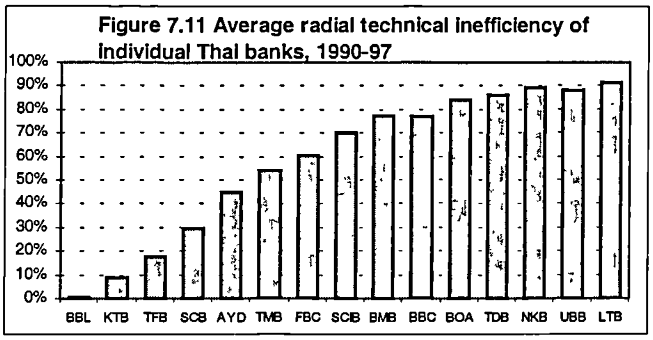


Figure 7.11 Average radial technical inefficiency of individual Thai banks, 1990-97

Figure 7.10 shows that average radial inefficiency of Thai banks declined from about 70% in 1990 to 50% in 1997. Figure 7.11 shows that BBL had the lowest average radial inefficiency, while many banks could have reduced the use of the three inputs by about 80%, in some of the years.

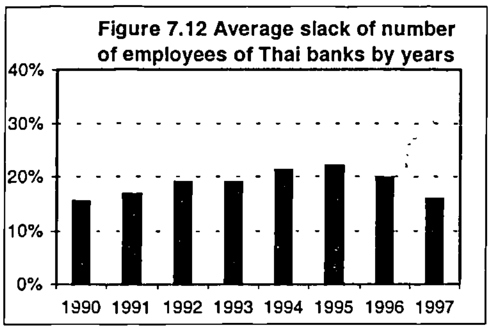


Figure 7.12 Average slack of number of employees of Thai banks by years

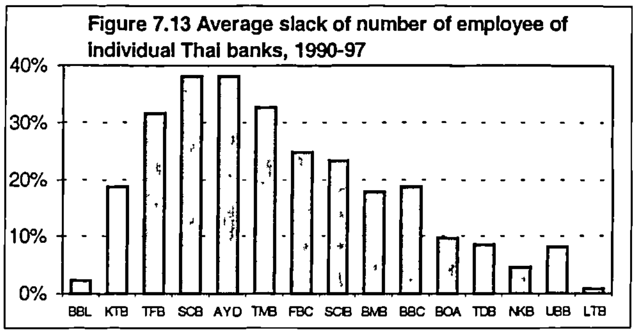


Figure 7.13 Average slack of number of employee of individual Thai banks, 1990-97

Figure 7.12 shows the percentage of number of employees that Thai banks could have reduced further, to achieve the same amount of output, over the 1990-97 period. It appears that the average slack of employees increased between 1990 and 1995 from

15% to 21%, but thereafter reduced to 16% in 1997. Figure 7.13 shows that average slacks of number of employees for SCB and AYD were relatively large; almost 40% of the number of employees that could have been further reduced. It is interesting that the pattern of steadily increasing (and levelling out) inefficiencies in Figure 7.11 is not repeated in Figure 7.13 where the mean slacks rise rapidly to the maximum, then decrease to almost zero.

Figure 7.14 Average slack of fixed assets of Thai banks by years

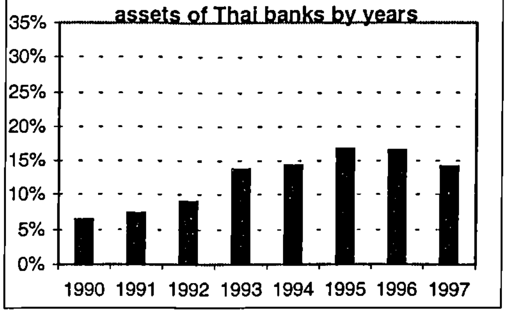


Figure 7.15 Average slack of fixed assets of individual Thai banks, 1990-97

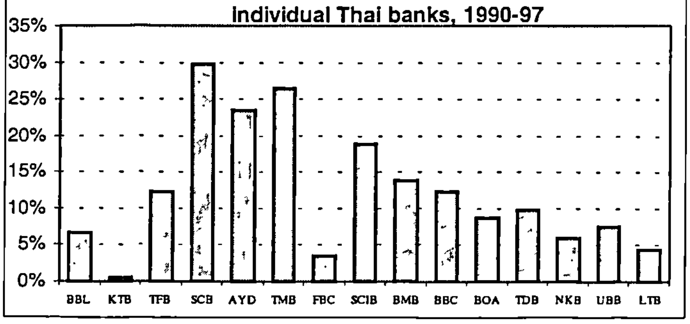


Figure 7.14 shows that the slacks of fixed assets for Thai banks, on average, gradually increased to about 10% between 1990 and 1995. Figure 7.15 shows that during 1990-97, KTB achieved a relatively better use of fixed assets, while SCB, AYD and TMB could have further reduced more than 20% of their fixed assets to produce the same level of output. Again, it is interesting to compare Figure 7.15 with Figure 7.13, there is a rough similarity of Figure 7.15 with Figure 7.13, with maximum slacks for banks AYD and SCB, and thereafter decreasing. However, banks KTB and FBC are out of line with the general upward and downward trend, in Figure 7.15.

Table 7.10 shows that average total employee and fixed assets inefficiency for Thai banks gradually declined, while those for foreign banks were around 50% between 1990 and 1996. It appears that foreign banks were relatively better at input usage. This is partly due to the fact that the number of branches for Thai banks increased on average from 152 in 1990 to 223 in 1997. As a result, the number of employees and fixed assets tended to be higher than those of foreign banks whose branching expansion was restricted. On average, radial inefficiency of both Thai and foreign banks declined over the 1990 to 1997 period.

Table 7.10 Average radial technical inefficiency and total input inefficiency of Thai and foreign banks, 1990-97

	1990	1991	1992	1993	1994	1995	1996	1997
Thai banks								
Radial Technical inefficiency	0.695	0.668	0.637	0.620	0.574	0.522	0.484	0.482
Total employee inefficiency	0.848	0.836	0.825	0.808	0.784	0.741	0.682	0.641
Total fixed asset inefficiency	0.760	0.742	0.727	0.757	0.717	0.688	0.649	0.624
Average number of branches	152	165	174	183	193	202	214	223
Foreign banks								
Radial Technical inefficiency	0.495	0.495	0.499	0.489	0.492	0.488	0.463	0.292
Total employees inefficiency	0.501	0.513	0.506	0.489	0.495	0.496	0.491	0.298
Total fixed assets inefficiency	0.510	0.495	0.530	0.531	0.522	0.527	0.522	0.342
Average number of branches	1	1	1	1	1	1	1	1

Note: The results are calculated from a grand frontier of 379 DMUs of Thai and foreign banks and the FSIs.

Table 7.11 The targets of input reduction of Thai banks in 1997: the grand frontier

Bank	Radial Inefficiency	Slack of number of employees	Slack of fixed assets	Inefficient use of employees	Inefficient use of fixed assets
BBL	0	0	0	0	0
KTB	0.004	0	0	0.004	0.004
TFB	0.127	0.147	0.101	0.274	0.228
SCB	0.137	0.062	0.164	0.199	0.301
AYD	0.222	0.382	0.173	0.604	0.395
TMB	0.316	0.271	0.284	0.587	0.600
FBC	0.326	0.288	0.279	0.614	0.605
SCIB	0.441	0.395	0.315	0.836	0.756
BMB	0.674	0.257	0.190	0.931	0.864
BBC	0.805	0.146	0.106	0.951	0.911
BOA	0.759	0.119	0.077	0.878	0.836
TDB	0.827	0.106	0.130	0.933	0.957
NKB	0.865	0.076	0.108	0.941	0.973
UBB	0.863	0.090	0.105	0.953	0.968
LTB	0.866	0.047	0.102	0.913	0.968

Note: The results are calculated from a grand frontier of 379 DMUs of Thai and foreign banks and the FSIs.

Table 7.11 shows the target of input reduction of Thai banks in 1997. BBL was the most efficient bank. If inefficient banks were to be as productive as BBL, the amount of input reduction needs to be targeted. For instance, if SCIB were to be efficient in 1997, it needs to reduce the number of employees, purchased funds and fixed assets by 44% and further decrease 39% of the number of employees and 31% of fixed assets.

From this point, it is possible to calculate the "adjusted" efficiency score that takes into account of radial inefficiency and input slacks. From Table 7.11, for example, the radial efficiency targets of TFB are to use 87.3% of each of the actual inputs to produce the same level of outputs. But this can also be achieved by using 72.6% of employees, 77.2% of fixed assets and 87.3% of funds. The adjusted technical efficiency of TFB can be calculated as the square root of:

$$\frac{(0.726E)^2 + (0.772FA)^2 + (0.873PF)^2}{E^2 + FA^2 + PF^2}$$

where E = actual number of employees, FA = actual fixed assets and PF = actual purchased funds. We calculated adjusted technical efficiency for each DMU. Figures 7.16 and 7.17 show the average actual and adjusted technical efficiencies of Thai banks.

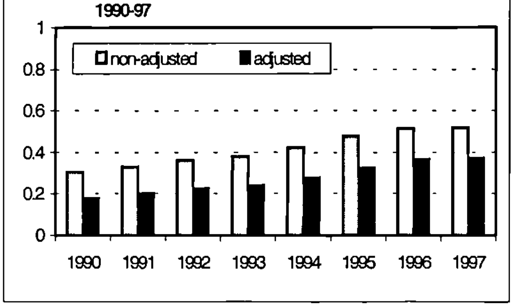


Figure 7.16 Thai banks' average technical efficiency, 1990-97

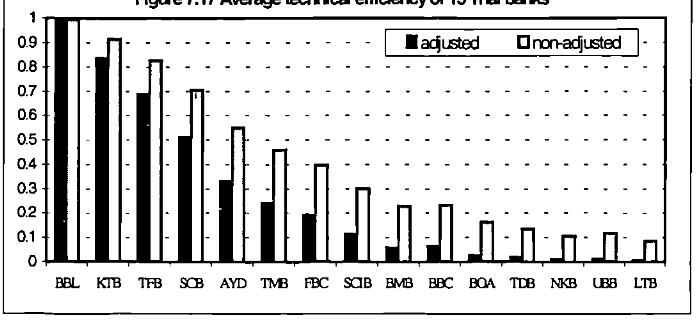


Figure 7.17 Average technical efficiency of 15 Thai banks

Figure 7.16 shows that adjusted technical efficiency of Thai banks increased by 18% over the period, and on average they were 14% lower than the actual scores[5]. For individual banks, Figure 7.17 shows that BBL is technically efficient, while 7 out of 15 banks have average adjusted efficiency scores lower than 10%.

The results from Figures 7.16 and 7.17 suggest that Thai banks may have a different production technology from foreign banks arising from their use of branch networks, and therefore, it is reasonable to investigate their radial technical efficiency and input slacks derived from their own production frontier.

The reconstruction of a grand frontier from 120 DMUs of 15 Thai banks also showed that there are input slacks which arose from the overutilisation of employees and fixed assets, but they are less in number and magnitude than from the full grand frontier. Figures 7.18 and 7.19 illustrate the results.

[5] Average adjusted technical efficiency scores of foreign banks and the FSIs are respectively 19% and 14% lower than the actual ones. This is the result of some inefficient DMUs. On average, however, adjusted efficiencies of foreign banks are higher than those of Thai banks and the FSIs.

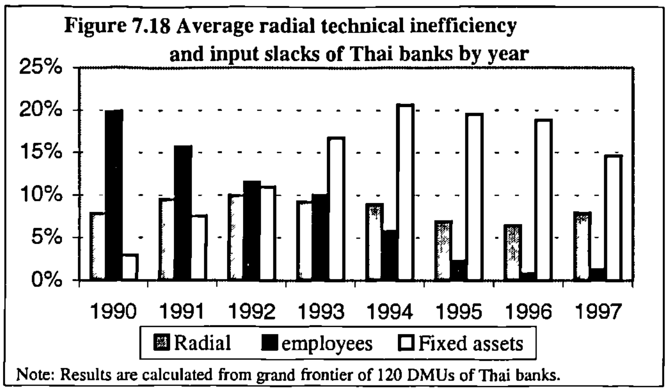


Figure 7.18 shows that Thai banks experienced 7%-10% inefficiency of the three input uses during 1990 to 1997. The employee slacks, on average, declined from 20% in 1990 to 1% in 1997. Meanwhile, the slacks of fixed assets, on average, increased from 3% to 14% over the same period. Comparing with Figures 7.10, 7.12 and 7.14, we see

a) overall less inefficiencies in magnitude
b) average employee slacks decline to almost zero under the Thai frontier, whereas they do not go lower than 15% under the grand frontier
c) the pattern of fixed assets slacks is similar for both frontiers.

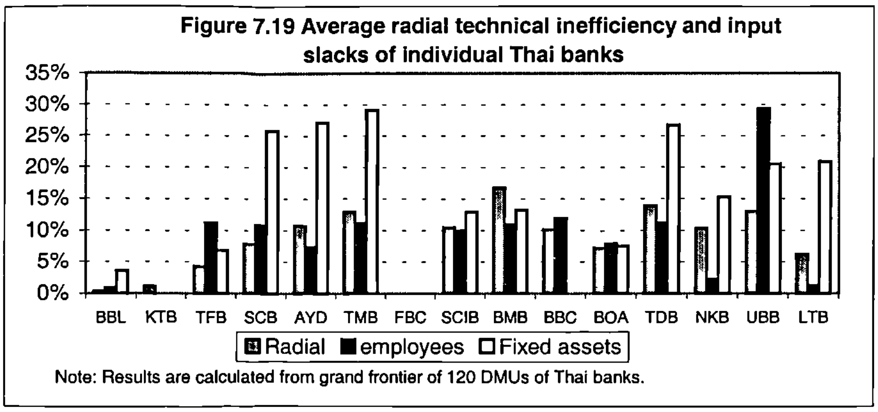


Figure 7.19 shows that FBC was technically efficient relative to the Thai frontier, while BBL and KTB reported small input slacks during the 1990 to 1997 period. UBB reported the largest average slack of employees about 30%, which suggests that altogether around 40% of its number of employees could have been reduced. Some banks experienced the average of 25% on slack of fixed assets; these were SCB, AYD, TMB and TDB. These results are similar to those in Figure 7.15 in which banks SCB, AYD and TMB have average slacks of over 20%.

Table 7.12 The targets of input reduction of Thai banks in 1997: the Thai frontier

Bank	Radial Inefficiency	Slack of number of employees	Slack of fixed assets	Inefficient use of employees	Inefficient use of fixed assets
BBL	0	0	0	0	0
KTB	0	0	0	0	0
TFB	0.059	0	0.026	0.059	0.085
SCB	0.045	0	0.117	0.045	0.162
AYD	0.070	0.010	0	0.080	0.070
TMB	0.101	0	0.363	0.101	0.464
FBC	0	0	0	0	0
SCIB	0.112	0	0.252	0.112	0.364
BMB	0.217	0	0.227	0.217	0.444
BBC	0.202	0.041	0	0.243	0.202
BOA	0	0	0	0	0
TDB	0.111	0	0.117	0.111	0.228
NKB	0.126	0	0.412	0.126	0.538
UBB	0.105	0.146	0.353	0.251	0.458
LTB	0.036	0	0.321	0.036	0.357

Note: Results are calculated from a grand frontier of 120 DMUs of Thai banks.

Table 7.12 shows the targets of input reduction of Thai banks in 1997. There are some similarities with Table 7.11 where NKB reported the largest inefficient use of fixed assets and UBB reported the largest inefficient use of employees, while BBL was the most technically efficient bank. However, Table 7.12 shows that there are 4 technically efficient banks, only 3 banks with employee slacks, and 9 banks with fixed assets slacks, out of 15 Thai banks. This compares with Table 7.11 where all banks except two had employee and fixed assets slacks, and only one bank was technically efficient. Of course, we would expect a greater number of efficient Thai DMUs, and higher efficiency scores, once efficient foreign bank DMUs (which were efficient benchmarks for some of the Thai bank DMUs) are removed from the dataset.

7.3 Bank size and relative efficiencies

This section examines the relationships between bank size and measured efficiencies. Bank sizes are measured by total assets. Small bank refers to the group of banks that have total assets less than 10,000 million baht, medium bank indicates the group of banks that have total assets range from 10,000-100,000 million baht, while large bank is the group of banks that have total assets more than 100,000 million baht.

Table 7.13 Correlation analysis between bank size and relative efficiencies

	Technical efficiency	Allocative efficiency	Cost efficiency
Pearson Correlation			
Thai banks	0.910*	0.505*	0.933*
Foreign banks	-0.044	0.431*	0.236
Finance and specialised institutions (FSIs)	0.703*	0.609*	0.838*
All banks	0.493*	0.455*	0.660*
Spearman rank correlation			
Thai banks	0.992*	0.534*	0.992*
Foreign banks	-0.482*	0.425*	-0.341*
Finance and specialised institutions (FSIs)	0.095	0.822*	0.665*
All banks	0.057	0.684*	0.298*
Mean efficiency scores by bank sizes			
Small bank (77 DMUs)	0.5844	0.5655	0.3381
Medium bank (220 DMUs)	0.2220	0.7333	0.1627
Large bank (82 DMUs)	0.6390	0.9016	0.5876

Notes: (*) indicate correlation is statistically significant at 5%.

Given the nature of the data, both metric and non-parametric measures of association (Pearson r and Spearman rho) have been calculated. These are examined in conjunction with mean efficiencies for each of the three size groups (Table 7.13) and with scatter plots (Figures 7.20 to 7.22).

Table 7.13 shows clear agreement between the three measures for a positive relationship between allocative efficiency and size. However, some of the measures are conflicting for the association between technical and cost efficiencies, and size. The mean values by size group suggest overall U-shaped relationships, but this is clearly not the case for Thai banks where both Pearson and Spearman correlation show strong significant positive relationships. The cost efficiency-size relationship for foreign banks need to be investigated further by graphical means, since the Pearson r is positive (0.236) and Spearman rho is negative (-0.341). There are also large differences between

Pearson *r* and Spearman rho measures for foreign banks and FSIs' technical efficiency association with size.

We further investigate these relationships from the plots of measured efficiencies against total assets.

Figure 7.20 The relationship between bank size and technical efficiency

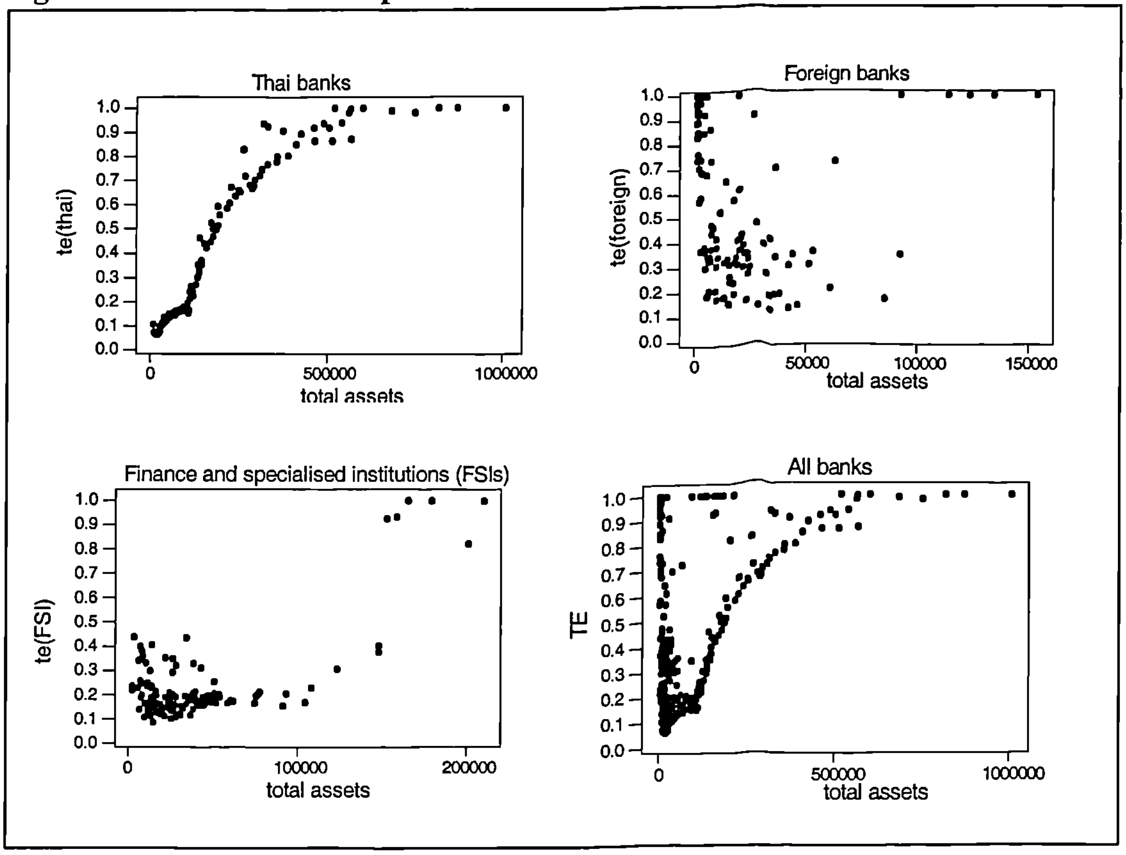


Figure 7.20 clearly illustrates the positive curvilinear relationship between technical efficiency and total assets of Thai banks. For foreign banks, there is a wide dispersion of technical efficiency of small DMUs, while DMUs with assets over 100 billion baht are technically efficient. On the other hand, the plot of FSIs' technical efficiency against their assets show that small DMUs with assets under 100 billion baht were relatively inefficient: most of efficiency scores were less than 0.5 and the plot shows an approximate U-shaped relationship between TE and size. The efficient DMUs are the large banks (GSB and GHB). The plot of all banks can now be interpreted as a combination of three rather different relationships.

Figure 7.21 The relationship between bank size and allocative efficiency

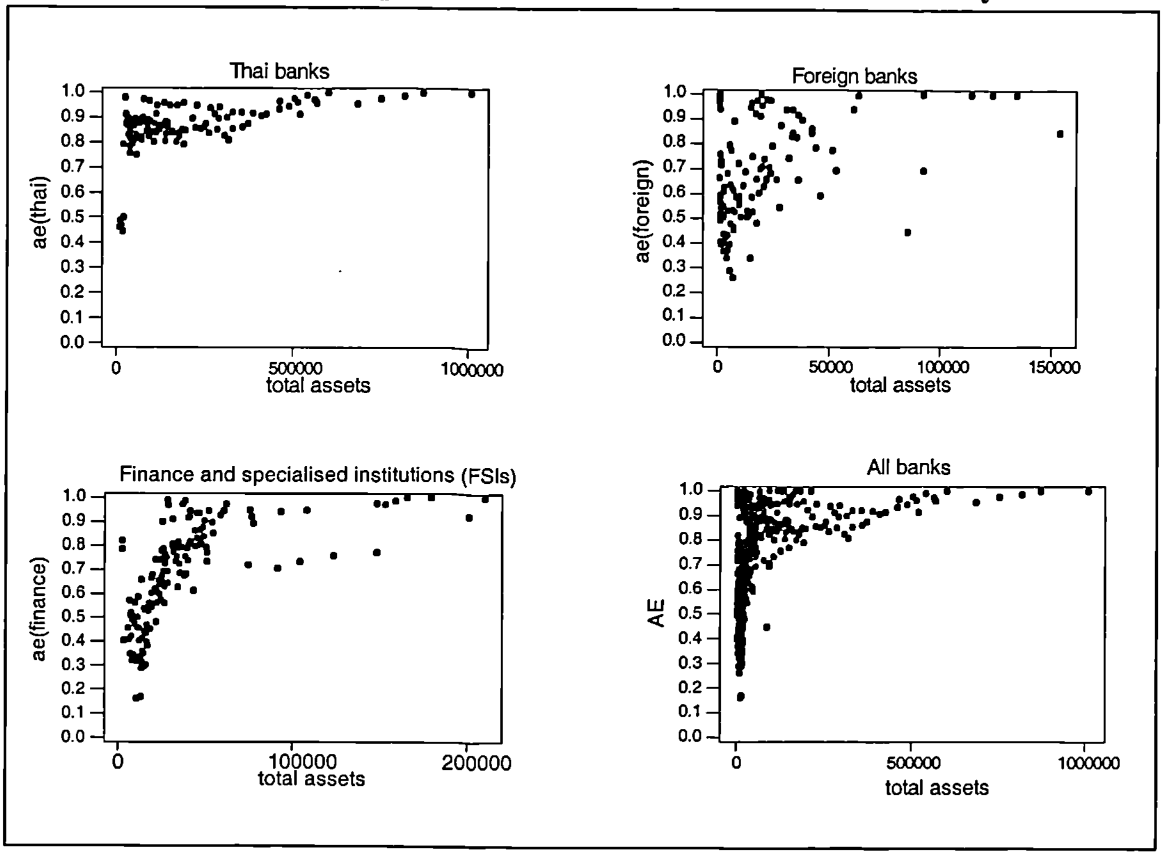


Figure 7.21 shows that Thai banks' allocative efficiency is generally high for all asset sizes, except for a few small DMUs. The relationships between bank size and allocative efficiency for foreign banks and the FSIs are similar, showing a large dispersion of allocative efficiency for small DMUs, while large DMUs had relatively high allocative efficiency. For all banks, large variability of allocative efficiency is observed for small DMUs, while large DMUs converge towards allocative efficiency. Overall, the plots confirm the positive (non-linear) relationships suggested by the statistics in Table 7.16, though this is weakest for the foreign banks.

Figure 7.22 The relationship between bank size and cost efficiency

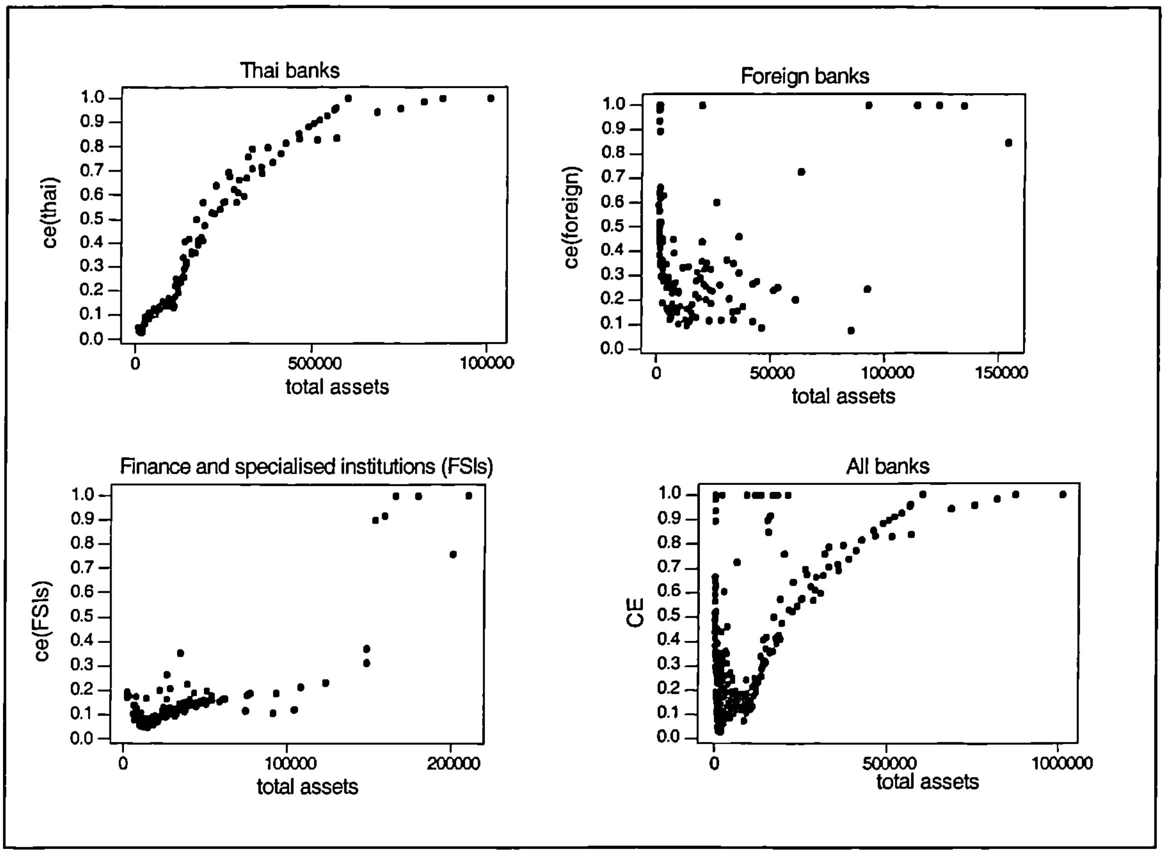


Figure 7.22 shows a positive curvilinear relationship between the cost efficiencies of Thai banks and their asset sizes. The plots of foreign banks illustrate a wide dispersion of cost efficiency for small bank, while efficiencies of the very largest DMUs are high. For the FSIs, cost efficiencies are low and not widely dispersed, except for a separate cluster of 6 DMUs (Government Savings and Housing Banks) which have high cost efficiencies. As for the technical efficiencies, the all banks plot of cost efficiencies can be interpreted as the combination of three different kinds of relationships, which cannot be summarised in a single measure.

Table 7.14 Mean efficiency scores by Leightner and Lovell (1998)'s size classification

Category	1990	1991	1992	1993	1994	1995	1996	1997	Mean 90-94	Mean 90-97
Technical efficiency										
Thai large	0.762	0.803	0.839	0.843	0.865	0.909	0.931	0.933	0.822	0.861
Thai medium	0.186	0.236	0.304	0.366	0.477	0.559	0.616	0.674	0.314	0.427
Thai small	0.113	0.117	0.126	0.124	0.147	0.185	0.221	0.192	0.125	0.153
Foreign small	0.324	0.331	0.310	0.285	0.276	0.325	0.385	0.474	0.305	0.339
Foreign tiny	0.832	0.820	0.846	0.919	0.925	0.847	0.812	0.794	0.868	0.849
Allocative efficiency										
Thai large	0.885	0.904	0.908	0.899	0.921	0.939	0.961	0.971	0.903	0.923
Thai medium	0.894	0.902	0.869	0.858	0.851	0.885	0.892	0.908	0.875	0.882
Thai small	0.811	0.847	0.801	0.779	0.768	0.853	0.860	0.842	0.801	0.820
Foreign small	0.646	0.570	0.696	0.689	0.777	0.774	0.727	0.814	0.676	0.712
Foreign tiny	0.668	0.638	0.634	0.641	0.611	0.522	0.581	0.419	0.638	0.589
Cost efficiency										
Thai large	0.676	0.726	0.766	0.762	0.801	0.857	0.896	0.907	0.746	0.799
Thai medium	0.166	0.211	0.263	0.312	0.406	0.496	0.552	0.614	0.272	0.377
Thai small	0.092	0.101	0.104	0.100	0.117	0.159	0.191	0.163	0.103	0.128
Foreign small	0.208	0.187	0.218	0.187	0.206	0.238	0.286	0.401	0.201	0.242
Foreign tiny	0.574	0.532	0.542	0.597	0.573	0.444	0.484	0.325	0.564	0.509

Table 7.14 examines the relationship of bank size and relative efficiencies using Leightner and Lovell (1998)'s size classification[6]. It shows that Thai large banks had the highest average technical, allocative and cost efficiencies, which appear to increase by more than 10% from 1990 to 1997. For Thai banks, Table 7.14 indicates that mean efficiencies are higher as bank asset sizes get bigger. This finding is similar to Leightner and Lovell (1998), who estimated technical efficiency of commercial banks in Thailand during 1990-94. In contrast to Leightner and Lovell (1998), mean technical and cost efficiencies of foreign tiny banks shown in Table 7.14 were higher than those of foreign small banks.

Our results indicate that the best practice frontier was determined by not only Thai large banks but also foreign tiny banks. It is interesting to note that mean cost efficiencies of foreign tiny banks declined throughout the period, while other banks increased. This was mainly due to the downward trend of allocative efficiency, while other banks' disefficiency largely resulted from the overutilisation of inputs as shown by low mean technical efficiencies. Overall in 1990-94 and 1990-97, Thai large banks had the highest average technical and cost efficiencies, followed by, foreign tiny, Thai

[6] Thai large banks are BBL, TFB, KTB and SCB. Thai medium banks are TMB, AYD, SCIB and FBC. Thai small banks are BOA, BMB, BBC, TDB, UBB, NKB and LTB. Foreign small banks are Citibank, Tokyo, HSBC, Sakura, STCB, America, Indosuez, Deutsche and Chase. Foreign tiny banks are ABN, ICBC, Sime, Bharat, and OCBC. Note that we do not have Sayam bank in our data and Leightner and Lovell (1998) did not indicate that Mitsui Taiyo Kobe has changed its name to Sakura Bank in April 1992.

medium, foreign small and Thai small banks. Moreover, there is quite a big gap between the top two groups and the bottom three.

7.4 Characteristics of the efficient DMUs and their returns to scale

This section examines the characteristics of the best-practice DMUs from the grand frontier of Thai and foreign banks and the FSIs. Banks are said to achieve technical efficiency if they are using the most efficient technology, and they could obtain allocative efficiency if they are using the cost minimising input mix. Thus, cost efficient banks adopt the most efficient technology and optimal input mix.

Table 7.15 Efficient DMUs on the grand frontier

Efficient DMU	1990	1991	1992	1993	1994	1995	1996	1997
Thai banks								
• Bangkok Bank	TE		CE				CE	CE
Foreign banks								
• ABN Amro Bank					TE			
• Bank of Tokyo								TE
• Banque Nationale de Paris								CE
• Bharat Overseas Bank							TE	
• Bank of China								TE
• Dai-Ichi Kangyo bank								CE
• Industrial bank of Japan								CE
• Sakura Bank								CE
• Sime Bank Berhad	CE			CE	TE		TE	
• Sumitomo Bank								CE
Finance and specialised institutions (FSIs)								
• Government Housing Bank								CE
• Government Saving Bank						CE	CE	

Notes: TE = technical efficient bank, CE = overall (cost) efficient bank.

Table 7.15 shows that there was no efficient DMU in 1991. There are 20 technical efficient DMUs between 1990 and 1997, approximately 5% of the sample. Of these 20 best-practice DMUs, 13 come from the final two years of the sample period in which 9 are foreign banks. There are 13 DMUs characterised as cost efficient, approximately 3% of the sample. Of these 13 best-practice DMUs, 7 come from the sample in 1997 in which 5 are foreign banks.

Table 7.15 indicates that BBL is the only efficient Thai bank, while GSB and GHB are efficient banks from the FSIs (they are also the largest FSIs). The highest number of efficient DMUs of foreign banks is Sime Bank Berhad, which was efficient in 1990, 1993, 1994 and 1996. Of the 7 efficient DMUs of foreign banks in 1997, 5 are the banks that began their operations in 1997: DKB, BNP, Sumitomo, IBJ and BOC.

In addition to identifying technical, allocative and cost efficient banks, the first-stage DEA efficiency analysis also provides information about returns to scale in production of frontier banks. By assuming constant input and output mixes, a bank is said to exhibit increasing returns to scale (IRS) if a small proportionate increase in all inputs would generate a more than proportionate increase in all outputs. A bank is said to exhibit decreasing returns to scale (DRS) if a small proportionate increase in all inputs generates a less than proportionate increase in the outputs. The constant returns to scale (CRS) prevails if a bank achieves the most productive scale size, where a small increase (or decrease) in all inputs generates a proportionate increase (or decrease) in all outputs, keeping the input and output mixes the same.

Table 7.16 Returns to scale of efficient DMUs on the grand frontier

	Total assets*	1990	1991	1992	1993	1994	1995	1996	1997
Thai banks									
Bangkok bank	728235†	DRS		DRS				DRS	DRS
Foreign bank branches									
Bharat	1449†							IRS	
Sime	1186†	IRS			IRS	IRS		IRS	
BOC	5628ª								IRS
ABN	7340†					IRS			
BNP	19632ª								CRS
Sakura	46299†								CRS
Tokyo	54840†								DRS
IBJ	92428ª								CRS
DKB	123670ª								CRS
Sumitomo	134780ª								CRS
Finance and specialised institutions (FSIs)									
GSB	174839‡						DRS	DRS	
GHB	184521y								DRS

Notes: (*) total assets are shown in million baht of 1990 price. (†) indicates average 1990-97 total assets. (ª) indicates total assets in 1997. (‡) indicates average 1994-97 total assets. (y) indicates average 1996-97 total assets.

Table 7.16 reports the returns to scale characteristic of frontier bank DMUs between 1990 and 1997. It shows that 8 out of 20 frontier DMUs exhibited decreasing returns to scale. Table 7.16 shows that the five frontier DMUs with constant returns to scale or the most productive scale size have total assets between 27,000 and 190,000 million baht.

Meanwhile, frontier DMUs with decreasing returns to scale have total assets greater than 210,000 million baht and those with increasing returns to scale have total assets less than 8,000 million baht. Most of the frontier DMUs from the group of foreign banks displayed increasing or constant returns to scale. Conversely, frontier DMUs from the group of Thai banks and the FSIs operated in the decreasing returns to scale region of production technology.

The results shown in Table 7.16 suggest that Thai banks and the FSIs were too large, while some foreign banks were too small to achieve the most productive scale size on the efficient frontier. The possible explanation is the Bank of Thailand's branching policy that allowed Thai banks and specialised banks (GHB and GSB) to expand their branch networks, while restricting foreign banks' business in Bangkok. This result is similar to that reported by Bhattacharyya *et al.* (1997) who provided evidence of an association between branch networks and returns to scale characteristics of frontier banks. It is interesting that the single branch, foreign banks, seem to have a production frontier that is relatively scale efficient over a large size range.

It is argued that efficient DMUs can increase or decrease their scale size in order to maximise the average productivity. Banker (1984) states that the most productive scale size for a given input and output mix is the scale size at which the output produced 'per unit' of the inputs is maximised. Following Banker (1984), we estimate the most productive scale size (mpss) of efficient DMUs.

To estimate a DMUs' mpss, the technical efficiency score estimated from the VRS (variable returns to scale) technology is divided by the sum of peer weights of inputs obtained from the CRS (constant returns to scale) model and multiplied by the actual output. The scale factor for output shows the rate at which output can be increased or decreased, and is the ratio of the VRS efficiency score to the sum of peer weights of input. Meanwhile, the scale factor for input is measured by the product of the scale factor for output and the technical efficiency score estimated from CRS technology. It shows the rate at which input can be increased or decreased to achieve the most productive scale size.

Table 7.17 Maximum productive scale sizes for the grand frontier efficient banks

Bank DMU	Year	Actual output	MPSS output	Scale factor for output	Scale factor for input
Decreasing returns to scale					
Bangkok bank	1990	463084	35304	0.08	0.01
Bangkok bank	1992	555919	27521	0.05	0.01
GSB	1995	145134	9436	0.07	0.02
Bangkok bank	1996	783664	18007	0.02	0.00
GSB	1996	157657	11258	0.07	0.02
Bangkok bank	1997	930652	21155	0.02	0.00
Bank of Tokyo	1997	150014	106772	0.71	0.30
GHB	1997	205640	37580	0.18	0.09
Increasing returns to scale					
Sime Bank	1990	1051	16683	15.87	10.94
Sime Bank	1993	965	60327	62.50	30.56
ABN	1994	2657	21957	8.26	2.51
Sime Bank	1994	877	28299	32.26	12.94
Bharat	1996	1095	42135	38.46	6.81
Sime Bank	1996	1055	8377	7.94	2.06
BOC	1997	5477	12678	2.31	1.31
Constant returns to scale					
BNP	1997	16079	16079	1.00	1.00
IBJ	1997	87675	87675	1.00	1.00
Sakura	1997	101527	101527	1.00	1.00
DKB	1997	122724	122724	1.00	1.00
Sumitomo	1997	133690	133690	1.00	1.00

Table 7.17 shows that the scale sizes of 8 efficient DMUs were too big. Bangkok Bank's mpss output could be achieved at 2% of its actual output or around 21 billion baht in 1997, while using 0.2% of its actual input mix. GSB (Government Savings Bank) could reduce its output to 7% of its actual, while using only 2% of its actual input during 1995-96. GHB (Government Housing Bank) and Bank of Tokyo could maximise their average productivity by producing respectively at 18% and 71% of their actual output.

On the contrary, the scale sizes of 7 efficient DMUs for foreign banks were too small. Sime Bank Berhad could increase its actual input and output respectively by 30 and 62 times in 1993. ABN could increase its output from 2 to 21 billion baht and increase its input use by 250% in 1994. Bharat could expand its output to 42 billion baht in 1996 and BOC (Bank of China) could increase its actual output to 12 billion baht in 1997.

There are 5 efficient DMUs, which were foreign banks in 1997, classified as operating at the most productive scale size. Their output sizes range from 16 to 133 billion baht. Overall, efficient banks could achieve the most productive scale size by producing output from 8 to 133 billion baht. This is consistent to Table 7.16, where the assets of efficient DMUs with constant returns to scale range from 19 to 134 billion baht.

The results should be treated with caution since the CRS efficiencies on which they are based involve extrapolation outside the range of the given data. However, they do suggest possible splitting up of some of the largest banks, and possible mergers or expansion targets for some of the smallest banks, to improve scale efficiency. In practice, change of size would be combined with changes in the input and output mix.

7.5 Diagnostic analysis of influential observations

This section examines the impact of influential observations on the first-stage DEA analysis. First, we examine how the entry of 6 foreign banks in 1997 affects the relative efficiencies and the frontier banks. Then, we investigate the influence of frontier banks based on the estimates of technical efficiency from VRS (variable returns to scale) and CRS (constant returns to scale) DEA grand frontiers.

7.5.1 Foreign bank entry

There were 6 new foreign banks in 1997: Banque Nationale de Paris (BNP), Bank of China (BOC), Dai-Ichi Kangyo Bank (DKB), Industrial Bank of Japan (IBJ), Sumitomo Bank and Dresdner Bank. The illustration of grand frontier banks in Table 7.18 shows that 5 of 6 new foreign banks are efficient in 1997[7]. Each of these 5 banks has a low ratio of funds to outputs; and this suggests that financial capital (which is not included as an input in the DEA analysis) is supporting much of the lending, presumably as a strategic move to gain market share.

[7] These efficient banks are Banque Nationale de Paris (BNP), Bank of China (BOC), Dai-Ichi Kangyo Bank (DKB), Industrial bank of Japan (IBJ), and Sumitomo Bank.

Table 7.18 The ratio of purchased funds to outputs of 6 new foreign banks

Bank	Funds/output (%)
Banque National de Paris (BNP)	1.7
Industrial Bank of Japan (IBJ)	19.5
Bank of China (BOC)	27.9
Dai-ichi Kangyo Bank (DKB)	28.5
Dresdner Bank	38.2
Sumitomo Bank	41.1
Foreign banks (average)	65.5
Thai banks (average)	98.2

Note: output is the aggregate of net total loans plus other earning assets.

Table 7.18 shows the ratio of funds to outputs of 6 new foreign banks (included 5 efficient bank in 1997), compared to average ratios of Thai and foreign banks in 1997. It indicates that their ratios are much lower than the average of Thai and foreign banks in 1997. BNP reported the lowest ratio of less than 2%.

This section will examine how the entry of 6 new banks in 1997 affects the results of DEA efficiency analysis.

Figure 7.23 The impact of 6 new foreign banks

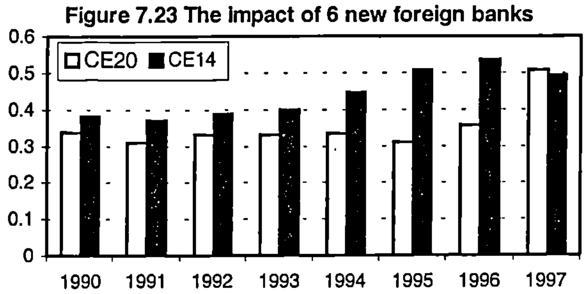


Figure 7.23 compares average cost efficiency of foreign banks estimated from the grand frontier of 379 DMUs (CE20) with those estimates after omitting 6 new foreign banks (CE14). It appears that the re-estimated average cost efficiency was slightly higher between 1990 and 1994 and was greater by about 20% in 1995 and 1996. However, the results are not much different in 1997[8].

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[8] The average and variability for relative efficiencies for Thai and foreign banks and FSIs, after excluding 6 new foreign banks in 1997, are shown in Appendix X.

Table 7.19 Efficient banks after omitting 6 new foreign banks from the grand frontier

Efficient bank	1990	1991	1992	1993	1994	1995	1996	1997
Thai banks								
• Bangkok Bank	TE		CE				CE	CE
Foreign banks								
• ABN Amro Bank					TE	CE		
• Bank of Tokyo								CE
• Bharat Overseas Bank							TE	
• Chase Manhattan Bank								TE
• Overseas Chinese Banking					TE	TE		TE
• Sakura Bank				TE				CE
• Sime Bank Berhad	CE			CE	TE		CE	
Finance and specialised institutions (FSIs)								
• Government Housing Bank								CE
• Government Saving Bank						CE	CE	
• Thai Investment securities					TE			

Notes: TE = technical efficient bank, CE = overall (cost) efficient bank.

A comparison of results presented in Tables 7.15 and 7.19 shows that the frontier banks, which were efficient before omitting 6 new foreign banks, have not changed, as expected[9]. However, there are 3 additional technically efficient banks (Chase Manhattan Bank in 1997, Overseas Chinese Banking in 1994, 1995 and 1997 and Thai Investment Securities in 1994). A re-estimation of grand frontier without 6 new foreign banks showed that the overall means of technical, allocative and cost efficiencies increased respectively by 7.5%, 5.5% and 6.3%[10]. The results suggest that the entry of 6 new foreign banks in 1997 does not make much difference qualitatively to the results of first-stage DEA efficiency analysis.

7.5.2 Influence of efficient DMUs

This section examines whether efficient DMUs are influential in the sense that they have been frequently used in the calculation of efficiency scores, and their absence alters the efficiency scores of a large number of inefficient DMUs. This study adopts a similar approach to Wilson (1995), who examines the effect of efficient DMUs by

[9] Note that the removal of DMUs can never decrease efficiency of remaining DMUs.

[10] The overall means technical, allocative and cost efficiencies before excluding 6 new banks are 0.386, 0.736 and 0.290 and after excluding them are 0.461, 0.791 and 0.353 respectively.

recomputing efficiency scores for each DMU in the sample while deleting one of the efficient DMUs from the reference set. The process is repeated for every efficient DMU in order to identify their influences. Table 7.20 reports the results after deleting 20 technically efficient DMUs of the grand frontier assuming variable returns to scale (VRS) technology.

Table 7.20 The influence of efficient DMUs from VRS DEA frontier

The deleted efficient bank DMU	Year	The number of DMUs for which efficiency is altered	Average change in measured efficiency	The weighted measure of influence
Bangkok Bank	1990	5	0.043	0.215
Sime Bank Berhad	1990	23	0.005	0.115
Bangkok Bank	1992	14	0.005	0.070
Sime Bank Berhad	1993	47	0.007	0.329
ABN	1994	72	0.009	0.648
Sime Bank Berhad	1994	1	0.031	0.031
GSB	1995	1	0.075	0.075
BBL	1996	10	0.002	0.020
Bharat	1996	33	0.006	0.198
Sime Bank Berhad	1996	7	0.005	0.035
GSB	1996	1	0.057	0.057
Bangkok Bank	1997	28	0.020	0.560
Bank of Tokyo	1997	5	0.017	0.085
Sakura Bank	1997	180	0.047	8.460
DKB	1997	57	0.025	1.425
BNP	1997	238	0.049	11.662
Sumitomo Bank	1997	56	0.007	0.392
IBJ	1997	138	0.019	2.622
Bank of China	1997	37	0.014	0.518
GHB	1997	63	0.030	1.890

Table 7.20 shows that DMU of BNP (Banque Nationale de Paris) in 1997 had the largest weight of influence of 11.662 and affected the largest number of inefficient DMUs, about 63% of observations in the sample. It is followed by DMUs of Sakura Bank and IBJ (Industrial Bank of Japan) in 1997 that had respective overall weighted influences of 8.46 and 2.62. Note that most of the influential DMUs were in 1997 and 5 out of 9 are new foreign banks, which were identified in Section 7.5.1. The average changes in measured efficiency influenced by these efficient DMUs are relatively small compared to the influence of GSB (Government Saving Bank) in 1995 that affects measured efficiency of only one DMU.

The results suggest that most of the efficient DMUs do not have a large impact on efficiency within the sample, although DMUs of BNP, Sakura Bank, IBJ and GHB in 1997, stand out from the rest, with much higher weighted influence. BNP and IBJ were identified in Table 7.18 as having extraordinary low ratios of funds to outputs, which seem to be producing some degree of distortion in the overall results.

7.5.3 Modified technical efficiency

This section examines the modified input weak efficiency (IWE) score for the technically efficient DMUs. The modification can be used first, to rank efficient DMUs (Anderson and Peterson, 1993) and second, to identify influential observations (Wilson, 1995). The method involves removing the *i th* efficient DMU from the constraint set when the efficiency for the *i th* DMU is recalculated (see chapter 6). Following Anderson and Peterson (1993), Wilson (1995) and Glass and Mckillop (2000), this study examines the DMUs constituting the efficient subset for the constant returns to scale (CRS) assumption[11]. These are DMUs of Sakura Bank, DKB (Dai-Ichi Kangyo Bank), BNP (Banque Nationale de Paris), Sumitomo Bank and IBJ (Industrial Bank of Japan) in 1997.

Table 7.21 The influence of efficient DMUs from CRS DEA frontier

The deleted efficient bank DMU	Modified input weak technical efficiency	The number of DMUs for which efficiency is altered	Average change in measured efficiency	The weighted measure of influence
Sakura Bank	1.089	99	0.0161	1.592
DKB	2.173	12	0.0928	1.114
BNP	9.591	318	0.0733	23.316
Sumitomo Bank	1.657	1	0.0190	0.0190
IBJ	1.953	190	0.0226	4.288

Table 7.21 shows that 4 out of 5 influential DMUs are new foreign banks which were identified in Section 7.5.1. Table 7.21 indicates that BNP has the largest weight of influence of 23.316 and it influences measured efficiency for 84% of the total DMUs in the sample. The IWE score of 9.591 suggests that this bank's inputs would have to be scaled up by more than 900% to reach the frontier supported by the remaining DMUs. The results suggest that the calculation of technical efficiency from the CRS DEA

[11] The investigation may yield non-existent solutions in the variable returns to scale assumption if deletion of *i th* DMU from the reference set results in an infeasible constraint set (see, Wilson, 1995).

frontier should exclude BNP, which also confirms its very high influence reported in the previous sections. BNP has an extremely low ratio of funds to loans plus other earning assets of 1.7% (as shown in Table 7.18), and is an outlier in the distribution of this ratio.

Table 7.21 also shows that IBJ has quite high influence which affects 190 inefficient DMUs. All 5 influential DMUs were identified in Section 7.5.2.

7.5.4 Resti (1997)'s alternative analysis of robustness

This section examines the influence of efficient DMUs using Resti (1997)'s approach. First, technical efficiencies of 379 DMUs are calculated under constant returns to scale (CRS) and variable returns to scale (VRS) assumptions. There are respectively 5 and 20 efficient DMUs. Second, technical efficiency is recomputed after excluding the respective efficient DMUs. Finally, correlation analyses between technical efficiency of DMUs before and after excluding efficient DMUs, based on the reduced samples, are carried out. If the efficient DMUs are influential, the results should be varied and not correlated *ceteris paribus*. Table 7.22 reports the results of correlation analysis.

Table 7.22 Correlation analysis of technical efficiency

Category	CRSTE	VRSTE
Pearson correlation	0.917	0.878
Rank correlation	0.911	0.930

Notes: The associated p-values for the above correlations are 0.000. CRSTE = technical efficiency from CRS DEA and VRSTE = technical efficiency from VRS DEA.

Table 7.22 shows that the correlations between technical efficiency calculated before and after removing efficient DMUs are significant. The results suggest that the efficiencies obtained using the full set of observations (379 DMUs) are reasonably robust, at least on an ordinal scale of ranking of the DMUs.

7.6 Analysis of consistency conditions and profitability test

The aim of this section is first, to examine the consistency of relative efficiencies in the first-stage DEA analysis and second, to identify banks that are both cost and profit efficient.

7.6.1 Consistency test

Bauer *et al.* (1998) note that efficiencies calculated from all different approaches should be consistent with financial ratios such as return on assets (ROA) or cost/revenue ratios (see, for example, the earlier Chapter 4 (4.2.3) of this thesis). It is important to investigate the consistency of measured efficiency with a bank's financial ratios because it may indicate the accuracy and credibility of efficiency analysis.

Pearson and Spearman rank correlation coefficients have been used to examine the correlation between technical, allocative and cost efficiencies, and the financial ratios: ROA and the ratio of total cost to total assets (TCTA). The discussion will be focused on the correlation between cost efficiency and financial ratios, since cost efficiency is the product of allocative efficiency and technical efficiency (see, chapter 6).

A priori it is assumed that ROA should be positively related to cost efficiency because cost efficient banks should achieve higher profitability. On the other hand, TCTA is assumed to be negatively related to cost efficiency since better production efficiency should lower the bank's costs. The correlation is statistically significant if the associated p-value is less than 0.05.

Table 7.23 Correlation of measured efficiencies and financial ratios

	Technical efficiency	Allocative efficiency	Cost efficiency
Pearson Correlation			
Return on assets (ROA)	0.074	-0.016	0.068
	(0.150)	(0.751)	(0.184)
Total cost to total assets (TCTA)	-0.223	0.103	-0.177
	(0.000)	(0.044)	(0.001)
Spearman rank correlation			
Return on assets (ROA)	0.029	-0.069	0.030
	(0.568)	(0.179)	(0.560)
Total cost to total assets (TCTA)	-0.313	0.178	-0.204
	(0.000)	(0.000)	(0.007)

Note: The associated p-values are shown in parentheses.

Table 7.23 shows the correlation coefficients between technical, allocative and cost efficiencies and financial ratios, ROA and TCTA. It appears that the results from Pearson correlation are consistent with those from Spearman rank correlation. Cost efficiency is positively related to ROA, however, the association is not statistically significance. On the other hand, cost efficiency appears to be negatively and significantly correlated with TCTA. The findings of weak correlation are similar to Bauer *et al.* (1998), who found overall association of 0.053 between DEA cost efficiency and accounting ratios.

The results shown in Table 7.23 suggest that the technical and cost efficiencies calculated in the first-stage DEA analysis are consistent with the total cost to total assets financial ratios. However, they do not show a significant positive relationship with ROA. This may be because the DEA models used in this study focus on cost minimisation and optimal use of inputs, and do not directly address the revenue maximisation problem.

7.6.2 Profitability test

In the first-stage DEA analysis, the efficiency of a bank is measured relative to the best practice frontier that relates a bank's costs to the output it produces. It is possible that a seemingly cost-inefficient bank might be offsetting higher expenses with higher revenues. On the other hand, a cost efficient bank might not be maximising its revenue as costs on promoting revenue (e.g. marketing) are reduced.

Spong *et al.* (1995) argued that the measurement of bank efficiency should meet specified criteria on both a cost efficiency and a profitability test. These combined tests measure the ability of banks to use their resources efficiently both in producing banking products and services and in generating income from these goods and services. It follows that the most efficient banks should do well on both tests *ceteris paribus*.

In their study of 1,439 US banks from 1990 to 1994, Spong *et al.* (1995) separate the most and the least efficient banks by using the following criteria:

- *Most efficient group*: banks that rank in the upper quartile on the cost efficiency measure and in the upper half on the ROA
- *Least efficient group*: banks that rank in the bottom quartile on the cost efficiency measure and the bottom half on ROA.

This section adopts Spong *et al.* (1995)'s profitability test, first, to identify the cost and profit efficient banks and second, to supplement the Bauer *et al.* (1998)'s consistency test. Table 7.24 reports the results.

Table 7.24 Profitability test using Spong *et al.* (1995)'s approach

Category	Number of DMUs	% of total 379 DMUs	Mean cost efficiency	Mean ROA	Criteria
Most efficient DMUs	52	13.7	0.689	0.025	CE ≥ 0.3610 and ROA ≥ 0.01299
Least efficient DMUs	55	14.5	0.083	0.005	CE ≤ 0.1120 and ROA < 0.01299

Note: the chi-square test = 2.782, df =1, p-value = 0.095

Table 7.24 shows that about 14% of total 379 DMUs are classified in the most and the least efficient categories. The most efficient group has average cost efficiency of about 70% and 2.5% average ROA. Meanwhile, the least efficient group has average cost efficiency of 8% and 0.5% average ROA. The chi-square test of Table 7.24 suggests an association between cost efficiency and ROA at the 10% level of significance. We conclude that the measured cost efficiency is consistent with the financial ratio, ROA.

We further examine the consistency of cost efficiency estimates with the profitability measure, ROA. We divide bank DMUs into four groups of top and bottom quartiles of ROA and cost efficiency in order to gain the insight of the profitability test. The first group comprises DMUs that are good at both generating profits and keeping cost at the minimum. The second group contains DMUs that are good at minimising cost but poor at generating profits. The third group includes DMUs that have poor cost efficiencies but good at generating profits. The last group comprises DMUs that have low cost efficiencies and profits. Table 7.25 reports the results.

Table 7.25 Profitability test using top and bottom quartiles of cost efficiency and ROA

Category	Number of DMUs	% of total DMUs	Mean cost efficiency	Mean ROA	Criteria
High CE and High ROA	105	27.7	0.455	0.025	CE ≥ 0.1640 and ROA ≥ 0.01382
High CE and low ROA	87	23.0	0.479	0.002	CE ≥ 0.1640 and ROA < 0.01382
Low CE and High ROA	85	22.4	0.113	0.024	CE < 0.1640 and ROA ≥ 0.01382
Low CE and Low ROA	102	26.9	0.107	0.001	CE < 0.1640 and ROA < 0.01382
Total	379	100			

Note: the chi-square test = 3.230, df =1, p-value = 0.072

Table 7.25 shows that 28% of total DMUs are good at both generating profits and minimising cost, while 27% of total have low profit and cost efficiency. It is interesting to note that average cost efficiency of DMUs that are good at minimising cost but poor at generating profits was 48%, which is higher than that of the best performance group (45%). This suggests that 23% of total DMUs were pursuing a deliberate strategy that is not based on profit maximisation. The chi-square test of association between cost efficiency and ROA in Table 7.25 is significant at 10% level, which is similar to the results from Table 7.24 (Spong *et al.* (1995)'s approach).

Table 7.26 Number of bank DMUs by top and bottom quartiles of cost efficiency and ROA

Category	Thai banks	% of total	Foreign banks	% of total	FSIs	% of total
High CE and High ROA	30	25.0	52	44.1	23	16.3
High CE and low ROA	36	30.0	44	37.3	7	5.0
Low CE and High ROA	3	2.5	14	11.9	68	48.2
Low CE and Low ROA	51	42.5	8	6.8	43	30.5
Total	120	100	118	100	141	100

Note: CE = cost efficiency, ROA = return on assets, FSIs = finance and specialised institutions.

Table 7.26 shows that the largest group of Thai banks' DMUs (42.5%) had poor profits and cost efficiency. Three DMUs of Thai banks that had low cost efficiency, but high profits were SCIB (1993) and BOA (1994, 1996). In contrast, 44% of foreign banks' DMUs were good at both generating profits and minimising costs. Only 8 DMUs of foreign banks are inefficient in both profit generation and cost minimisation[12]. The largest group of FSIs' DMUs (48%) were better at generating profits but had low cost efficiency, while 30% had poor performance, low cost efficiency and profits. There are 7 DMUs (5%) of FSIs, which come from 5 specialised institutions[13], that are good at minimising cost but have low profits. Overall, there were about 21% of FSIs' DMUs that had high cost efficiency compared to 55% of Thai banks' DMUs and 81% of foreign banks' DMUs.

Table 7.27 Mean financial ratios by top and bottom quartiles of cost efficiency and ROA

Category	ROE	TCTA	OPTA	NIETA	EQTA	TLTA	LLRTL
High CE and High ROA	0.1615	0.0838	0.0240	0.0243	0.2121	0.7560	0.0545
High CE and low ROA	0.0881	0.0783	0.0240	0.0203	0.2464	0.7764	0.0713
Low CE and High ROA	0.2169	0.1339	0.0254	0.0319	0.1269	0.7947	0.0337
Low CE and Low ROA	0.0135	0.1083	0.0292	0.0234	0.0824	0.8126	0.0224

Note: CE = cost efficiency, ROA = returns on assets, ROE = returns on equity, TCTA = total cost to total assets, OPTA = operating expense to assets, NIETA = non-interest expense (included personnel expense) to total assets, EQTA = equity to total assets, TLTA = total loans to total assets, LLRTL = loan loss reserve to total assets. Data on interest received and other income are not included here because foreign banks' data are not available to researcher.

Table 7.27 shows that highly cost and profit efficient DMUs, on average, have relatively high ROE and proportion of capital in assets, and have low proportions of cost, operating expense and total loan in assets. It is interesting to note that these DMUs also have high non-interest expense to assets ratio and credit risk. DMUs with low cost efficiency and profit have relatively high liquidity risk (average loan to assets of over 80%) and are conceivably less prudent since mean capital to assets ratio is relatively lower than the others.

[12] These are Citibank (1990, 1991, 1997), HSBC (1991, 1994, 1995, 1996) and Bank of America (1992).
[13] These are Exim Bank (1994, 1997), GSB (1996), GHB (1997), BAAC (1996, 1997), and IFCT (1997). These institutions are operating under specific government policies and not profit-oriented.

7.7 Second stage regression results and their implementations for the effects of financial deregulation

This section investigates the main issue addressed in this study, i.e. whether financial deregulation leads to an improvement in bank efficiency. The analyses of Tobit, stochastic frontier, and OLS regression results are expected to provide the meaningful conclusions.

There are two parts of the regression analysis. The dependent variables in the first part are respectively the technical, allocative and cost efficiencies calculated in the first-stage VRS DEA analysis. The second part uses technical efficiency and its modified score from the CRS grand frontier as dependent variables.

The regressors in both parts include explanatory variables similar to those used in previous studies, for example, Kaparakis *et al.* (1990), Mester (1993 and 1996) Elyasiani *et al.* (1994), Molyneux *et al.* (1996), Berger and Mester (1997), Bhattacharyya *et al.* (1997), and Bauer *et al.* (1998). There are five bank-specific variables: return on assets (ROA), total cost to total assets (TCTA), equity to total assets (EQTA) loan loss reserve to total loans (LLRTL) and total loan to total assets (TLTA). We also include bank type dummies (D1=1 for Thai banks and D2=1 for foreign banks) and time dummies (TD91-TD97) to account for differences in bank types and changes in financial regulation.

We have seen in Chapter 6 that these variables are not highly correlated with each other and with bank input and output variables used in the first-stage DEA analysis. *A priori* the coefficients of ROA and EQTA are expected to be positively related to the relative efficiencies as higher profits and capital adequacy of banks are expected to improve efficiency. Meanwhile, the coefficients of TCTA, TLTA and LLRTL are expected to be negatively related to efficiency.

7.7.1 Regression analysis of the relative efficiencies from the VRS grand frontier

This section examines the impact of financial deregulation using relative efficiencies from the first-stage VRS grand frontier as dependent variables. The discussion of the second-stage regression analysis will be focused mainly on the model estimated for cost efficiency, as suggested by Elyasiani *et al.* (1994). This is because cost efficiency is equal to the product of allocative efficiency and technical efficiency (see, Chapter 6).

Table 7.28 Tobit regression results

Explanatory variable	Technical efficiency		Allocative efficiency		Cost efficiency	
	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
Intercept	0.681	4.925**	0.620	6.700**	0.436	3.606**
ROA	2.732	3.310**	1.864	3.354**	3.321	4.560**
TCTA	-0.307	-1.881	0.335	3.031**	-0.212	-1.459
EQTA	0.376	3.383**	0.078	1.062	0.288	2.987**
LLRTL	-0.587	-2.303*	0.492	2.831**	-0.032	-0.141
TLTA	-0.700	-4.522**	-0.057	-0.552	-0.482	-3.570**
D1	0.232	6.822**	0.225	9.748**	0.257	8.500**
D2	0.228	5.247**	-0.046	-1.570	0.087	2.276*
TD91	0.039	0.624	-0.040	-0.934	0.017	0.306
TD92	0.022	0.359	-0.004	-0.107	0.008	0.146
TD93	0.008	0.130	-0.016	-0.399	-0.010	-0.197
TD94	0.037	0.623	0.014	0.352	0.022	0.411
TD95	0.065	1.097	0.011	0.280	0.045	0.854
TD96	0.117	1.935	0.040	0.988	0.100	1.867
TD97	0.297	4.284**	0.086	1.845	0.268	4.376**
R^2 adjusted †	0.3233		0.2665		0.3012	
$F_{14,364}$†	13.90**		10.81**		12.64**	

Notes: (**) and (*) indicates significant different from zero at the 1% and 5% level (two-tailed test). (†) F-test and R^2 adjusted are calculated from the OLS regression.

Table 7.28 shows the results of the Tobit regressions. As expected, ROA and the ratio of equity to total assets are positively correlated with cost efficiency. Also, the ratio of total loan to total assets is negatively correlated with cost efficiency. The results also suggest that cost efficiency of Thai and foreign banks, on average, are significantly different from that of FSIs. There is also a statistically significant relationship between cost efficiency and TD97, suggesting that changes in financial regulation, which led to greater competition in 1997, had a positive effect on bank efficiency[14]. The adjusted R^2

[14] It must be noted that the Thai banking crisis took place at the end of 1997 and therefore, the problem did not emerge in the 1997 accounts. As indicated by Kazmin (2000), bad loans peaked at 47.7% of total lending in May 1999. Another possible explanation for this result is that there was a reduction in input use (employees), while output continued to increase (see Chapter6, Section 6.1.1).

suggests that about 30% of the variation of measured cost efficiency is explained by these factors.

Table 7.29 Stochastic frontier regression results

Explanatory variable	Technical efficiency		Allocative efficiency		Cost efficiency	
	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
Intercept	0.633	3.636**	0.941	13.872**	0.422	1.719
ROA	2.689	3.664**	1.202	2.759**	3.230	6.679**
TCTA	-0.294	-1.916	0.244	2.394*	-0.201	-1.454
EQTA	0.302	2.989**	0.101	1.697	0.263	2.869**
LLRTL	-0.580	-2.432*	0.264	1.740	-0.058	-0.274
TLTA	-0.639	-4.544**	-0.167	-2.407*	-0.466	-3.644**
D1	0.229	7.229**	0.143	5.473**	0.256	8.949**
D2	0.236	5.718**	-0.038	-1.422	0.094	2.556*
TD91	0.043	0.716	-0.030	-0.864	0.020	0.363
TD92	0.026	0.450	0.027	0.761	0.010	0.199
TD93	0.013	0.234	0.007	0.197	-0.007	-0.138
TD94	0.041	0.732	0.026	0.788	0.027	0.531
TD95	0.074	1.330	0.008	0.250	0.050	0.971
TD96	0.119	2.094*	0.044	1.288	0.103	1.988*
TD97	0.283	4.377**	0.091	2.337*	0.259	4.654**
σ -squared	0.058		0.069		0.047	
Gamma	0.000		0.928		0.000	
LR test	***		27.810		***	
Observations	379		379		379	

Notes: (**) and (*) indicates significant different from zero at the 1% and 5% level (two-tailed test). (***) indicates the values of likelihood ratio is less than that obtained using OLS regression.

Table 7.29 shows the results of the stochastic frontier regressions. As for the Tobit regression, cost efficiency is positively related to ROA and equity to assets ratio, but negatively correlated with the ratio of total loan to total assets and there is a statistically significant difference in relative efficiencies of Thai and foreign banks from the FSIs. Table 7.29 also indicates that cost efficiency improved overall in 1996 and 1997 compared with 1990, *ceteris paribus*, but not in the previous years. Here, there is a slight difference from the Tobit regression results which did not show statistical significance for the 1996 time dummy[15].

Table 7.29 also shows the likelihood ratio test for one-sided error term, which suggests that, the null hypothesis of $\lambda=0$ cannot be rejected for the models of technical and cost efficiencies. This implies that there is no one-sided error or random part of the calculated efficiency variation. Thus, $e_i = v_i$, a two-sided error term or systematic

[15] This is using a two-sided test. Using a one-sided test in which the hypothesised alternative is coefficient greater than zero, the Tobit regression also support that mean cost and technical efficiency improved in 1996 from their 1990 levels.

component which captures the effect of environmental variables. The results suggest that these models are better estimated by using OLS regression that simply assumes a normal distribution for the error term.

Table 7.30 Regression analysis of cost efficiency: Tobit, stochastic frontier and OLS

Explanatory variable	TOBIT		STOCHASTIC FRONTIER		OLS	
	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
Intercept	0.436	3.606**	0.422	1.719	0.422	3.57**
ROA	3.321	4.560**	3.230	6.679**	3.230	4.49**
TCTA	-0.212	-1.459	-0.201	-1.454	-0.201	-1.40
EQTA	0.288	2.987**	0.263	2.869**	0.263	2.79**
LLRTL	-0.032	-0.141	-0.058	-0.274	-0.058	-0.26
TLTA	-0.482	-3.570**	-0.466	-3.644**	-0.466	-3.53**
D1	0.257	8.500**	0.256	8.949**	0.256	8.58**
D2	0.087	2.276*	0.094	2.556*	0.094	2.49*
TD91	0.017	0.306	0.020	0.363	0.020	0.36
TD92	0.008	0.146	0.010	0.199	0.010	0.19
TD93	-0.010	-0.197	-0.007	-0.138	-0.007	-0.14
TD94	0.022	0.411	0.027	0.531	0.027	0.52
TD95	0.045	0.854	0.050	0.971	0.050	0.95
TD96	0.100	1.867	0.103	1.988*	0.103	1.95
TD97	0.268	4.376**	0.259	4.654**	0.259	4.31**
R^2 adjusted	0.3012		-		0.3010	
Observations	379		379		379	

Notes: (**) and (*) indicates significant different from zero at the 1% and 5% level (two-tailed test).

Table 7.30 compares the regression results from the three models: OLS, Tobit, and stochastic frontier. OLS regression is conducted in order to examine whether the results are different from using the stochastic frontier model that assumed a two-sided error term[16]. It appears that the three different models do not alter the results appreciably.

The results indicate that first, cost efficiency is positively correlated with returns on assets. The relationship is statistically significant at 1% level, suggesting that more profitable banks tend to achieve higher cost efficiency. This result is consistent with Mester (1993) who found a negative relationship between ROA and inefficiency for mutual S&Ls.

Second, the ratio of equity to assets has a positive and statistically significant relationship with cost efficiency. This is consistent with the view that banks become more efficient as their safety and soundness improve. A possible explanation of this

[16] The only differences between the stochastic frontier and OLS regressions are small differences in the estimated T-ratio.

result is the tightening in capital requirements since the application of the Basle standard on capital adequacy in 1993. This finding is consistent with Mester (1996), who found a negative correlation between the capital to assets ratio and inefficiency for a sample of 1991-92 data of 214 US banks.

Third, a higher proportion of loans in total assets is significantly related to lower cost efficiency. This suggests that an expansion in lending activities created by financial deregulation has not improved cost efficiency, all other things being equal. It implies that banks with higher proportion of loans in assets had higher costs of inputs to generate a given level of outputs. This result differs from Elyasiani *et al.* (1994), who reported a positive relationship between consumer loans to assets ratio and cost efficiency.

Fourth, there is a significant difference, on average, in cost efficiency of Thai and of foreign banks from that of the FSIs. This supports the non-parametric Kruskal-Wallis test that relative efficiencies of Thai and foreign banks and FSIs are significantly different. The positive sign of coefficients suggest that average cost efficiency of Thai and foreign banks are higher than the FSIs.

Finally, average cost efficiency is significantly higher in 1997, compared to 1990, in all 3 models. However, the other years' dummies are not significant (except for TD96 in stochastic frontier regression). This provides rather mixed evidence for the effect of liberalisation and deregulation, as this result is partly due to the effect of foreign bank entry in 1997.

Table 7.30 also shows negative coefficients of TCTA and LLRTL but the results are not significantly different from zero using a two-sided test. There is very weak evidence that banks with higher expenses are lower cost efficient, all other things being equal[17].

It is interesting to ask whether mean relative efficiencies of Thai and foreign banks are different, all other things being equal. This can be examined by testing a hypothesis about coefficients of bank type dummies from Tobit regression using the likelihood ratio test statistic[18]. We estimate first, the restricted model where bank type

[17] If a one-sided test is used (Ho: $\beta = 0$ vs $H_1 < 0$), then the coefficient of TCTA is significant at the 10% level.

[18] The likelihood ratio statistic is $\lambda = -2(\ln L_r - \ln L_u)$ where L_r and L_u are respectively the log likelihood for restricted and unrestricted models (see, Greene, 1997).

dummy equals 1 if the DMU is either a Thai or a foreign bank and second, the unrestricted model (results shown in Table 7.31) in which the differences of Thai and foreign banks' efficiencies from the FSIs are accounted for. The null hypothesis is that the mean efficiencies of Thai and foreign banks are equal (no significant difference between the coefficients of the Thai and foreign bank dummies in the unrestricted regression).

Table 7.31 Likelihood ratio test of difference between Thai and foreign banks' relative efficiencies

Model	Log likelihood for restricted model	Log likelihood for unrestricted model	Likelihood ratio statistic	Decision
Technical efficiency	-37.0524	-37.0459	0.0130	Cannot reject Ho
Allocative efficiency	75.5288	114.5353	78.0130	Reject Ho
Cost efficiency	1.1123	10.7190	19.2134	Reject Ho

Note: the 1% critical value from the chi-squared distribution with 1 degree of freedom is 6.6349

Table 7.31 shows that the likelihood ratio test statistic on technical efficiency is lower than the critical value and therefore, we cannot reject the null hypothesis of homogeneity between Thai and foreign banks' technical efficiency. On the other hand, allocative and cost efficiencies of Thai and foreign banks are different. We reject the null hypothesis at 1% level of significance.

Next, it is important to investigate whether there is heteroscedasticity in the data, since there might be a relationship between the explanatory variables and the error variance. Table 7.32 reports OLS results corrected for heteroscedasticity.

Table 7.32 OLS regression with heteroscedasticity test

Explanatory variable	Technical efficiency		Allocative efficiency		Cost efficiency	
	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
Intercept	0.633	4.135**	0.607	4.679**	0.422	2.161*
ROA	2.689	3.392**	1.750	3.317**	3.230	4.029**
TCTA	-0.294	-3.665**	0.346	2.370*	-0.201	-3.024**
EQTA	0.302	3.006**	0.060	0.660	0.263	2.617**
LLRTL	-0.580	-2.068*	0.445	2.332*	-0.058	-0.209
TLTA	-0.639	-3.617**	-0.043	-0.289	-0.466	-2.036*
D1	0.229	6.944**	0.223	10.916**	0.256	8.130**
D2	0.236	5.869**	-0.039	-1.230	0.094	3.150**
TD91	0.043	0.667	-0.036	-1.094	0.020	0.357
TD92	0.026	0.413	-0.001	-0.036	0.010	0.194
TD93	0.013	0.211	-0.011	-0.336	-0.007	-0.135
TD94	0.041	0.656	0.021	0.611	0.027	0.509
TD95	0.074	1.202	0.017	0.520	0.050	0.926
TD96	0.119	1.863	0.044	1.265	0.103	1.793
TD97	0.283	3.543**	0.080	1.758	0.259	3.410**
R^2 adjusted	0.3233		0.2666		0.3012	
BPG test	73.394**		65.757**		114.498**	
$F_{14,364}$	13.90**		10.81**		12.64**	

Notes: ** and * indicates significant different from zero at the 1% and 5% level (two-tailed test). BPG test (the Breusch-Pagan-Godfrey test) with 14 degrees of freedom.

The results shown in Table 7.32 are consistent with those in Tables 7.28, 7.29 and 7.30. Higher technical and cost efficiencies are strongly related to the changes in financial regulation in 1997. BPG tests reported in Table 7.32 confirm the presence of heteroscedasticity in data. One interesting difference is that the results in Table 7.32 now support the postulated relationship between technical (and cost) efficiency and TCTA, where there was only a weak support from the original results in Table 7.30.

It is also interesting to ask how much the estimates can be improved by using the seemingly unrelated regression model. It is assumed that the disturbance terms of technical, allocative and cost efficiency equations are uncorrelated, but the equations are related by their disturbances.

Table 7.33 Seemingly Unrelated regression results

Explanatory variable	Technical efficiency		Allocative efficiency		Cost efficiency	
	Coefficient	T-ratio	Coefficient	T-ratio	Coefficient	T-ratio
Intercept	0.633	4.918**	0.607	6.857**	0.422	3.644**
ROA	2.689	3.434**	1.750	3.250**	3.230	4.584**
TCTA	-0.294	-1.886	0.346	3.225**	-0.201	-1.432
EQTA	0.302	2.940**	0.060	0.846	0.263	2.843**
LLRTL	-0.580	-2.445*	0.445	2.727**	-0.058	-0.270
TLTA	-0.639	-4.448**	-0.043	-0.440	-0.466	-3.606**
D1	0.229	7.048**	0.223	9.993**	0.256	8.751**
D2	0.236	5.707**	-0.039	-1.360	0.094	2.542*
TD91	0.043	0.711	-0.036	-0.869	0.020	0.362
TD92	0.026	0.444	-0.001	-0.032	0.010	0.198
TD93	0.013	0.231	-0.011	-0.290	-0.007	-0.138
TD94	0.041	0.723	0.021	0.535	0.027	0.530
TD95	0.074	1.310	0.017	0.440	0.050	0.973
TD96	0.119	2.078*	0.044	1.112	0.103	1.990*
TD97	0.283	4.325**	0.080	1.772	0.259	4.397**
R^2 adjusted	0.3233		0.2666		0.3012	
$F_{14,384}$	13.90**		10.81**		12.64**	

Notes: (**) and (*) indicates significant different from zero at the 1% and 5% level (two-tailed test).

Table 7.33 shows that the results of the significance tests are similar to those of Tobit and stochastic frontier regressions. The t-statistics from the seemingly unrelated regression are higher than those from the Tobit regression but generally lower than those from stochastic frontier regression.

7.7.2 Supplementary regression analysis of technical efficiency

This section explores further the impact of financial deregulation on technical efficiency. We use two different dependent variables. The first is the original technical efficiency from the VRS (variable returns to scale) grand frontier (as before) and the second is the adjusted technical efficiency that took into account radial inefficiency and input slacks (see section 7.2).

Table 7.34 Regression analysis of VRSTE and adjusted technical efficiency

Explanatory variable	VRS technical efficiency		Modified technical efficiency	
	Coefficient	T-ratio	Coefficient	T-ratio
Intercept	0.633	4.82**	0.529	3.77**
ROA	2.689	3.37**	2.733	3.20**
TCTA	-0.294	-1.85	-0.244	-1.43
EQTA	0.303	2.88**	0.458	4.08**
LLRTL	-0.580	-2.40*	-0.543	-2.10*
TLTA	-0.639	-4.36**	-0.699	-4.47**
D1	0.229	6.91**	0.242	6.81**
D2	0.236	5.59**	0.151	3.35**
TD91	0.043	0.70	0.031	0.47
TD92	0.026	0.44	0.018	0.28
TD93	0.013	0.23	0.006	0.09
TD94	0.041	0.71	0.021	0.35
TD95	0.074	1.28	0.043	0.70
TD96	0.119	2.04*	0.091	1.46
TD97	0.283	4.24**	0.257	3.61**
R^2 adjusted	0.323		0.292	
$F_{14,378}$	13.9**		12.11**	

Notes: ** and * indicates significant different from zero at the 1% and 5% level (two-tailed test).

Table 7.34 shows similar results between VRS and adjusted technical efficiencies, with the exception of TD96. It appears that the associated t-ratios are slightly lower when using the adjusted technical efficiency as dependent variable. For both models, ROA, capital adequacy ratio and changes in financial regulation in 1997 are positively and significantly related to technical efficiency. Thai and foreign banks' average technical efficiencies are different from that of the FSIs. The coefficients of LLRTL and TLTA are negative and statistically significant, which suggest that higher proportions of loan loss reserve to total loans and loan to assets associated with lower technical efficiency on average.

Overall, we observe that the results using adjusted technical efficiency as dependent variable are similar to those from VRS grand frontier.

7.8 Conclusion

This chapter examined whether there has been an improvement of productive efficiency in the Thai banking market during the 1990-97 financial deregulation. The two-stage approach was applied, where relative efficiencies were estimated in the first-stage using the grand frontier DEA analysis, while correlation and regression analysis were used in the second-stage to explain the impact of financial deregulation.

In the first-stage DEA analysis, we found that foreign banks had the highest average technical efficiency, while Thai banks had highest average allocative and cost efficiencies. Most of the efficient DMUs, however, are foreign banks. The 1997 financial crisis did not seem to have an impact on average relative efficiencies. There was evidence to suggest that financial deregulation increased the variability of relative efficiencies.

The decomposition of cost efficiency indicates that Thai banks were better at optimising input mix but not input uses. Meanwhile, cost efficiency of foreign banks is attributed to both technical and allocative efficiencies, and the poor performance of FSIs was due to overutilisation of inputs.

A further investigation of allocative disefficiency indicates that Thai banks had higher proportions of fixed assets and employees to purchased funds than optimal, on average, while the opposite was found for foreign banks and FSIs. This reflects the impact of deregulation measures such as the abolition of bond holding requirements for new branches of Thai banks, which in effect increases the use of fixed assets and employees. We found that this overutilisation resulted in technical inefficiency of Thai banks. An investigation of the grand frontier with and without DMUs of foreign banks and FSIs indicates that Thai banks, on average reduced their inefficient use of employees, but inefficient use of fixed assets increased during 1990-97 period.

On the relationship between bank size and relative efficiencies, there was strong evidence to suggest that Thai large banks are more efficient than Thai small banks. On the other hand, we found a U-shaped relationship between asset size and relative efficiencies of foreign banks and FSIs where efficiencies of small DMUs are largely dispersed and large DMUs are highly efficient. The results showed that the efficient frontier was determined by not only Thai large banks but also foreign tiny banks.

The impact of financial deregulation was apparent in 1997, when there was the greatest number of efficient DMUs. The majority are foreign banks, whose asset sizes range from 1.4 to 134 billion baht. We found that not all efficient DMUs are scale efficient. DMUs of Thai banks were too big, some foreign banks were too small. An analysis of maximum productive scale size suggests that scale efficient banks should have assets between 16 and 134 billion baht, depending on their mix of inputs and outputs.

The diagnostic analysis shows that our relative efficiencies are not too badly affected by influential observations, although there are two 1997 foreign banks with abnormally low funds ratios. We found a weak, but significant, association between cost efficiency and financial ratios, which suggests that our results are broadly consistent with financial ratio analysis. The relationship was confirmed by profitability tests, where we also found that about 28% of DMUs did well on both cost efficiency and profitability and most of them are foreign banks.

Finally, results of the regression analysis strongly support that first, profitability as measured by ROA is positively related to all three efficiency measures. Second, technical and cost efficiencies are positively related to financial strength as measured by equity to assets ratio and third, asset quality as measured by the ratio of loan loss reserve to total loans is positively related to technical efficiency. Third, mean efficiencies of Thai and foreign banks are greater than those of FSIs, all other things being equal. Fourth, regression results indicate a significant improvement of technical and cost efficiencies in 1997, which was 7 years after financial deregulation was initiated. All these results may be considered robust since they were evident in all the regression models.

There was also some evidence from the regressions that cost and technical efficiencies are negatively related to the ratio of total cost to total assets, and that the mean cost and allocative efficiencies of Thai and foreign banks are different, all other things being equal. Some regressions showed a significant improvement in efficiencies in 1996 as well as 1997.

Chapter 8 Productivity Change in Thai Banking

INTRODUCTION

This chapter examines the productivity change of 15 Thai and 14 foreign banks, representing over 50% of industry assets, during 1990-97. The aim is to examine whether financial deregulation has improved the productivity of commercial banks.

We use the nonparametric DEA technique, explained in Chapters 4 and 6, to measure total factor productivity change and to decompose this into technological change and, technical efficiency change. The latter change in efficiency is also decomposed into pure technical efficiency change and scale efficiency change. This chapter explores first, the productivity indices of Thai and foreign banks. Section 2 examines the relationship between bank size and productivity change. Section 3 investigates alternative measures of productivity changes. Section 4 analyses the impact of financial deregulation on productivity change and section 5 concludes.

8.1 Exploratory analysis of Malmquist productivity index and its components

This section examines the total factor productivity change (tfpch) of Thai and foreign banks during the 1990 to 1997 period. Productivity change from one year to the next is measured by the Malmquist input-based productivity index. A value greater than unity indicates an improvement, while a value less than unity suggests a decline, and a value equal to one indicates that productivity is unchanged.

First, the Malmquist productivity index is decomposed into technical efficiency change (the catching up effect) and technological change (the frontier shift effect).

Second, technical efficiency change (effch) is decomposed into pure technical efficiency change (pech) and scale efficiency change (sech). A significant increase or decrease of average productivity indices is evaluated by the nonparametric sign tests of the medians, and by the construction of confidence intervals for the geometric means, using a bootstrap procedure with 1000 replications[1].

8.1.1 Decomposition of Malmquist productivity indices

Table 8.1 shows that mean total factor productivity (TFP) of Thai banks significantly increased by 2% in 1991/92. However, in all the other years there was either no significant change in mean productivity, or a significant decline (in 1992/93). Overall, Thai banks experienced no net change in average productivity over the period. The 25% technological progress was offset by the 20% decline in technical efficiency during 1990-97. Appendix XI shows that only 5 out of 15 Thai banks had mean values of TFP greater than one, over the seven year period.

Table 8.1 shows that foreign banks had higher mean values of TFP except in 1991/92. Mean TFP of the foreign banks significantly increased in 1992/93 (11%) and 1994/95 (21%). Over the 1990-97 period, the mean TFP of foreign banks significantly increased by 8% due to technological progress (16%) which offset the average decline in technical efficiency of 8%. With the exception of Sime Bank Berhad, all foreign banks experienced TFP improvement over the period[2], as shown in Appendix XI.

Both Thai and foreign banks have their highest mean values of technological change in 1993/94, 77% and 30% respectively. This reflects a substantial outwards shift in the production frontier; more output (loans and earning assets) could be produced using the same inputs. This is attributable to the introduction of new banking activities such as offshore banking (BIBF) and credit cards. When all banks are considered, technological progress was more important than efficiency gains in explaining the growth in productivity. Table 8.1 shows that the mean annual productivity of all banks

[1] The macro commands for bootstrapping were constructed by Z.M. Brown.

[2] This result, however, should be treated with caution because the DMUs of Sime Bank Berhad are influential (see Chapter 7).

significantly increased by 3.6%, which was due to mean technological progress of 21% per year, offsetting a mean annual decline of 14% in efficiency change.

Table 8.1 The Malmquist productivity index and its components

Period	Category	Total Productivity change	Efficiency change	Technological change
1990/91	Thai banks	1.021	0.831*†	1.228*†
	Foreign banks	1.052	0.944†	1.115*†
	All banks	1.036	0.884*†	1.172*†
1991/92	Thai banks	1.023†	1.011	1.012*†
	Foreign banks	0.993	1.001	0.992
	All banks	1.009	1.006	1.002*
1992/93	Thai banks	0.932*	0.819*†	1.138*†
	Foreign banks	1.112†	0.984	1.131†
	All banks	1.015	0.895*†	1.134*†
1993/94	Thai banks	0.988	0.557*†	1.775*†
	Foreign banks	1.104	0.847†	1.304*†
	All banks	1.042	0.682*†	1.529*†
1994/95	Thai banks	1.020	0.848*†	1.203*†
	Foreign banks	1.209†	0.994	1.217*†
	All banks	1.107*	0.915*†	1.210*†
1995/96	Thai banks	1.011	0.820*†	1.233*†
	Foreign banks	1.030	0.928	1.111
	All banks	1.020	0.871*†	1.172*†
1996/97	Thai banks	1.000	0.785*†	1.274*†
	Foreign banks	1.048	0.801†	1.309*†
	All banks	1.023	0.793*†	1.291*†
7-years	Thai banks	0.999	0.800*†	1.249*†
	Foreign banks	1.077*†	0.925*†	1.163*†
	All banks	1.036†	0.858*†	1.207*†

Notes: The change for each category relates to the geometric mean for 15 Thai banks and 14 foreign banks. (*) indicates median is significantly different from unity at the 5% level. (†) indicates geometric means are significantly different from unity at the 5% level.
Source: author's own calculations.

Table 8.2 which is derived from Table 8.1 shows that the cumulative TFP of Thai banks has not changed significantly, except in 1992 when productivity increased by 4.5% from 1990, and in 1994 when cumulative productivity decreased by 4% from the 1990 level. Note that the ceiling on all lending rates was abolished in 1992, when the median cumulative TFP of Thai banks was significantly greater than one, suggesting that this change had a positive effect. On the other hand, foreign banks achieved a much higher cumulative TFP, which rose steadily to 68% in 1997. Both Thai and foreign banks' productivity increases were mainly due to technological progress or the outward shift of the frontier, as we saw in Table 8.1, which was significant throughout the period. It is notable that Thai banks, on average, achieved higher technological change than foreign banks over the 7 years, but their poor TFP was due to a cumulative efficiency change that declined by almost 80% in 1997 relative to 1990.

Table 8.2 Cumulative indices of the Malmquist productivity index and its components

Period	Category	Total Productivity change	Efficiency change	Technological change
1990/91	Thai banks	1.021	0.831*†	1.228*†
	Foreign banks	1.052	0.944†	1.115*†
	All banks	1.036	0.884*†	1.172*†
1990/92	Thai banks	1.045*†	0.840*†	1.243*†
	Foreign banks	1.045	0.945†	1.106†
	All banks	1.045*	0.889*†	1.175*†
1990/93	Thai banks	0.974	0.688*†	1.414*†
	Foreign banks	1.162†	0.929†	1.251*†
	All banks	1.061	0.796*†	1.333*†
1990/94	Thai banks	0.962*	0.383*†	2.511*†
	Foreign banks	1.283†	0.787*†	1.630*†
	All banks	1.106	0.542*†	2.038*†
1990/95	Thai banks	0.982	0.325*†	3.021*†
	Foreign banks	1.551†	0.782†	1.983*†
	All banks	1.224	0.496*†	2.466*†
1990/96	Thai banks	0.993	0.266*†	3.723*†
	Foreign banks	1.598*†	0.726*†	2.203*†
	All banks	1.249	0.432*†	2.890*†
1990/97	Thai banks	0.993	0.209*†	4.742*†
	Foreign banks	1.676*†	0.581*†	2.883*†
	All banks	1.278†	0.343*†	3.730*†

Notes: 1) The change for each category relates to the geometric mean of cumulative indices for 15 Thai banks and 14 foreign banks. (*) indicates median is significantly different from unity at the 5% level. (†) indicates geometric means are significantly different from unity at the 5% level.
2) Results are derived from Table 8.1.

During 1990-97, the decline in cumulative technical efficiency change was large and statistically significant. Table 8.2 reveals two substantial declines in cumulative efficiency in 1994 and 1997 relative to 1990. By 1994, Table 8.2 shows that mean cumulative technical efficiency of Thai banks had declined by 60%, while the average for foreign banks declined by about 20% relative to 1990. Subsequently, the mean cumulative efficiency change in 1997 of Thai banks was a fall of 80% relative to 1990, while that of foreign banks dropped by 40% relative to 1990. These decreases in the mean efficiency change index show that on average banks were further away from the new frontier than from the previous year's frontier. So although the frontier was shifting outwards each year, many banks were not able to maintain their positions relative to it.

Apppendix VII shows that there are 5 out of 15 Thai banks achieving TFP improvement in 1997 relative to 1990. These are BBL (30%), AYD (0.3%), BOA (24%), TDB (17%) and LTB (11%). At the same time, foreign banks, except for Sime Bank Berhad, attained much higher cumulative TFP. The highest cumulative TFP in 1990/97 is 490% for Chase Manhattan Bank, followed by Deutsche Bank (450%), and Bank of Tokyo (277%)[3]. When mean cumulative changes of all banks are considered, TFP in 1997 relative to 1990 increased by about 28%, although mean efficiency declined by 66%. This is largely due to huge technological progress at 373%.

Figure 8.1 Cumulative indices of Thai and foreign banks' productivity change

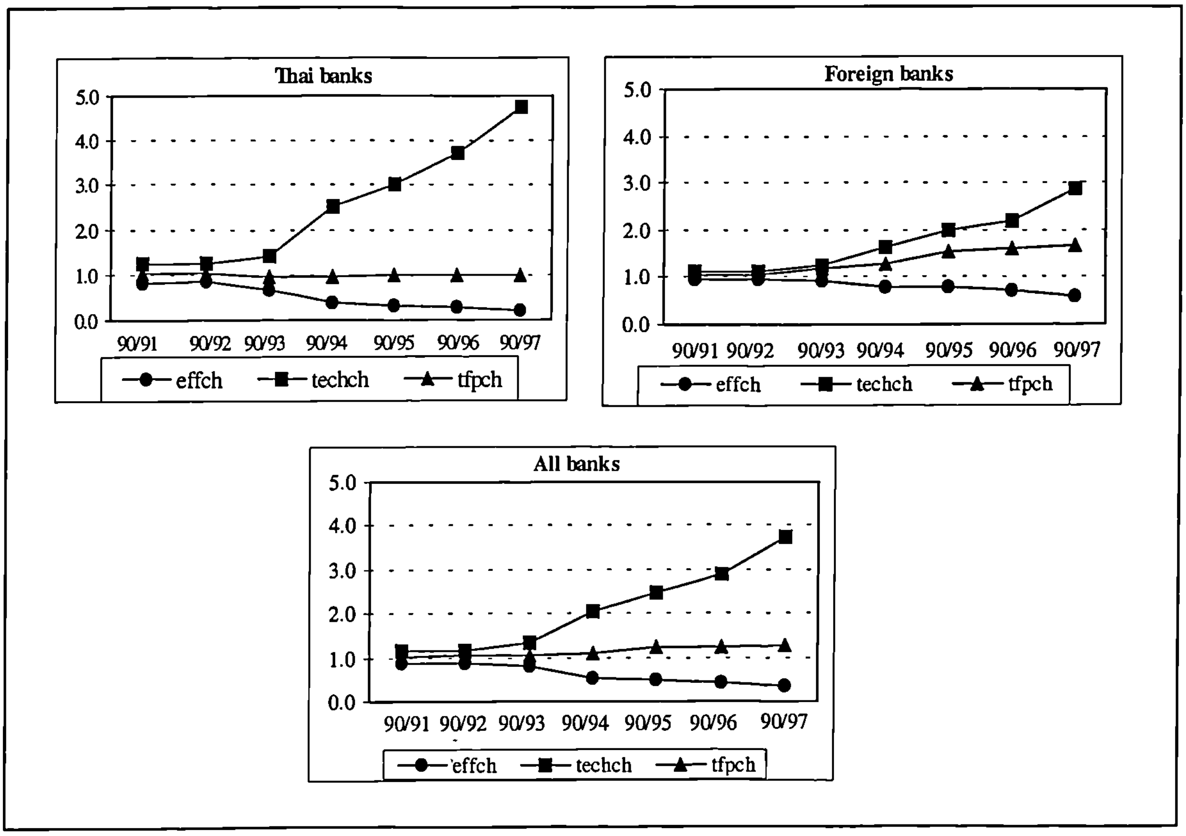


Figure 8.1 shows the results given in Table 8.2 in graphical form. They clearly indicate that productivity change of banks during 1990-97, on average, was mainly due to technological progress. Both Thai and foreign banks exhibit efficiency decline. On average, technological change of Thai banks was higher than that of foreign banks,

[3] These banks had a relatively large output to (all three) input ratio.

suggesting that Thai banks were more dynamic in the adoption of new technology, or more precisely, that they started from a lower base and so their achievable improvement was greater than for the foreign banks who entered the market with more advanced technology from their parent companies (head offices). It must be remembered that " technology" has to be interpreted as including marketing opportunities and not just the use of information technology.

Figure 8.2 Malmquist productivity indices for Thai and foreign banks, 1990-97

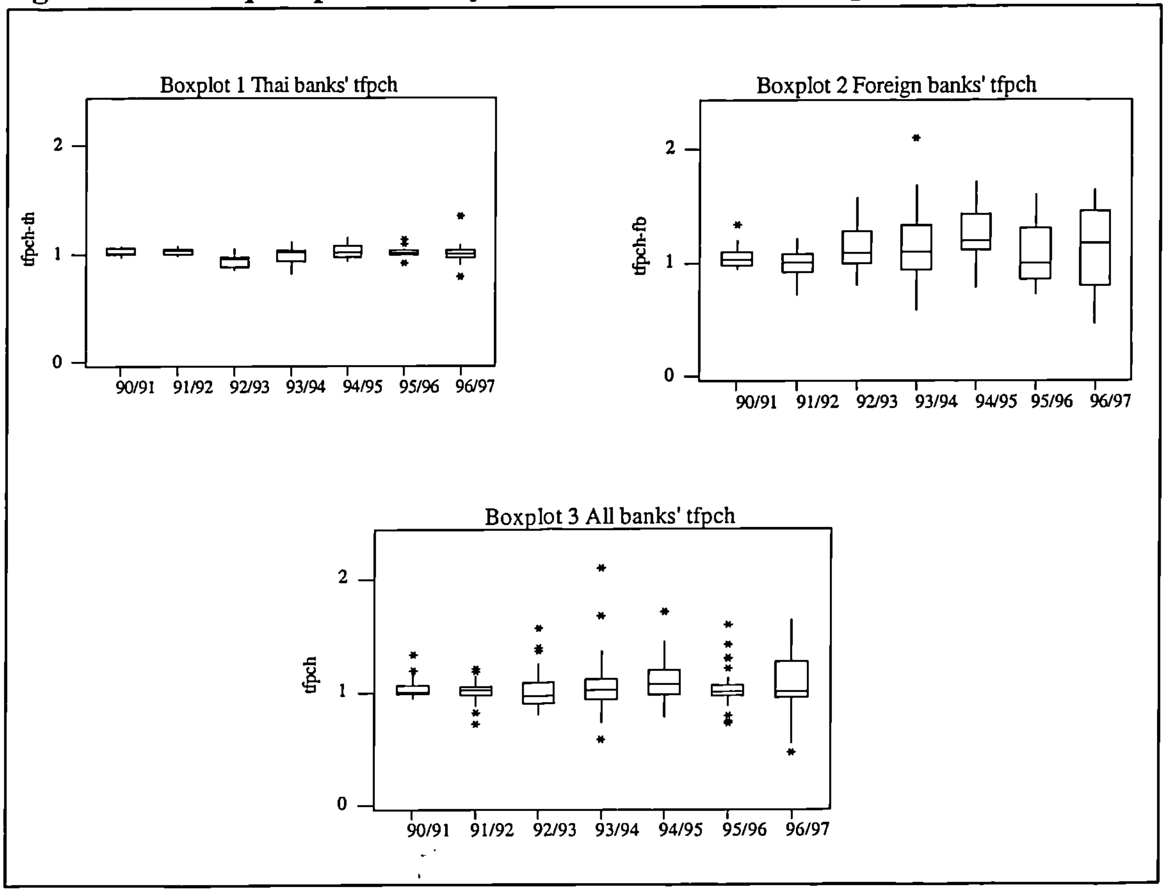


Figure 8.2 shows the distributions of total factor productivity (TFP) changes for Thai, foreign and all banks in the form of boxplots. It can be seen that there was little dispersion of TFP change of Thai banks, except in 1996/97. An outlier is identified in 1993/94; this is Bank of America with (apparently) over 100% increase in productivity[4]. In 1996/97, Bangkok bank exhibited the highest TFP change (34%), while TFP of

[4] The ratio of output to (all three) input of this bank increased by more than 100% from 1993 to 1994.

Bangkok Bank of Commerce declined by 29%. Foreign banks' TFP change have become more dispersed from 1992/93 to 1996/97. For all banks, the differences of TFP change were greater in 1996/97 compared to 1990/91. The plots reflect greater volatility brought about by financial deregulation. We saw in Chapter 7 (Section 7.1) when examining the dispersion of efficiency scores that "winners and losers" seemed to be emerging as deregulation took effect.

Figure 8.3 Technical efficiency change of Thai and foreign banks, 1990-97

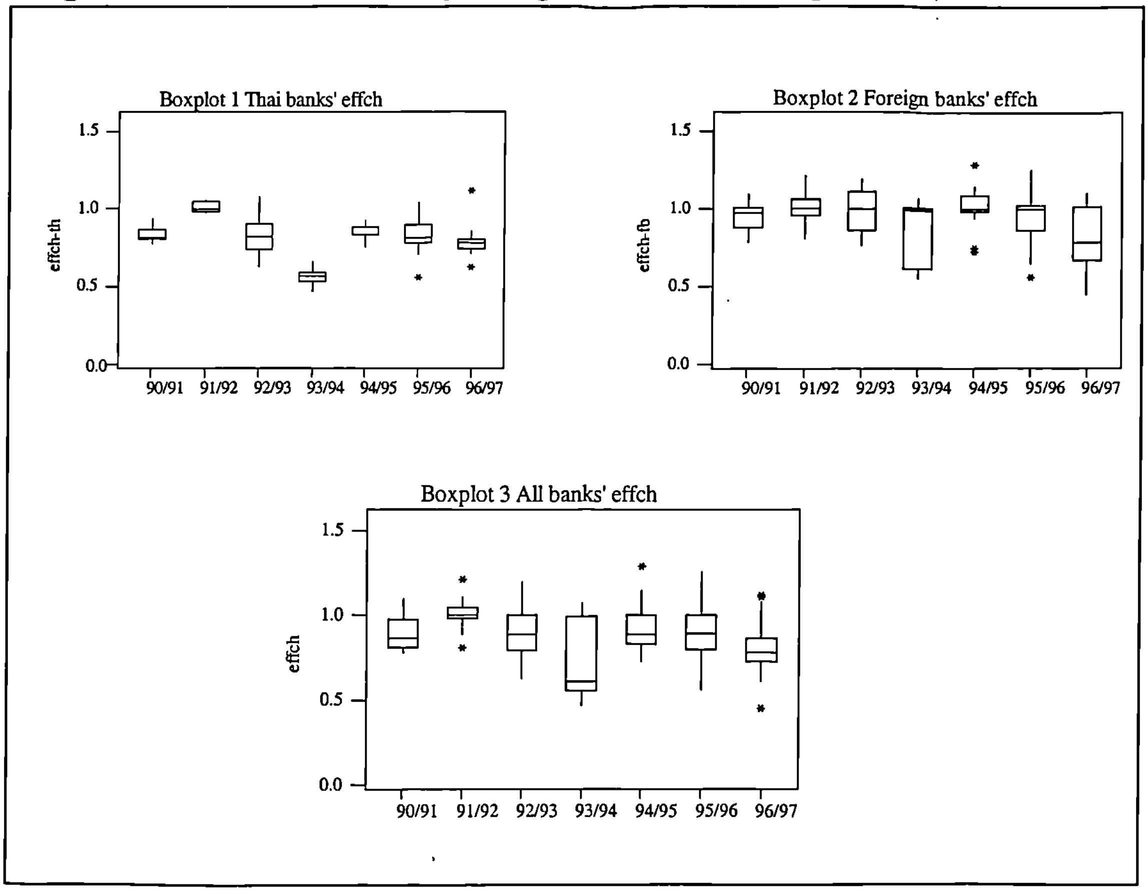
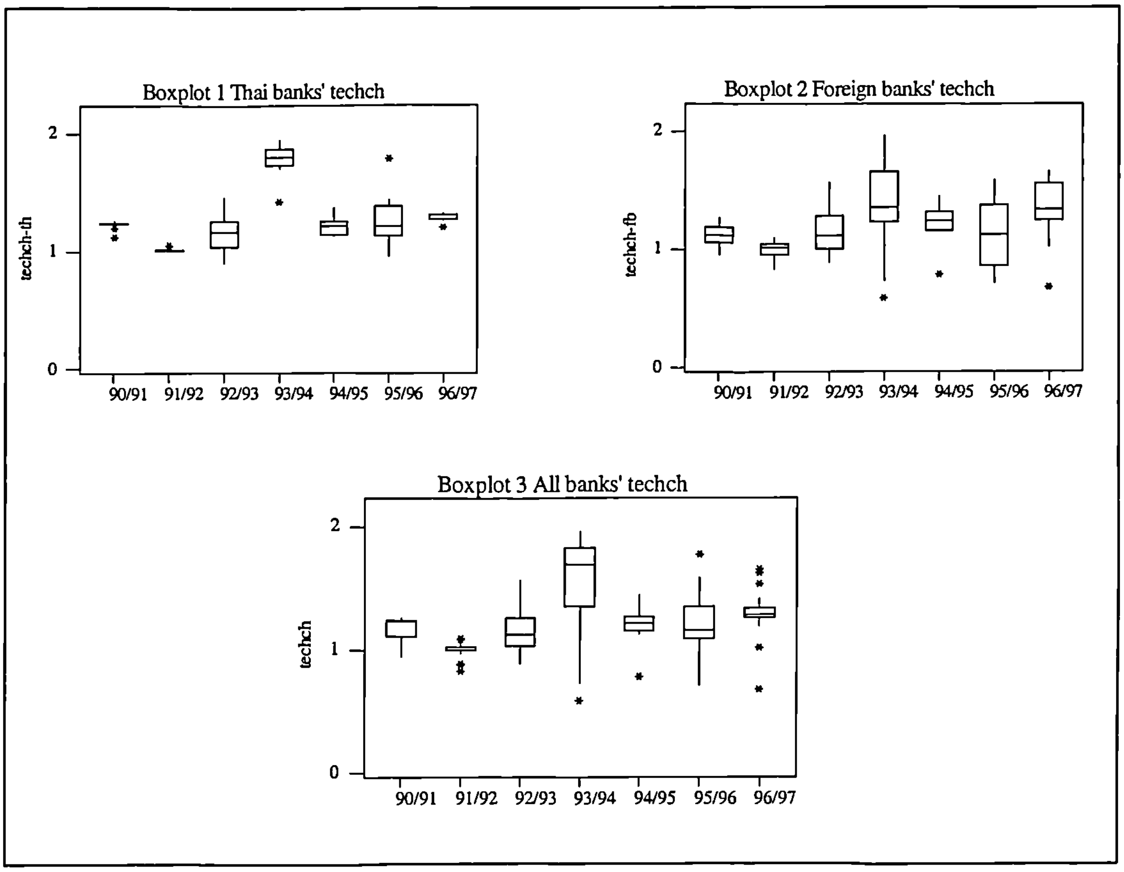


Figure 8.3 shows that the median efficiency change (EFFCH) of Thai banks fell markedly in 1993/94 and its dispersion, as indicated by the inter-quartile range, was largest in 1992/93 and 1995/96. Bangkok Bank experienced an efficiency increase (12%) in 1996/97, while other banks exhibited a decline[5]. Efficiency change of foreign banks, on the other hand, was more dispersed than Thai banks. There were especially

[5] Bangkok Bank had a relatively large increase in output to (all three) input ratio from 1996 to 1997.

large dispersions in 1992/93, 1993/94 and 1996/97. There was a large drop of median for efficiency change in 1996/97 because 8 out of 14 foreign banks had substantial efficiency decline (see, Appendix XI). For all banks, the plots show the largest dispersion in 1993/94.

Figure 8.4 Technological change of Thai and foreign banks, 1990-97



Technological change (TECHCH) reflects a shift of the production frontier. Figure 8.4 shows that the distribution of TECHCH of Thai banks has very little dispersion in 1990/91 and 1991/92, while greater variability is observed in 1992/93, 1993/94, 1994/95 and 1995/96. The highest median TECHCH was in 1993/94, when 12 out of 15 Thai banks achieved technological progress of more than 50% (see, Appendix XI). In Box 2, foreign bank' TECHCH was also less dispersed in 1990/91 and 1991/92, while there was a large variation in 1993/94 and 1995/96. There are 3 outliers in which technological regress is substantial: Sime Bank in 1993/94 (42%) and 1996/97 (33%) and Sakura Bank (22%) in 1994/95 (see, Appendix XI). The fact that these and other

DMUs, have technological change less than one in some years means that some parts of the frontier shifted *inwards*, radically, rather than *outwards*. For all banks, the plots show the highest median technological change in 1993/94, which was accompanied by the largest variability. As noted earlier, 1994 saw the introduction of new banking activities as a result of deregulation.

Overall, the findings in this section support the view that financial deregulation has improved the productivity of banks. Although different sample data are used, the conclusion reached here is consistent with Berg *et al.* (1992) and Gilbert and Wilson (1998) but contrary to Grifell-Tatjé and Lovell (1996). Berg et al. (1992) found that the productivity of Norwegian banks increased by 69.5% in 1989 relative to 1980, Gilbert and Wilson (1998) found the productivity of banks in Korea increased by 60% in 1994 relative to 1980, while we found that the cumulative productivity of Thai banks increased by about 28% in 1997 relative to 1990. In contrast, Grifell-Tatjé and Lovell (1996) found that the annual productivity of Spanish savings banks decreased by 5.5% on average during 1986-91. All comparisons, however, should be treated with caution as different production frontiers and definitions of input and output are used in these studies.

Further analysis provided evidence that productivity growth was largely due to progressive and continuing shifts in "technology" rather than improvements in technical efficiency. This is similar to the findings of Glass and Mckillop (2000) who investigated sources of productivity growth in UK building societies in the post deregulation period 1989-93. We found that foreign banks succeeded in achieving a remarkable response to the increasingly more competitive environment brought about by financial deregulation, although their average technological changes were less than Thai banks. The poor technical efficiency change of Thai banks as compared with foreign banks was also noteworthy. The figures show that productivity, efficiency and technological change became more dispersed following deregulation.

8.1.2 Decomposition of efficiency change

The further decomposition of the input-based Malmquist productivity index enables us to decompose efficiency change into changes in scale efficiency (SECH) and pure technical efficiency (PECH). This section examines the sources of relative technical efficiency change.

Table 8.3 Decomposition of the change in technical efficiency

Period	Category	Change in pure technical efficiency	Change in scale efficiency	Efficiency change
1990/91	Thai banks	1.006	0.826*†	0.831*†
	Foreign banks	1.000	0.944†	0.944†
	All banks	1.003	0.881*†	0.884*†
1991/92	Thai banks	1.005	1.007	1.011
	Foreign banks	0.989	1.013	1.001
	All banks	0.997	1.010	1.006
1992/93	Thai banks	0.989	0.828*†	0.819*†
	Foreign banks	1.011	0.973	0.984
	All banks	1.000	0.895*†	0.895*†
1993/94	Thai banks	0.882*†	0.631*†	0.557*†
	Foreign banks	0.892	0.949†	0.847†
	All banks	0.887*†	0.768*†	0.682*†
1994/95	Thai banks	1.012	0.838*†	0.848*†
	Foreign banks	1.045	0.951	0.994
	All banks	1.027†	0.891*†	0.915*†
1995/96	Thai banks	0.738*†	1.112	0.820*
	Foreign banks	0.917	1.012	0.928
	All banks	0.820*†	1.062	0.871*
1996/97	Thai banks	0.725*†	1.083	0.785*†
	Foreign banks	0.934	0.857†	0.801†
	All banks	0.820*†	0.967	0.793*†
7-years	Thai banks	0.900*†	0.889*†	0.800*†
	Foreign banks	0.968*	0.956†	0.925*†
	All banks	0.932*†	0.920*†	0.858*†

Notes: The change for each category relates to the geometric mean for 15 Thai banks and 14 foreign banks. (*) indicates median is significantly different from unity at the 5% level. (†) indicates geometric means are significantly different from unity at the 5% level.

Table 8.3 indicates that the mean changes in efficiency and its components were not significant in 1991/92. For Thai banks, average declines of efficiency in 1990/91, 1992/93, and 1994/95 were due to the significant decreases in scale efficiency, while the pure technical efficiency change in 1995/96 and 1996/97 caused the decline in mean efficiency. The largest efficiency decline (45%) was in 1993/94, when average PECH and SECH of Thai banks dropped by 12% and 37%, respectively. PECH of 2 banks (BBL and KTB) were static, while 3 banks (TDB, NKB and UBB) achieved scale efficiency gains (see Appendix XI). Over 7 years, Table 8.3 shows that the average efficiency change (20%) of Thai banks was due to a 10% decline in both pure technical efficiency and scale efficiency. Efficiency change of foreign banks was significant in 1990/91, 1992/93, 1993/94 and 1996/97. On average, foreign banks experienced a 7.5% decline in technical efficiency per year over 7 years, which was due to declines in both scale efficiency and pure technical efficiency[6]. Only Deutsche Bank achieved efficiency gains of 0.4% over the period. Note that both PECH and SECH of Sakura bank were static and therefore efficiency was unchanged (see Appendix XI).

Table 8.3 shows that an average 15% efficiency decline for all banks was due to downward changes in both pure technical efficiency and scale efficiency.

Table 8.4 Cumulative indices of technical efficiency change and its components

Period	Category	Change in pure technical efficiency	Change in scale efficiency	Efficiency change
1990/91	Thai banks	1.006	0.826*†	0.831*†
	Foreign banks	1.000	0.944†	0.944†
	All banks	1.000	0.881*†	0.884*†
1990/92	Thai banks	1.011	0.832*†	0.840*†
	Foreign banks	0.989	0.956†	0.945†
	All banks	0.999	0.889*†	0.889*†
1990/93	Thai banks	0.999	0.689*†	0.688*†
	Foreign banks	1.000	0.930*†	0.929†
	All banks	0.999†	0.796*†	0.796*†
1990/94	Thai banks	0.882†	0.434*†	0.383*†
	Foreign banks	0.892†	0.882*†	0.787*†
	All banks	0.888*†	0.611*†	0.542*†
1990/95	Thai banks	0.892†	0.364*†	0.325*†
	Foreign banks	0.932†	0.839†	0.782†
	All banks	0.911*†	0.545*†	0.496*†
1990/96	Thai banks	0.658*†	0.405*†	0.266*†
	Foreign banks	0.855	0.849*	0.726*
	All banks	0.747*†	0.579*†	0.432*†
1990/97	Thai banks	0.477*†	0.438*†	0.209*†
	Foreign banks	0.799†	0.727*†	0.581*†
	All banks	0.612*†	0.560*†	0.343*†

Notes: 1) The change for each category relates to the geometric mean of cumulative indices for 15 Thai banks and 14 foreign banks. (*) indicates median is statistically significant difference from unity at the 5% level. (†) indicates geometric means are significantly different from unity at the 5% level.
2) Results are derived from Table 8.3

[6] This is justified on the statistical tests shown in Table 8.3; the 7-year median of pure technical efficiency change and geometric mean of scale efficiency change are significantly different from unity at 5% level.

Table 8.4 shows that mean cumulative change in technical efficiency of Thai banks in 1997 relative to 1990 is 21% compared to 58% for foreign banks. This indicates that the mean efficiency of Thai banks declined by 79%, while foreign banks' efficiency dropped by 42% in 1997 compared to 1990. This is due to the significant changes in cumulative scale efficiency, which are observed for Thai and foreign banks throughout the period. Also, there was a significant decline in cumulative changes of pure technical efficiency from 1994 to 1997 compared to 1990, which made the overall efficiency change even worse.

Further investigation of cumulative indices of 15 Thai banks indicates that scale efficiency of 7 banks and pure technical efficiency of 6 banks declined by more than 70% in 1997 compared to 1990. At the same time, the cumulative efficiency changes of foreign banks can be partly explained by more than a 50% decline in cumulative scale efficiency change of 3 banks (Citibank, Bharat, ICBC) and 74% decrease in pure efficiency of HSBC in 1990/97 (see Appendix XII).

Overall results confirm the findings in Table 8.3. Only Deutsche Bank achieved cumulative efficiency gains of 2.9% in 1990/97.

Figure 8.5 Pure technical efficiency change of Thai and foreign banks, 1990-97

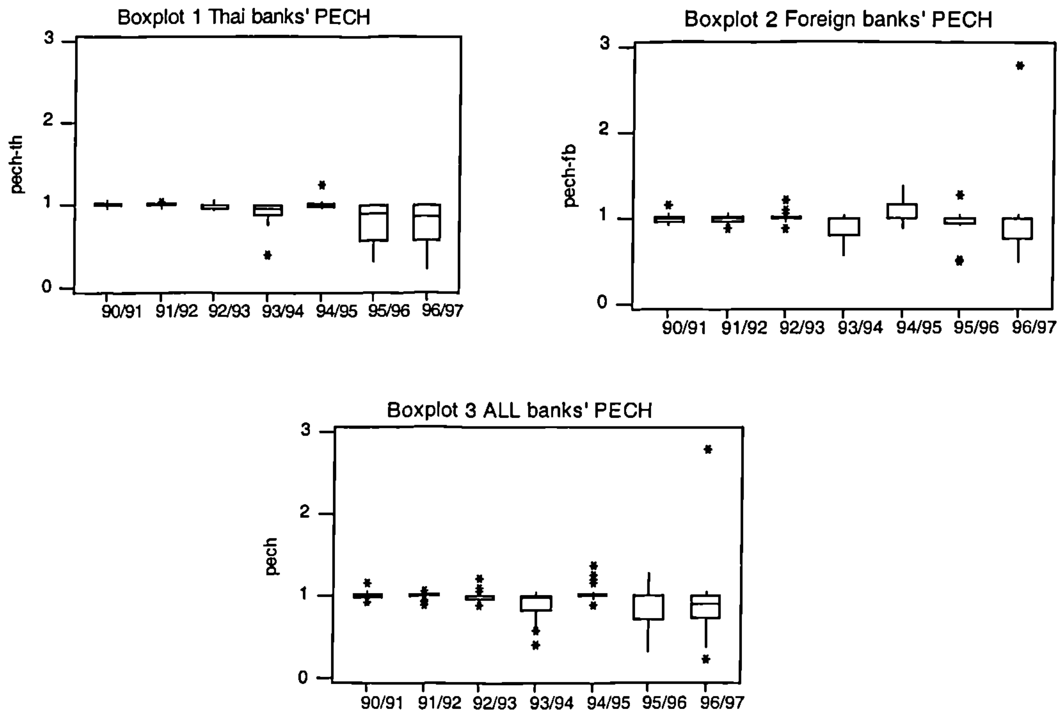


Figure 8.5 shows that there is hardly any dispersion of pure technical efficiency changes (PECH) of Thai and foreign banks in 1990/91, 1991/92 and 1992/93. A greater dispersion of PECH is observed in later periods, which again suggests the impact of financial deregulation. Citibank had the highest PECH at 270%, while PECH of BBC declined by 77% in 1996/97 (see Appendix XI).

Figure 8.6 Scale efficiency change of Thai and foreign banks, 1990-97

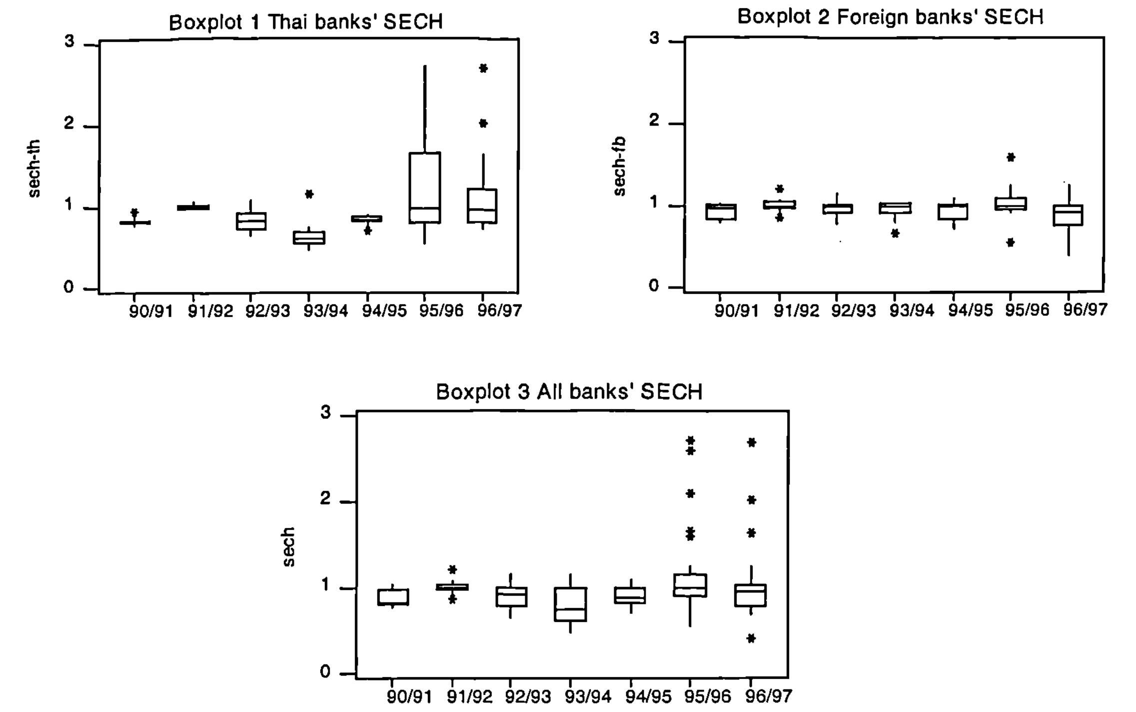


Figure 8.6 shows that scale efficiency changes (SECH) of Thai and foreign banks were tightly distributed during 1990 to 1995. The large variability of scale efficiency change (SECH) of Thai banks occurred in 1995/96 and 1996/97. There was a substantial increase in scale efficiency of over 200% for 3 banks (NKB, UBB and LTB) in 1995/96 and 2 banks (BBC and TDB) in 1996/97 (see Appendix XI). There are two noticeable SECH of foreign banks in 1995/96 where there was over 50% increase in SECH of Citibank, while OCBC experienced 45% scale efficiency decline[7]. Overall, the variability of SECH is apparent in 1995/96 and 1996/97.

Overall results in this section indicate that decline in efficiency is attributable to negative changes in both pure technical efficiency and scale efficiency. We also found greater variability for the composition of technical efficiency following financial deregulation.

[7] NKB, UBB, LTB and OCBC were getting larger, while BBC, TDB and Citibank became smaller.

8.1.3 Productivity change and bank ownership

This section investigates whether total factor productivity changes of Thai and foreign banks are different. Following Worthington (1999), we use the nonparametric Kruskal-Wallis (one-way analysis of variance) test to examine the null hypothesis of equality of medians.

Table 8.5 Kruskal-Wallis test of the Malmquist productivity index and its components

Category/period	Thai banks	Foreign banks	H-statistic	p-value	Hypothesis test
Productivity change					
1990/91	1.021	1.052	0.07	0.793	Cannot reject Ho
1991/92	1.023	0.993	0.37	0.541	Cannot reject Ho
1992/93	0.932	1.112	8.55	0.003	Reject Ho
1993/94	0.988	1.104	1.49	0.222	Cannot reject Ho
1994/95	1.020	1.209	7.80	0.005	Reject Ho
1995/96	1.011	1.030	0.12	0.727	Cannot reject Ho
1996/97	1.000	1.048	1.29	0.256	Cannot reject Ho
7-years	0.999	1.077	13.76	0.000	Reject Ho
Technological change					
1990/91	1.228	1.115	7.68	0.006	Reject Ho
1991/92	1.012	0.992	0.06	0.810	Cannot reject Ho
1992/93	1.138	1.131	0.02	0.896	Cannot reject Ho
1993/94	1.775	1.304	11.59	0.001	Reject Ho
1994/95	1.203	1.217	1.49	0.222	Cannot reject Ho
1995/96	1.233	1.111	1.01	0.315	Cannot reject Ho
1996/97	1.274	1.309	3.72	0.054	Cannot reject Ho
7-years	1.249	1.163	10.43	0.001	Reject Ho
Efficiency change					
1990/91	0.831	0.944	9.07	0.003	Reject Ho
1991/92	1.011	1.001	0.00	0.983	Cannot reject Ho
1992/93	0.819	0.984	8.07	0.005	Reject Ho
1993/94	0.557	0.847	14.29	0.000	Reject Ho
1994/95	0.848	0.994	10.81	0.001	Reject Ho
1995/96	0.820	0.928	4.79	0.029	Reject Ho
1996/97	0.785	0.801	0.06	0.810	Cannot reject Ho
7-years	0.800	0.925	20.61	0.000	Reject Ho
Pure Technical efficiency change					
1990/91	1.006	1.000	0.92	0.338	Cannot reject Ho
1991/92	1.005	0.989	0.10	0.751	Cannot reject Ho
1992/93	0.989	1.011	1.16	0.281	Cannot reject Ho
1993/94	0.882	0.892	0.64	0.423	Cannot reject Ho
1994/95	1.012	1.045	1.05	0.305	Cannot reject Ho
1995/96	0.738	0.917	5.76	0.016	Reject Ho
1996/97	0.725	0.934	3.46	0.063	Cannot reject Ho
7-years	0.900	0.968	5.57	0.018	Reject Ho
Scale efficiency change					
1990/91	0.826	0.944	11.45	0.001	Reject Ho
1991/92	1.007	1.013	0.37	0.541	Cannot reject Ho
1992/93	0.828	0.973	8.45	0.004	Reject Ho
1993/94	0.631	0.949	14.79	0.000	Reject Ho
1994/95	0.838	0.951	6.69	0.010	Reject Ho
1995/96	1.112	1.012	0.28	0.600	Cannot reject Ho
1996/97	1.083	0.857	1.49	0.222	Cannot reject Ho
7-years	0.889	0.956	20.44	0.000	Reject Ho

Notes: The change for each category relates to the geometric mean for 15 Thai banks and 14 foreign banks. The null hypothesis (Ho) is rejected if median of indices for Thai banks is significantly different from that of foreign banks at the 5% level.

Table 8.5 indicates that the difference of median total factor productivity change (TFPCH) of Thai and foreign banks in 1992/93 and 1994/95 was due to changes in technical efficiency. The further decomposition shows that the difference between medians of Thai and foreign banks' efficiency change is largely due to scale efficiency change. Pure technical efficiency changes of Thai and foreign banks were statistically different only in 1995/96. Over the 7 years, Thai banks had lower average TFPCH, and efficiency, pure technical efficiency, and scale efficiency changes than foreign banks and these differences are statistically significant at 5% level.

Table 8.6 Kruskal-Wallis test of cumulative indices of the Malmquist productivity index and its components

Category/period	Thai banks	Foreign banks	H-statistic	p-value	Hypothesis test
Productivity change					
1990/91	1.021	1.052	0.07	0.793	Cannot reject Ho
1990/92	1.045	1.045	0.00	0.983	Cannot reject Ho
1990/93	0.974	1.162	9.33	0.002	Reject Ho
1990/94	0.962	1.283	4.03	0.045	Reject Ho
1990/95	0.982	1.551	5.76	0.016	Reject Ho
1990/96	0.993	1.598	8.81	0.003	Reject Ho
1990/97	0.993	1.676	13.76	0.000	Reject Ho
Technological change					
1990/91	1.228	1.115	7.68	0.006	Reject Ho
1990/92	1.243	1.106	3.86	0.049	Reject Ho
1990/93	1.414	1.251	5.45	0.020	Reject Ho
1990/94	2.511	1.630	12.04	0.001	Reject Ho
1990/95	3.021	1.983	6.74	0.009	Reject Ho
1990/96	3.723	2.203	16.47	0.000	Reject Ho
1990/97	4.742	2.884	10.43	0.001	Reject Ho
Efficiency change					
1990/91	0.831	0.944	9.07	0.003	Reject Ho
1990/92	0.840	0.945	7.11	0.008	Reject Ho
1990/93	0.688	0.929	13.78	0.000	Reject Ho
1990/94	0.383	0.787	16.57	0.000	Reject Ho
1990/95	0.325	0.782	19.15	0.000	Reject Ho
1990/96	0.266	0.726	21.12	0.000	Reject Ho
1990/97	0.209	0.581	20.61	0.000	Reject Ho
Pure technical efficiency change					
1990/91	1.006	1.000	0.92	0.338	Cannot reject Ho
1990/92	1.011	0.989	0.07	0.790	Cannot reject Ho
1990/93	0.999	1.000	0.35	0.552	Cannot reject Ho
1990/94	0.882	0.892	0.28	0.600	Cannot reject Ho
1990/95	0.892	0.932	1.69	0.193	Cannot reject Ho
1990/96	0.658	0.855	5.99	0.014	Reject Ho
1990/97	0.477	0.799	4.96	0.026	Reject Ho
Scale Efficiency change					
1990/91	0.826	0.944	11.45	0.001	Reject Ho
1990/92	0.832	0.956	14.45	0.000	Reject Ho
1990/93	0.689	0.930	15.10	0.000	Reject Ho
1990/94	0.434	0.882	19.87	0.000	Reject Ho
1990/95	0.364	0.839	20.26	0.000	Reject Ho
1990/96	0.405	0.849	7.33	0.007	Reject Ho
1990/97	0.438	0.727	2.75	0.097	Cannot reject Ho

Notes: The change for each category relates to the geometric mean of cumulative indices for 15 Thai banks and 14 foreign banks. The null hypothesis (Ho) is rejected if median of indices for Thai banks is significantly different from that of foreign banks at the 5% level.

Table 8.6 indicates that there are significant differences of medians of cumulative change of total factor productivity between Thai and foreign banks from 1993 to 1997 relative to 1990. This is due to the changes in technological and technical efficiency, which were significantly different over the period. From 1990 to 1995, scale efficiency change seems to be the major factor underlying differences in cumulative efficiency change, since differences in pure technical efficiency change are not significant. The significant differences of cumulative change in pure technical efficiency were in 1990/96 and 1990/97. Overall, Table 8.6 shows that cumulative indices, except for technological change, of foreign banks are significantly higher than Thai banks. The results support the findings in Table 8.5.

The findings in this section indicate that there were significant differences in median total factor productivity and its components between Thai and foreign banks, with Thai banks showing consistently higher technological change and foreign banks consistently showing smaller decreases in the efficiency index than the Thai banks.

8.2 Bank size and Malmquist productivity indices

This section examines whether there is a relationship between bank size and the Malmquist productivity indices. Bank sizes are measured by total assets. In section 8.2.1, small bank refers to the group of banks that have total assets less than 10,000 million baht, medium bank denotes the group of banks that have total assets between 10,000-100,000 million baht, while large bank is the group of banks that have total assets more than 100,000 million baht. In section 8.2.2 three size categories of Thai banks and two of foreign banks are used, to compare our results with Leightner and Lovell (1998).

8.2.1 Evidence from correlations and graphical displays

Table 8.7 Correlation analysis between bank size and Malmquist productivity index and its components

Category	Productivity change	Technological change	Efficiency change	Pure technical efficiency change	Scale efficiency change
Pearson correlation					
Thai banks	0.100	0.012	0.012	0.215*	-0.170
Foreign banks	0.202*	0.238*	-0.023	0.050	0.102
All banks	-0.110	0.103	-0.198**	0.029	-0.158*
Rank correlation					
Thai banks	-0.065	0.025	-0.065	0.146	-0.148
Foreign banks	0.076	0.160	-0.048	-0.127	0.088
All banks	-0.172*	0.153*	-0.342**	-0.142*	-0.271**
Geometric mean of indices by bank size					
Large bank	0.991	1.264	0.784	0.943	0.831
Medium bank	1.052	1.227	0.857	0.886	0.968
Small bank	1.058	1.120	0.944	0.999	0.945

Notes: Bank size is measured by total assets. (**) and (*) indicate correlation is statistically significant respectively at 1% and 5% levels

Table 8.7 shows some evidence of a positive and significant relationship between asset size and changes in total factor productivity (TFP) and technological change for foreign banks. There is also weak evidence for a positive relationship between Thai banks' pure technical efficiency and asset size. For all banks, there is evidence of a negative relationship between bank size and changes in TFP, technical efficiency, and pure technical efficiency and scale efficiency. The geometric means of indices for large, medium and small bank sizes also supports negative relationships between TFP and efficiency changes and bank size and a positive relationship between size and technological change. However, none of the correlations are large and there are some differences of significance, and sometimes of sign, between the parametric and non-parametric correlations.

Next, we investigate the relationship of bank size and productivity changes from the plots of Malmquist productivity indices and total assets.

Figure 8.7 The relationship between bank size and TFPCH

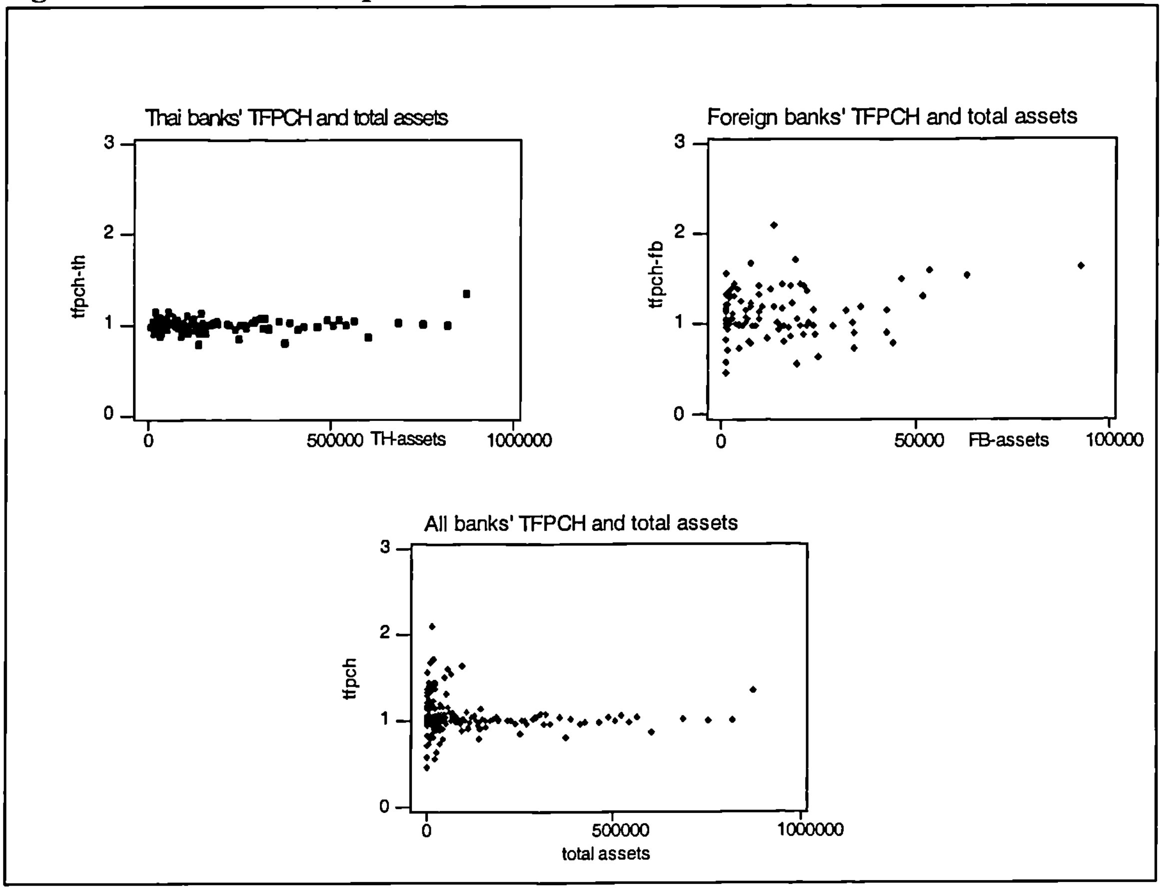


Figure 8.7 shows that foreign small banks have more variability of TFP change, and TFP increases as asset size is larger. For Thai banks, TFP change and asset size appear to be uncorrelated. For all banks, there is more dispersion of TFP change for small banks than large banks. Overall, there is little if any relationship between productivity change and bank size.

Figure 8.8 The relationship between bank size and efficiency change

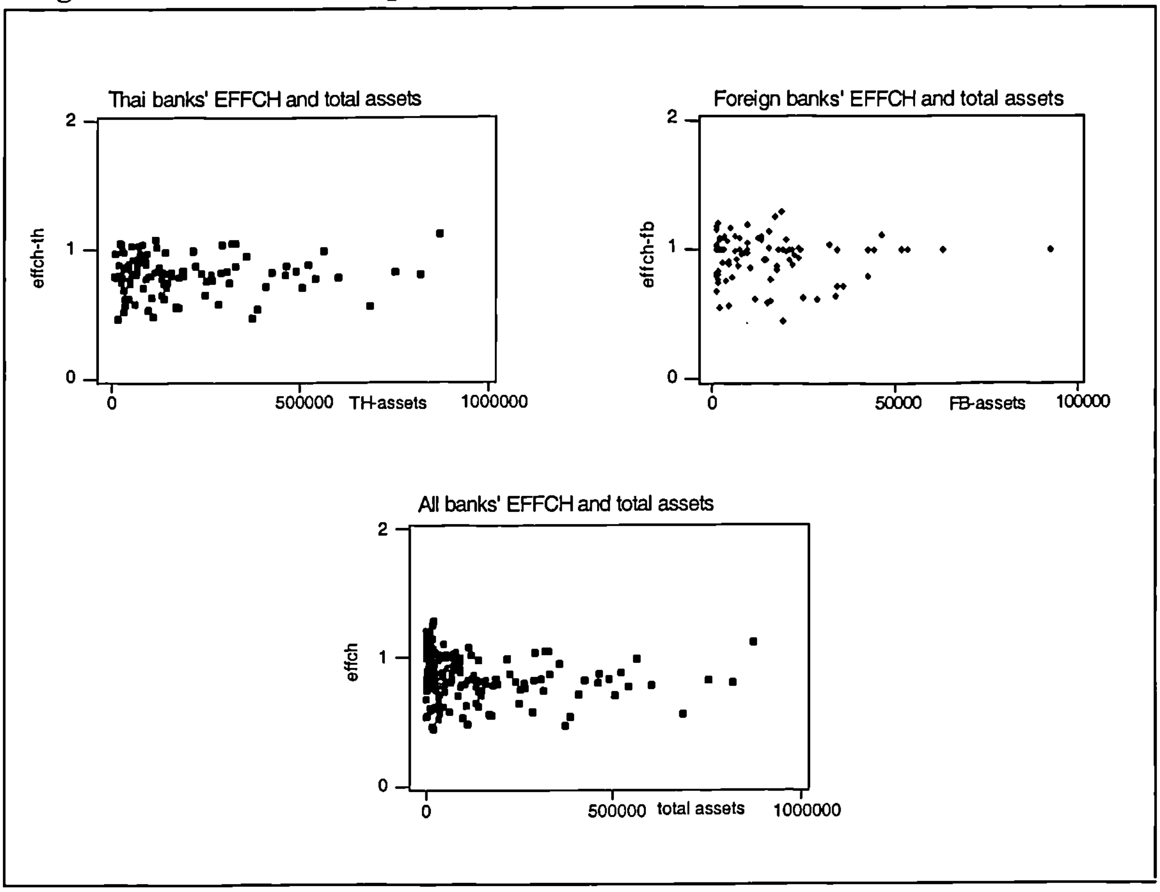


Figure 8.8 shows that efficiency changes of Thai and foreign small banks are widely dispersed and the majority has a decreasing efficiency. The plots for all banks' DMU show that efficiency declines are substantial for all bank sizes. Again, there is little evidence of any relationship of efficiency change with size (though Table 8.7 gives a negative Spearman correlation of –0.34, which is significant, for all banks).

Figure 8.9 The relationship between bank size and technological change

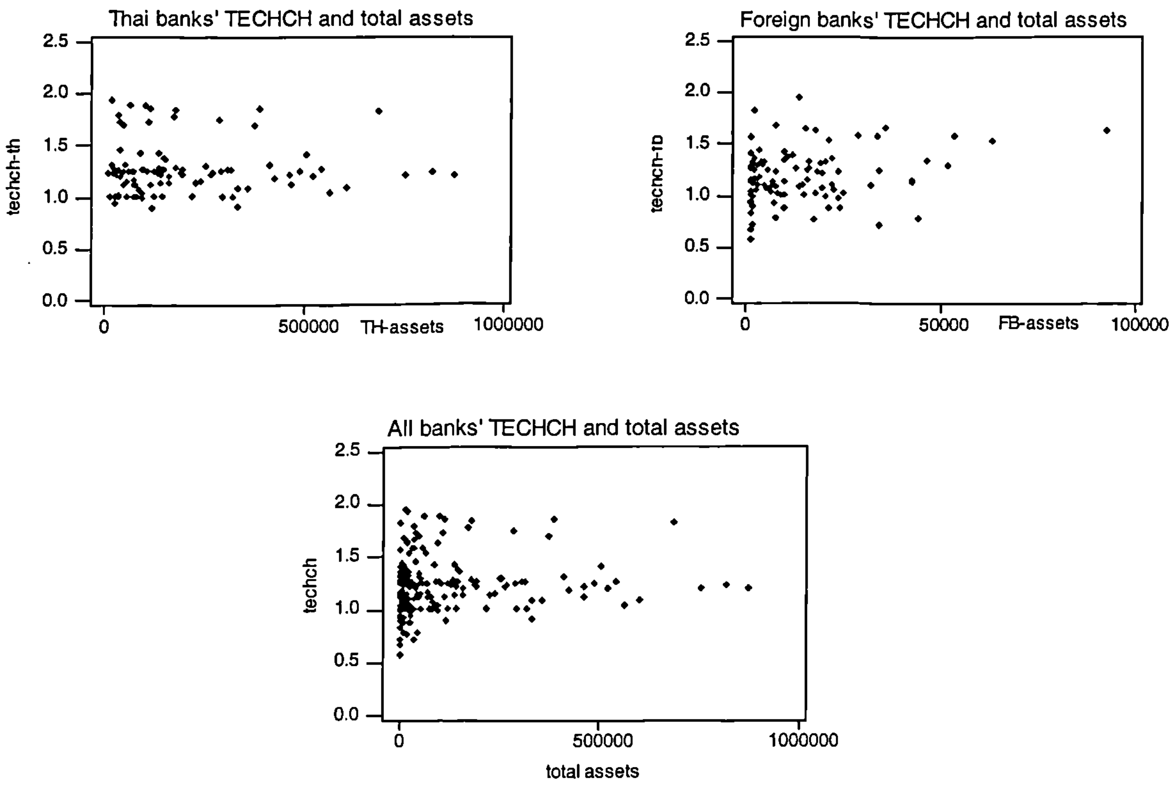


Figure 8.9 shows a wide dispersion of technological change for all asset size. A few DMUs of foreign small banks have technological regress. However, the majority of Thai and foreign banks in all asset sizes have technological progress. The plots confirm the statistics in Table 8.7, showing virtually no relationship between technological change and size.

Figure 8.10 The relationship between bank size and pure technical efficiency change

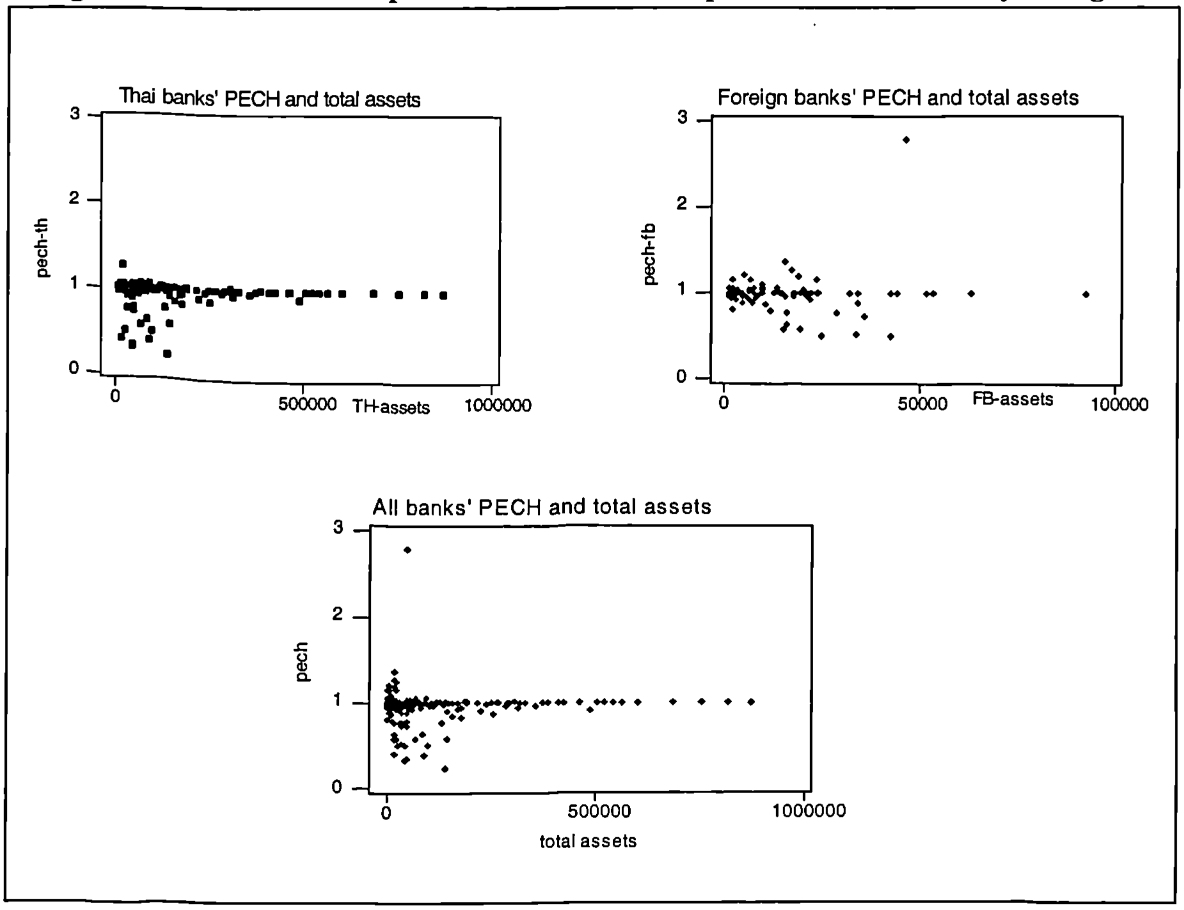


Figure 8.10 shows that pure technical efficiency change (PECH) of Thai and foreign small banks exhibits variability with many DMUs experiencing a decline in PECH. The highest PECH is 277% by Citibank. The plots for all banks suggest that PECH of large banks and most of small banks are static, and there is essentially no relationship with size, which confirms the statistics in Table 8.7.

Figure 8.11 The relationship between asset size and scale efficiency change

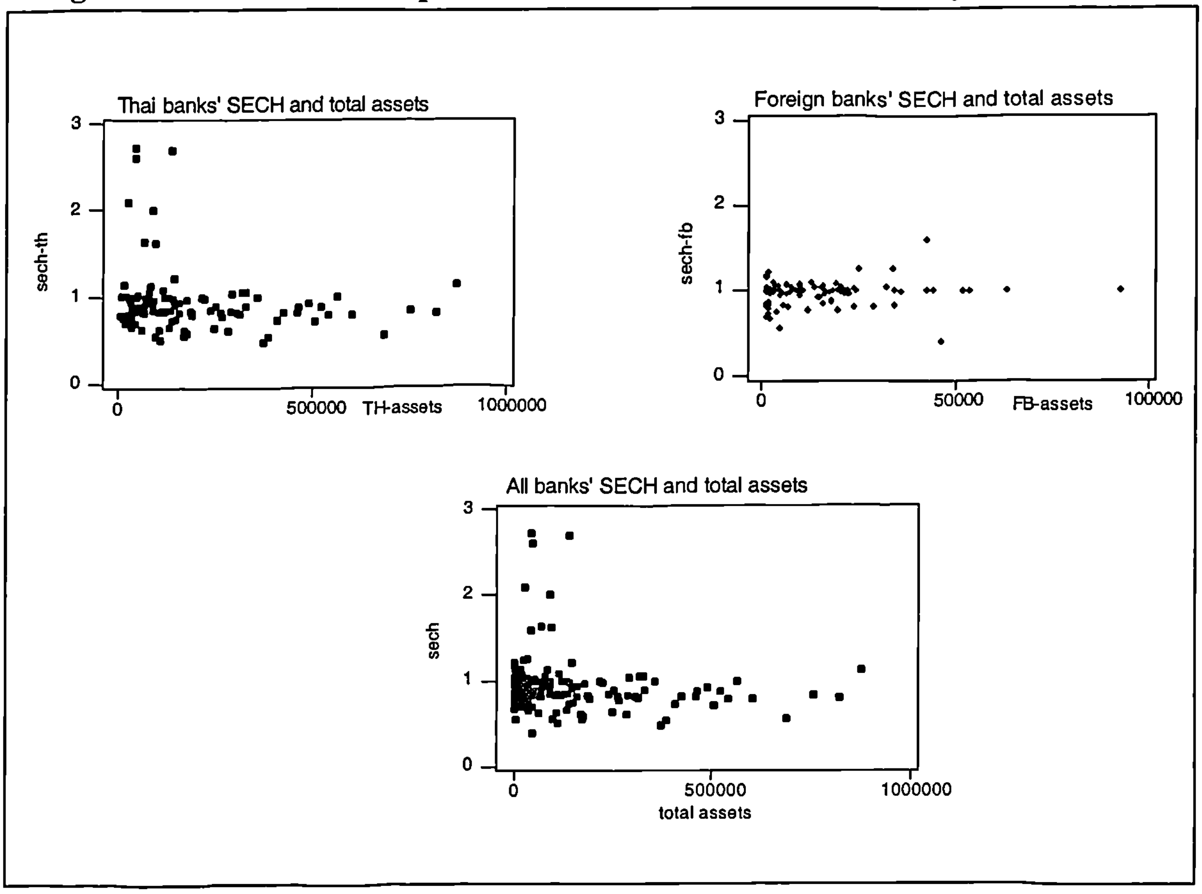


Figure 8.11 shows that there is some dispersion of scale efficiency change (SECH) for Thai and foreign small banks. A few DMUs of Thai small banks (TDB, NKB, UBB and LTB) had scale efficiency gains of over 100%, reflecting increases in size, moving up the IRS part of the frontier (region) towards a mpss, while larger banks' SECH slightly declined (see Appendix XI). The plots for all banks indicate that SECH for the majority of bank DMUs was less than one. Figure 8.11 confirms that SECH is not related to bank size if the group of small Thai DMUs is excluded.

Overall, the results so far show that productivity changes and their components, are independent of size of bank, or at best only weakly related.

8.2.2 Comparison with Leightner and Lovell (1998)'s results: Malmquist productivity index

Table 8.8 Mean productivity indices

Category	90/91	91/92	92/93	93/94	94/95	95/96	96/97	Product 92-94	Product 90-94	Product 90-97
Productivity change										
Thai large	1.013	1.039	0.906	0.972	1.008	1.007	1.084	0.877	0.922	1.016
Thai medium	1.037	1.020	0.956	0.965	0.983	0.982	0.996	0.922	0.975	0.936
Thai small	1.017	1.017	0.937	1.017	1.054	1.033	0.967	0.951	0.986	1.032
Foreign small	1.043	1.020	1.126	1.216	1.220	1.120	1.210	1.374	1.462	2.319
Foreign tiny	1.082	0.970	1.138	1.063	1.256	0.953	0.965	1.166	1.260	1.479
Efficiency change										
Thai large	0.829	1.024	0.844	0.545	0.843	0.823	0.867	0.454	0.385	0.229
Thai medium	0.858	1.005	0.892	0.565	0.810	0.765	0.777	0.508	0.441	0.203
Thai small	0.819	1.008	0.784	0.564	0.874	0.868	0.756	0.441	0.366	0.205
Foreign small	0.949	1.004	1.016	0.863	1.013	0.936	0.848	0.874	0.828	0.676
Foreign tiny	0.947	1.008	0.950	0.880	0.986	0.967	0.783	0.858	0.817	0.555
Technological change										
Thai large	1.223	1.015	1.097	1.782	1.195	1.235	1.258	1.956	2.429	4.466
Thai medium	1.211	1.016	1.090	1.726	1.216	1.325	1.282	1.898	2.343	4.628
Thai small	1.242	1.008	1.210	1.809	1.205	1.206	1.278	2.187	2.738	5.017
Foreign small	1.104	1.016	1.108	1.419	1.201	1.223	1.404	1.562	1.776	3.528
Foreign tiny	1.145	0.957	1.211	1.266	1.277	1.009	1.220	1.496	1.663	2.911

Table 8.8 reports calculated values of the mean Malmquist productivity indices, within each year for each bank class. We group 15 Thai and 14 foreign banks as in Leightner and Lovell (1998) and compare the results for 1990-94.

Leightner and Lovell (1998) reported that Thai large banks and foreign small banks had productivity increases during 1990-94 when inputs and outputs were defined according to commercial bank objectives. When Bank of Thailand objectives were used to define inputs and outputs for 1992-94, foreign banks experienced increasing productivity while domestic banks suffered declining productivity. Our findings in Table 8.8 are similar to their latter results (our definition of inputs and outputs is similar to their "bank regulation objectives"). The average cumulative productivity of foreign small and tiny banks increased by 37% and 17% respectively during 1992-94[8].

We investigate further the components of productivity change in 5 bank classes. Table 8.8 shows that high cumulative productivities of foreign banks were attributable to the relatively small efficiency declines combined with technological gains throughout the period. Thai small banks had the highest technological progress, but their poor performance was due to cumulative efficiency declines of up to 80% from 1990 to

[8] Leightner and Lovell (1998) found average productivity increases of 59% for foreign small banks and 19% for foreign tiny banks in 1992/94, under Bank of Thailand objectives.

1997. For each of the three groups of Thai banks, it is clear that the important change occurred in 1993/94 when average efficiency dropped by more than 40%, while technological efficiency improved substantially by more than 70%.

The means of cumulative productivity change in 1990/94, 1992/94 and 1990/97 are similar: foreign small banks had the highest productivity gains, followed by foreign tiny banks and Thai small banks.

The findings in this section suggest that banks of all sizes experienced declines in technical efficiency, but technological progress is observed in all bank sizes. This finding is similar to Wheelock and Wilson (1999) who examined productivity change in US banking during 1984-93. Financial deregulation appeared to have different effects on productivity change and the composition of technical efficiency change for small banks.

8.3 Alternative measure of Malmquist productivity index

It is noted that the Malmquist (M) productivity index can be calculated either for adjacent periods or relative to a fixed-base period (see, Chapter 6). For the adjacent period version, productivity change is calculated as the distance between the frontiers in period t and $t+1$, as shown in section 8.1. For the fixed-base period, however, productivity change is calculated as the ratio of the distance between the base period, for which we use the grand frontier in this study, and the frontiers in period t and $t+1$. We calculate first, the productivity change relative to the previous year (with constant returns to scale imposed on the component distance function) and second, the productivity change relative to the previous best practice (with variable returns to scale imposed on the component distance function). The latter is called the Malmquist growth index by Leightner and Lovell (1998).

The aim of this section is to examine the consistency of the Malmquist productivity index. We first investigate whether the M-index calculated from adjacent base method is affected by intersecting frontiers. Second, we explore the M-indexes calculated from grand frontier base methods. Grifell-Tatjé and Lovell (1996) note that the M-indexes calculated from adjacent and (CRS) grand frontier base methods should generate the same values unless the annual frontiers intersect. Finally, we examine the relationship between bank size and Malmquist growth index and compare the results with Leightner and Lovell (1998).

8.3.1 An analysis of cross-efficiencies

The drawback of computing the productivity change index using adjacent periods is that each period is allowed to have a completely different production technology (Grosskopf, 1993). The strength of this approach is that the effects of frontier shifts can be measured. However, a possible disadvantage is that technical efficiency change can have different values from the two methods because of possible intersecting frontier technologies[9]. Therefore, the values of the productivity change index can be affected.

Table 8.9 shows that there were crossing frontiers in periods t relative to $t+1$ (90/91, 93/94, 94/95, 95/96, 96/97) and periods t relative to $t-1$ (92/91, 96/95). The results suggest that, for example, the efficiency of efficient DMU of Bank of Tokyo in 1994 relative to the 1993 frontier increased by 9%, but decreased by 13% when measured relative to the frontier in 1995.

[9] Crossing frontiers occur when some of the efficient DMUs on the frontier year t exhibit efficiency gains, while others exhibit a decline, with respect to frontier year $t+1$ (see Chapter 6 for schematic diagrams).

Table 8.9 Cross-efficiencies of efficient bank DMUs in yearly DEA analysis

Year	Efficient bank DMU	Cross-efficiency relative to previous year	Cross-efficiency relative to following year
1990	Bank of Tokyo	N/A	1.013
	Sakura Bank	N/A	1.016
	Chase Manhattan Bank	N/A	0.890
	Bank of America	N/A	0.813
	Sime Bank Berhad	N/A	1.453
1991	Sakura Bank	1.154	1.267
	Citibank	1.007	1.008
	ABN	1.243	0.999
	ICBC	1.156	1.274
	Sime Bank Berhad	1.320	1.737
1992	Bank of Tokyo	0.968	1.039
	Sakura Bank	0.982	1.040
	Bank of Indosuez	1.118	1.145
	Chase Manhattan Bank	0.985	1.057
	ABN	1.128	1.187
	Sime Bank Berhad	1.185	1.224
1993	Sakura Bank	1.953	2.008
	Chase Manhattan Bank	1.607	0.658
	ABN	1.454	0.912
	Sime Bank Berhad	3.000	3.774
1994	Bank of Tokyo	1.093	0.867
	Sakura Bank	1.063	1.932
	Chase Manhattan Bank	1.860	0.898
	Bank of America	2.602	0.969
	ABN	1.699	0.931
	Sime Bank Berhad	1.285	1.280
1995	Bank of Tokyo	1.162	0.858
	Sakura Bank	1.180	0.828
	Deutsche Bank	1.498	0.743
	Chase Manhattan Bank	1.833	1.034
	Bank of America	1.460	1.267
	ABN	1.942	2.099
	Sime Bank Berhad	1.717	1.617
	OCBC	1.619	0.820
1996	Bank of Tokyo	1.447	0.677
	Sakura Bank	2.096	0.792
	Bank of America	0.990	1.084
	ABN	1.293	0.781
	Sime Bank Berhad	0.835	2.147
1997	Bank of Tokyo	1.803	N/A
	Sakura Bank	1.871	N/A
	Deutsche Bank	1.412	N/A

8.3.2 Grand frontier based Malmquist Productivity index

We noted in Chapter 6 that the Malmquist productivity index can be calculated either for adjacent periods or for all periods relative to a fixed base period as in Glass and

Mckillop (2000). The use of the fixed base period is useful because it satisfies the circular relationship of the index, in the sense that $M_{t,\,t+2} = M_{t,\,t+1}$ times $M_{t+1,t+2}$ where $M_{r,\,s}$ is the index for productivity change between period r and period s.

This section analyses the total factor productivity change (M) index by using the grand frontier as the (fixed) base period as suggested by Grifell-Tatjé and Lovell (1996). We compare the M-index from the adjacent frontier method with the M-index from constant returns to scale (CRS) grand frontier base period. The aim is to examine the consistency of the M-index, since the results calculated from adjacent base periods may be affected by the intersecting frontiers. The higher the correlation between the two results, the lower the effect of cross efficiencies and the more reliable the M-index. Also, we explore the Malmquist growth index (calculated from the variable returns to scale grand frontier base method) and its relationship with productivity indexes.

Table 8.10 A comparison of M-index calculated from adjacent and grand frontier base periods

Period	Category	Adjacent base	CRS Grand frontier base	Malmquist growth Index
1990/91	Thai banks	1.021	1.016†	1.083†
	Foreign banks	1.052	1.133†	1.074
	All banks	1.036	1.071†	1.079†
1991/92	Thai banks	1.023†	1.033†	1.102†
	Foreign banks	0.993	0.983	0.998
	All banks	1.009	1.008	1.051
1992/93	Thai banks	0.932*	0.947*†	1.039
	Foreign banks	1.112†	1.007	0.984
	All banks	1.015	0.976	1.012
1993/94	Thai banks	0.988	1.006	1.132†
	Foreign banks	1.104	1.191	1.124†
	All banks	1.042	1.091	1.128†
1994/95	Thai banks	1.020	1.014	1.194*†
	Foreign banks	1.209†	1.127*†	1.047
	All banks	1.107*	1.067*†	1.121*†
1995/96	Thai banks	1.011	1.030†	1.024
	Foreign banks	1.030	1.075	1.058
	All banks	1.020	1.051	1.040
1996/97	Thai banks	1.000	0.963†	0.986
	Foreign banks	1.048	1.058	1.090
	All banks	1.023	1.008	1.035
7-years	Thai banks	0.999	1.001	1.078*†
	Foreign banks	1.077*†	1.079*†	1.053*†
	All banks	1.036†	1.038†	1.066†

Notes: The figure for each category relates to the geometric mean for 15 Thai banks and 14 foreign banks. (*) indicates median is significantly different from unity at the 5% level. (†) indicates geometric means are significantly different from unity at the 5% level.

Table 8.10 shows that productivity change of Thai banks relative to the CRS grand frontier base improved by 2-3% in 1990/91, 1991/92 and 1995/96, while foreign banks exhibit significant productivity increases of 13% in 1990/91 and 1994/95. There was a decline in productivity of Thai banks in 1992/93 (5%) and 1996/97 (4%), which are statistically significant. Overall, the geometric means of M-index from the CRS grand frontier base period are similar to those from the adjacent period measure and that the 7 year means are almost identical. Over the 7 years, productivity of Thai banks did not improve, while foreign banks' productivity increased by about 8% and all banks' productivity were around 4% increases.

Table 8.10 also shows the mean of the M-index from the VRS grand frontier base or the Malmquist growth index. For Thai banks, the growth indexes are higher than the M-index from adjacent and CRS grand frontier base periods, except in 1995/96. The growth indexes of foreign banks are, however, mainly lower than the M-index calculated from adjacent and CRS grand frontier base periods. The highest growth index was in 1993/94, a mean of 13% productivity increase for all banks. Over the 7 years, the Malmquist growth index suggests that Thai banks grew by 7.8% and foreign banks by 5.3%.

Figure 8.12 Malmquist growth indexes of Thai and foreign banks

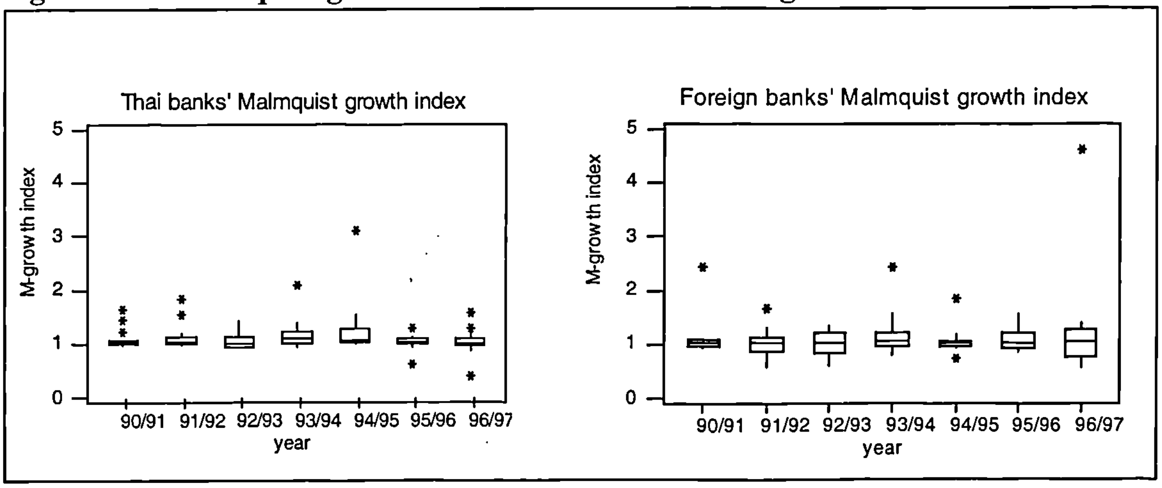


Figure 8.12 shows that Malmquist growth indexes of foreign banks are more dispersed than that of Thai banks, except in 1990/91 and 1994/95. The highest growth of Thai banks was the DMU of BBC in 1994/95 and the highest growth of foreign banks was the DMU of Citibank bank in 1996/97.

Table 8.11 A comparison of cumulative M-index calculated from adjacent and grand frontier base periods

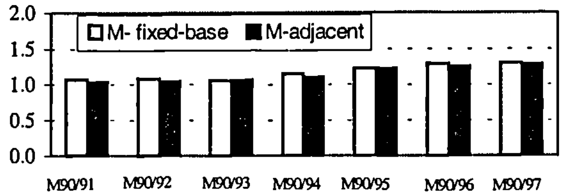
Period	Category	Adjacent base	CRS grand frontier base	Malmquist growth index
1990/91	Thai banks	1.021	1.016	1.083†
	Foreign banks	1.052	1.133†	1.074
	All banks	1.036	1.071†	1.079†
1990/92	Thai banks	1.045*†	1.049†	1.194†
	Foreign banks	1.045	1.113	1.072
	All banks	1.045*	1.080	1.133†
1990/93	Thai banks	0.974	0.994	1.240†
	Foreign banks	1.162†	1.122	1.055
	All banks	1.061	1.054	1.147†
1990/94	Thai banks	0.962*	0.999	1.404†
	Foreign banks	1.283†	1.336†	1.186†
	All banks	1.106	1.150	1.294†
1990/95	Thai banks	0.982	1.013	1.677†
	Foreign banks	1.551†	1.505†	1.242†
	All banks	1.224	1.226†	1.451†
1990/96	Thai banks	0.993	1.043†	1.717†
	Foreign banks	1.598*†	1.618†	1.314†
	All banks	1.249	1.289*†	1.509*†
1990/97	Thai banks	0.993	1.005	1.693*†
	Foreign banks	1.676*†	1.711*†	1.433*†
	All banks	1.278†	1.299†	1.562*†

Notes: The change for each category relates to the geometric mean of cumulative indices for 15 Thai banks and 14 foreign banks. (*) indicates median is significantly different from unity at the 5% level. (†) indicates geometric means are significantly different from unity at the 5% level.

Table 8.11 shows the mean cumulative M-indexes from adjacent and grand frontier base periods. It appears that the mean cumulative M-indexes from the CRS grand frontier base are similar to those from the adjacent base method. Foreign banks report much higher productivity increases of 71% in 1997 relative to 1990, while Thai banks' productivity change is not statistically significant. Note that productivity of foreign banks rose at a faster rate after 1994, suggesting that foreign banks gained advantages from deregulation measures such as the introduction of BIBF. For all banks, the results suggest that productivity increased by around 30% in 1997 relative to 1990.

Table 8.11 also shows the cumulative Malmquist growth index which indicates that growth of Thai banks relative to best practice in 1990 was higher than foreign banks throughout the period. For all banks in 1997 relative to 1990, the cumulated growth index indicates a 56% improvement, which came from 69% and 43% cumulated growth of Thai and foreign banks, respectively.

Figure 8.13 Cumulative M-index calculated from grand frontier and adjacent base periods



Note: Figure based on CRS assumption.

Figure 8.13 shows that mean cumulative productivity of all banks relative to their best practice in 1990 clearly improved during 1994 to1997. The plots show that the M-index from the adjacent base method is consistent with that from the CRS grand frontier base method.

Figure 8.14 Cumulative M-index calculated from CRS grand frontier base

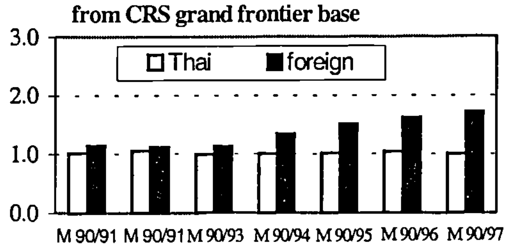
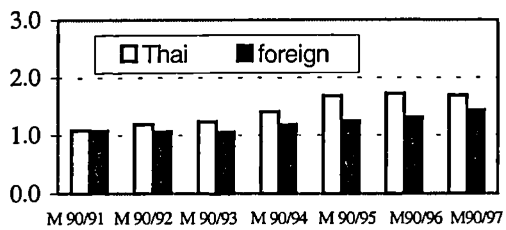


Figure 8.15 Cumulative M-growth index



Figures 8.14 confirms the Kruskal-Wallis test in Tables 8.5 and 8.6 that the mean cumulative productivity indexes of foreign banks are higher than that of Thai banks. Figure 8.15 shows that mean cumulative growth index of Thai banks seems to be higher than foreign banks.

Table 8.12 investigates whether Malmquist growth indexes of Thai and foreign banks are different. The Kruskal-Wallis test shows that there are no significant differences between medians of Thai and foreign banks' growth index, except in 1994/95 where Thai banks grew by 19.4% and foreign banks by 4.7%. Also, there are no significant differences of the 7 year medians and the medians of cumulative growth index. The results suggest that there were no significant differences in median growth index, with an exception in 1994/95 when Thai banks grew faster than foreign banks.

Table 8.12 Kruskal-Wallis test of the Malmquist growth index

Year	Thai banks	Foreign banks	H-statistic	p-value	Hypothesis test
Malmquist growth index					
1990/91	1.083	1.074	0.37	0.541	Cannot reject Ho
1991/92	1.102	0.998	1.39	0.239	Cannot reject Ho
1992/93	1.039	0.984	0.07	0.793	Cannot reject Ho
1993/94	1.132	1.124	0.08	0.777	Cannot reject Ho
1994/95	1.194	1.047	4.96	0.026	Reject Ho
1995/96	1.024	1.058	0.30	0.585	Cannot reject Ho
1996/97	0.986	1.090	0.23	0.631	Cannot reject Ho
7-years	1.078	1.053	0.01	0.913	Cannot reject Ho
Cumulative Malmquist growth index					
1990/91	1.083	1.074	0.37	0.541	Cannot reject Ho
1990/92	1.194	1.072	1.95	0.163	Cannot reject Ho
1990/93	1.240	1.055	0.23	0.631	Cannot reject Ho
1990/94	1.404	1.186	0.62	0.432	Cannot reject Ho
1990/95	1.677	1.242	2.07	0.150	Cannot reject Ho
1990/96	1.717	1.314	1.55	0.214	Cannot reject Ho
199097	1.693	1.433	0.02	0.896	Cannot reject Ho

Notes: The figure for each category relates to the geometric mean for 15 Thai banks and 14 foreign banks. The null hypothesis (Ho) is rejected if median of index for Thai banks is significantly different from that of foreign banks at the 5% level.

Table 8.13 Correlation analysis of M-index

	M-CRS grand frontier base	M-growth index	Cumulative M-CRS grand frontier base	Cumulative growth index
Pearson correlation				
M-growth index	0.466**			
M-adjacent base	0.751**	0.383**		
Cumulative growth index			0.222**	
Cumulative M-adjacent base			0.794**	0.145*
Spearman rank correlation				
M-growth index	0.591**			
M-adjacent base	0.774**	0.417**		
Cumulative growth index			0.552**	
Cumulative M-adjacent base			0.699**	0.263**

Note: (**) and (*) indicate correlation is statistically significant at 1% and 5% levels.

Table 8.13 shows a positive and significant relationship between the Malmquist (M) indexes calculated from adjacent and grand frontier base periods and the Malmquist growth index. The results are statistically significant for both parametric and nonparametric methods though correlations between cumulative are smaller than the original M-indexes. The findings confirm that M-indexes obtained from adjacent and fixed base periods are robust and that the larger the productivity indexes the better the bank performance relative to the previous year.

8.3.3 Comparison with Leightner and Lovell (1998)'s results: Malmquist growth index

Table 8.14 shows the mean of the Malmquist growth indexes for each bank class. The classifications of 15 Thai and 14 foreign banks are the same as in Leightner and Lovell (1998). A comparison of our findings with Leightner and Lovell (1998) indicates some differences. First, Thai medium banks had the most rapid growth, followed by Thai small banks, while Leightner and Lovell (1998) found the highest cumulative growth indexes for foreign small banks. Second, our results show that cumulative growth indexes for each bank class are positive during the period 1992/94 and 1990/94. During the same time period, Leightner and Lovell (1998) found that foreign tiny banks failed to generate positive growth. In 1997 relative to 1990, Thai medium banks had the highest Malmquist growth index on average of 4.174, while all banks had average growth of 1.841 and foreign tiny banks grew at 8% per year.

Table 8.14 Mean of Malmquist growth index by bank size

Category	90/91	91/92	92/93	93/94	94/95	95/96	96/97	Product 92-94	Product 90-94	Product 90-97
Thai large	1.064	1.043	0.994	1.032	1.049	1.035	0.994	1.077	1.204	1.246
Thai medium	1.284	1.395	1.169	1.423	1.208	1.105	1.116	1.972	3.373	4.174
Thai small	1.007	1.010	1.012	1.076	1.401	0.993	0.981	1.714	1.732	1.328
Foreign small	1.175	1.017	0.975	1.264	1.106	1.118	1.429	1.360	1.520	1.888
Foreign tiny	0.999	1.044	1.084	1.009	1.000	0.991	0.974	1.096	1.162	1.086
All banks	1.104	1.076	1.032	1.165	1.165	1.053	1.139	1.445	1.721	1.841

Table 8.15 Correlation analysis between bank size and Malmquist growth index

	Thai banks	Foreign banks	All banks
Pearson correlation	-0.100	0.217*	-0.033
Spearman rank correlation	0.169	0.117	0.167*
	Small bank	*Medium bank*	*Large bank*
Geometric mean by bank size	1.032	1.058	1.112

Note: * indicates significant different from zero at the 5% level.

Table 8.15 shows that there is no significant relationship between asset size and M-growth index for Thai banks. There is also weak evidence for a positive relationship between asset size and M-growth index for foreign banks[10]. The geometric means of M-growth index for large, medium and small bank sizes supports a positive relationship between bank size and M-growth index for all banks. However, the overall results show differences of significance and sign between the parametric and nonparametric correlations.

Figure 8.16 The relationship between the Malmquist growth index and bank size

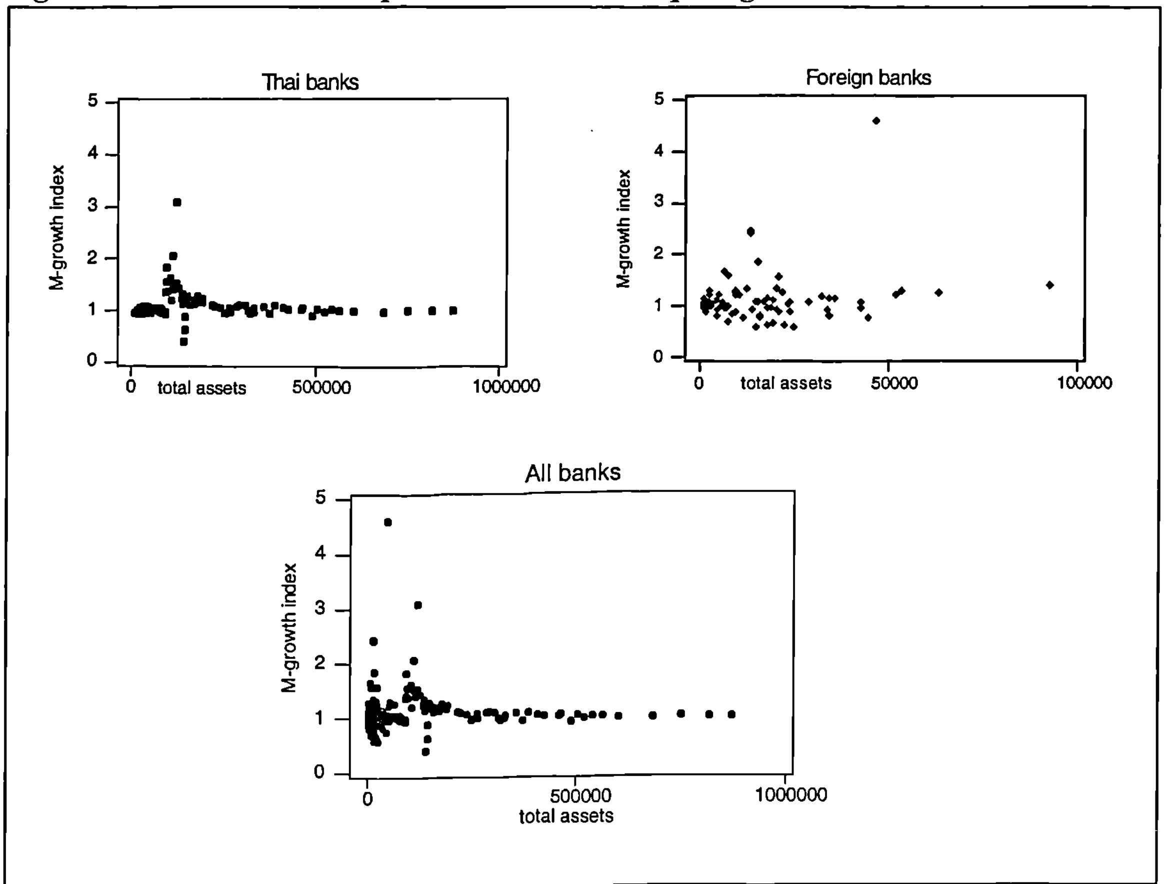


Figure 8.16 shows that a particular Thai bank (BBC) had a large deviation of Malmquist growth indexes for its DMUs. The highest one was in 1994/95 (3.09) and the smallest was in 1996/97 (0.39). M-growth index and asset size of foreign banks appear to be uncorrelated The figure shows the highest M-growth index (4.61) of Citibank's DMU in 1996/97[11]. Overall, there is little if any relationship between productivity change relative to best practice and bank size.

[10] The relationship is influenced by DMU of Citibank in 1996/97. After removing this outlier, the Pearson correlation is 0.091 (p=0.377).

[11] Technical efficiency of this bank rose by 72% from 1996 to 1997.

8.4 The impact of financial deregulation on productivity change

This section examines whether financial deregulation has an impact on total factor productivity change of banks. We follow Worthington (1999) who carried out OLS regression of Malmquist indices using total factor productivity change, technical efficiency change and technological change as dependent variables. The independent variables include bank-specific and control variables which are the same as those in Chapter 7.

We use return on assets (ROA) as a measure of bank profitability, total cost to total assets (TCTA) as a measure of bank costs, and equity to assets (EQTA) as a measure of capital adequacy, while loan loss reserve to total loan (LLRTL) and total loan to total assets (TLTA) measure bank-specific risk. Two dummy variables included are bank type (BANK equal to 1 for Thai banks and 0 for foreign banks) to control for ownership differences and time dummy variable (the omitted is TD90/91) to determine the impact of financial deregulation.

Table 8.16 The impact of financial deregulation on productivity change

Predictor	Productivity change		Technological change		Efficiency change	
	coefficient	T-ratio	coefficient	T-ratio	coefficient	T-ratio
Intercept	1.139	4.72**	0.893	3.76**	1.131	6.78**
ROA	0.146	0.13	-0.087	-0.08	0.040	0.05
TCTA	-1.260	-1.26	0.282	0.29	-0.946	-1.37
EQTA	0.006	0.05	0.108	0.98	-0.078	-1.02
LLRTL	-0.488	-1.67	-0.425	-1.48	-0.039	-0.19
TLTA	0.123	0.50	0.302	1.24	-0.103	-0.61
BANK	-0.125	-3.38**	0.052	1.42	-0.126	-4.92**
TD91/92	-0.013	-0.26	-0.185	-3.58**	0.136	3.73**
TD92/93	-0.022	-0.44	-0.040	-0.79	0.018	0.52
TD93/94	0.020	0.39	0.415	7.91**	-0.194	-5.26**
TD94/95	0.057	1.02	0.045	0.82	0.016	0.41
TD95/96	-0.002	-0.05	0.312	0.59	-0.005	-0.15
TD96/97	0.023	0.43	0.127	2.36*	-0.076	-2.04*
R^2 (adjusted)	10.4%		45.3%		38.6%	
$F_{12,190}$	2.95**		14.93**		11.56**	

Notes: ** and * indicates significant different from zero at the 1% and 5% levels (two-tailed test).

Table 8.16 shows that the coefficients for bank-specific variables are not statistically significant, which suggest that changes in total factor productivity and its components are not related to the bank's financial characteristics. The regression results provide strong evidence that Thai banks experienced different changes in productivity and technical efficiency from foreign banks. However, there is no difference in technological change, on average, between Thai and foreign banks, after controlling for other variables.

For the impact of financial deregulation, the results suggest that there is no significant effect on the productivity change. However, there are significant effects in the regressions of technological and efficiency changes, in 1991/92, 1993/94 and 1996/97, which are negatively related. After controlling for other variables, the results suggest that mean technological change in 1991/92 was less than in the base year 1990/91, while efficiency was greater. In addition, technological progress was significantly higher in 1993/94 and 1996/97 than in 1990/91, while there was a relative decline in efficiency. The possible reason for this is that there was a large expansion of bank output in 1993/94 (16.8%) and 1996/97 (17.1%) compared with those in 1990/91 (13.5%).

Regressions were also carried out in which the number of branches was included as an additional regressor as in Grifell-Tatjé and Lovell (1996). However, the estimated coefficients were insignificant in each case.

Finally, we investigated the impact of financial deregulation using fixed and random effect models (see, Appendix XIII). The results have not shown much insight except for the coefficient of TCTA. The fixed effect model suggests that technical efficiency change is positively related to the ratio of total costs to total assets, and this regression is significant at the 5% level. However, the significantly non-zero coefficient disappears when time dummies are included. We also found negative and significant coefficients of TCTA for fixed and random effect models for technological and productivity changes, but the regressions are not statistically significant. The Hausman test in each case shows that the fixed effect model is preferable.

Despite a great deal of testing in different models, we are unable to find any relationship between bank characteristics of soundness, loan quality, costs and return on assets and the three main productivity indices. There is a substantial amount of unexplained variation in productivity over and above the variation that seems to be due to deregulation and bank ownership. Importantly, this could be due to unmeasured factors such as differences in managerial ability and more generally, potential correlates that were not included in the analysis.

8.5 Conclusion

This chapter examined whether there has been an improvement in productivity of Thai and foreign banks during 1990-97 financial deregulation. We found that mean total factor productivity of foreign banks increased substantially. The decomposition of the Malmquist productivity indices indicated that productivity growth was largely due to technological progress. Thai banks experienced no change in productivity on average because technological progress was offset by relative efficiency decline. The further decomposition of efficiency change indicated that declines in efficiency observed in all banks were attributable to decreases in both pure technical efficiency and scale efficiency change.

The distributions of productivity, efficiency and technological change had greater divergence following financial deregulation. We found that there are significant differences in productivity change between Thai and foreign banks. The relationship between bank size and total factor productivity change is very weak. There was a large dispersion of productivity change for small banks. Meanwhile, we found technological progress and efficiency decline for all bank sizes.

There is evidence to suggest that our results using the adjacent base method are consistent to those obtained using the fixed (grand frontier) base period. We also found that Thai medium and small banks had relatively higher Malmquist growth indexes, but their average productivity declined. Overall, we found a weak relationship between bank size and Malmquist growth index.

The regression analysis indicated that bank-specific variables did not explain total factor productivity change or its components since deregulation. The regression confirmed that there are significant differences in average total factor productivity and efficiency change between Thai and foreign banks. The results indicated that the 1990-97 financial deregulation had no significant effects on total factor productivity change. However, there were significant effects on changes in technological and technical efficiency in 1991/92, 1993/94 and 1996/97 relative to the 1990/91 level. Since these were in opposite directions, the net effect on total factor productivity was not significant.

Chapter 9 Conclusion and Limitations

Introduction

Financial liberalisation encompasses deregulation, a process of change in the regulation of the banking sector that involves the freeing up of bank structure and conduct rules. This process is invariably accompanied by the re-regulation of bank supervision. In Thailand, bank deregulation was implemented within the three-year development plan of the financial liberalisation programme that began in 1990.

An important economic objective of deregulation is to improve productive efficiency of banking firms (European Commission, 1997; Cecchini, 1988; Gardener *et al.*, 1998). Deregulation is expected to facilitate more intense competition that leads, for example, to price falls, output increases, more innovation and greater allocative efficiency in the use of bank capital. To date, however, empirical studies provide mixed evidence on the impact of bank deregulation.

This study set out to provide select empirical evidence on the effects of financial liberalisation and deregulation on the efficiency and productivity of banks in Thailand. The annual accounting data of 15 Thai banks, 20 foreign bank branches, 27 finance companies and 5 specialised institutions from 1990 to 1997 were used; this dataset was shaped *inter alia* by data availability. Up until now (2001) there have been two existing studies on the efficiency and productivity of the Thai banking sector. Leightner and Lovell (1998) used Malmquist productivity and growth indexes to measure the productivity change of Thai and foreign banks during 1990-94, while Okuda and Mieno (1999) applied the econometric approach to measure cost inefficiency, economies of scale and technological progress of Thai banks during 1985-1994. We compared and found some consistent results with Okuda and Mieno (1999) in Chapter 6 and Leightner and Lovell (1998) in Chapters 8 & 9. Neither of these studies, however, explains the effects of deregulation nor do they examine specifically the sources of inefficiency and productivity change.

The present study is the first to investigate the efficiency and productivity of the Thai banking sector using a single data set; a consistent specification of bank inputs and outputs; the DEA technique for calculation of relative efficiencies and productivity indices; and it is also the first empirical study to include finance and specialised institutions (FSIs) in the empirical analysis[1]. In addition, this study extends existing studies on the Thai banking sector in two important respects. First, we identify the sources of cost (allocative) dis-efficiencies, technical inefficiency and productivity change; and, second, we examine the impact of deregulation on the variability of bank efficiency and productivity. Specifically, we aim to contribute to the understanding of the effects of financial deregulation on the banking sector in an emerging economy, which experienced radical changes and rapid transition from a highly regulated and domestic environment, to a less regulated and more open (free market) regime.

9.1 Has the 1990-97 financial deregulation improved efficiency and productivity of banks?

The empirical investigation of this study aimed to answer the research question: "Has the 1990-97 financial deregulation improved efficiency and productivity of banks in Thailand?"

The first part of the empirical analysis investigated the impact of deregulation on productive efficiency. The results suggest that there were slight improvements in average technical, allocative and cost efficiencies of Thai and foreign banks and the FSIs, and that they are significantly different for banks in the three groups studied. Foreign banks had the greatest number of efficient DMUs. There was an increased variability of efficiency scores over the study period, which suggests that deregulation created "winners" and "losers", rather than a convergence towards best practice.

[1] The same data and methodology were used to produce a paper presented to the Annual Conference of the European Association of University Teachers in Banking and Finance 2000 (Göteborg University, Sweden), which is included in the bibliography.

Allocative efficiency appeared to be the main contributor to the cost efficiency of Thai banks and FSIs. On the other hand, there were two main groups of foreign bank DMUs: one such group had allocative efficiency and the other had technical efficiency as the main source of their respective cost efficiency. Further investigation showed that the cost (allocative) disefficiency of Thai banks was associated with higher ratios of fixed assets and employees to purchased funds than optimal, while the findings for foreign banks and FSIs were the opposite. It was also found that inefficient DMUs in the first and second quartiles of allocative efficiency needed to increase their actual ratios of fixed assets and employees to purchased funds, while those in the third quartile of allocative efficiency needed to reduce these same ratios.

On the investigation of technical efficiency, it was found that Thai banks, with the exception of the largest banks BBL and KTB, could apparently have reduced their relative use of employees and fixed assets. An analysis of the relationship between bank size and measured efficiencies showed that technical, allocative and cost efficiencies of Thai banks were strongly and positively correlated with bank size. On the other hand, a very weak (U-shaped) relationship between efficiencies and size for foreign banks and FSIs was found.

A further analysis of cost-efficient DMUs found that around 5 per cent of DMUs in this sample were efficient and BBL was the only efficient Thai bank. The existence of diseconomies of scale along part of the estimated frontier suggested that the efficient DMUs of Thai banks and FSIs were too large, while some of the efficient foreign banks were too small compared with the most productive scale size, which ranged from 19 to 34 billion baht of total assets.

To ensure the robustness of efficiency estimates, we analysed the impact of influential observations on the DEA efficiency analysis. The results showed that efficiency scores obtained in the first-stage DEA analysis were not badly affected by the influential observations. We then examined the consistency of efficiency measures with financial ratios and the results suggested a weak correlation. Further investigation of the relationship between cost efficiency and the profitability measure (ROA) also suggested similar results.

The analysis of productive efficiency in the second-stage regression analysis suggests that there was a positive and significant relationship between profitability

(ROA) and all three efficiency measures, other things being equal. Financial strength was positively related to technical and cost efficiencies, and higher asset quality was related to greater technical efficiency. There was some evidence of a negative relationship between the ratio of total costs to assets, and technical and cost efficiencies. All other things being equal, the mean cost and allocative efficiencies of Thai and foreign banks were different, and the means of all three efficiency measures of Thai and foreign banks were greater than those of FSIs. Finally, we found significant improvements of technical and cost efficiencies in 1997, which suggested that it could take some years for bank deregulation to show a positive (efficiency-improving) effect.

In the second part of the empirical analysis, we investigated the impact of financial deregulation on productivity change. We found that, on average, the productivity change of banks during 1990-97 was due to "technological progress". In the Thai case, these outward shifts of the production frontier year by year seem to have been largely driven by the huge expansion in lending that took place during 1990 to 1997. Average productivity of Thai banks did not increase, although their technological change was greater than foreign banks. This was due to a substantial decline in average efficiency change. The decomposition of change in technical efficiency suggested that the efficiency decline for banks was due to the downward changes in both pure technical efficiency and scale efficiency. The results showed greater variability of productivity indices towards the end of the study period, which again suggested "winners" and "losers" brought about by deregulation. We also found that the mean productivity indices of Thai and foreign banks were significantly different, and foreign banks had higher means, except for technological change, than Thai banks.

On the analysis of the relationship between bank size and productivity indices, we found very weak correlations between all productivity indices and bank size. Technological progress and efficiency decline were evident for all bank sizes, and small banks had a large dispersion of productivity change.

We examined the consistency of the total factor productivity index and found that the results using the adjacent base method were consistent with those obtained using the fixed (grand frontier) based period. Investigation of the Malmquist growth index showed that Thai medium and small banks had relatively higher indexes, but the relationship between bank size and the Malmquist growth index was weak. Finally, the second-stage regression analysis of productivity change suggested no significant effects of financial deregulation on total factor productivity change.

The overall conclusion is that the 1990-97 financial deregulation hardly improved productive efficiency, but had a beneficial effect on the technological change of commercial banks. We expect to see more deregulation in the Thai banking industry because many banks still have not been able to use all of their inputs efficiently to produce outputs. The competitive conditions are likely to change even more profoundly because of more foreign bank entries in 1997. Finally, we expect to see a number of mergers and acquisitions because many banks are apparently too small to achieve the most productive scale size.

9.2 Possible policy implications

The earlier analyses and conclusions from the empirical study suggest some possible policy implications which are as follows:

(i) ***Improvement of bank prudential supervision.*** Despite the emphasis given to the re-regulation between 1993 and 1997 (see, Chapter 3, Table 3.3), following the deregulation of interest rates during 1990-92, the analysis has shown that the risk index of Thai banks and FSIs increased over the period of study (see, Chapter 5, Table 5.10). The Thai authorities need to re-examine and re-establish the present supervisory monitoring system so as to be appropriate for the more vulnerable and competitive financial environment. Our empirical results (in Chapter 7) strongly suggest that greater financial strength and soundness (reflected in higher bank capital ratios) is positively related to technical and cost efficiencies. There are at least two ways to improve bank prudential supervision (see, for example, Ebert, 1998). First, the authorities need to increase transparency in financial markets on policies such as the disclosure of non-performing loans and corporate losses. The more transparent policies should help to reduce the risk of volatility which, in turn, should lower the costs of new capital. Also, this increased transparency should play an important role in restoring confidence that

was lost as a result of the financial crisis, giving more incentive to potential investors. Second, the authorities need to monitor the inflow of capital and ensure that financial institutions efficiently allocate their capital.

(ii) ***The role of bank management.*** The empirical results (in Chapters 7 and 8) suggest that the poor performance of Thai banks was related to the overutilisation of inputs and the decline in technical efficiency change. In an environment of the increased structural deregulation, domestic banks require a more sophisticated management if they are to survive the increased competition. This includes an improvement of leadership skills, human resources, staff training, marketing, processing and risk management. One way to increase managerial ability is to import managers and techniques from abroad (Casserley and Gibb, 1999). Alternatively, the unprecedented mergers and acquisitions wave following the financial crisis suggests that productive efficiency of domestic banks can be improved through the superior management of the acquirers. Finally, the greater competition from abroad implies that domestic banks will have to refocus on areas where they can build the greatest competitive advantage i.e., they should focus their strategies on consumers and products that attract the least intense foreign competition and using their branch networks to access cheap sources of funds (deposits).

9.3 What happened to the Thai banking industry in the post 1997 financial crisis?

This study examined the efficiency and productivity of banks during 1990 to 1997 (only these data were available at the time the research was conducted). It is likely that in the period immediately preceding 1997, the build-up to the crisis had already begun and, therefore, influenced our results. What happened in the post-1997 financial crisis period is, therefore, important and relevant to our study.

Following the financial crisis at the end of 1997, Thailand continued to address the problems of the banking sector under the IMF restructuring program[2]. The remedial measures in 1998 included mergers and acquisitions, write-down of capital,

[2] Further details can be obtained from the Bank of Thailand *Annual Report*, 1998-99.

recapitalisation, and privatisation of Thai banks and finance companies. These resulted in three mergers: the first was between BBC, FBC and KTB; the second was between LTB and Radanasin Bank[3]; and third, UBB merged with 13 finance companies after their capital was written down. Two banks (BMB and SCIB) were ordered to recapitalise and privatise, while BOA was acquired by ABN. The post-crisis mergers and acquisitions in Thailand and other emerging East Asian countries is well documented by, for example, Leung, Poullet and Shavers (1999). Chapter 7 found that these banks (BBC, BMB, FBC, BOA, SCIB, UBB and LTB) had very low average relative efficiencies during 1990-97.

The restructuring program in 1998 was accompanied by measures to improve prudential supervision. The important measures were: first, the new classification of on- and off-balance sheet items using qualitative criteria of debt servicing capacity with different provisioning requirements[4]. Second, financial institutions are required to submit the qualitative analysis of their asset portfolios on a quarterly basis. Third, the composition of tier-1 capital is lowered from a minimum of 6% to 4.25% for commercial banks and from 5.5% to 4% for finance companies given that they must maintain the existing capital adequacy ratios respectively at 8.5% and 8%. Finally, the criteria on net foreign reserve modified to include BIBF foreign exchange position, and the average weekly surplus and deficit must not exceed 15% of tier-1 capital or US$5 million.

In 1999, the Bank of Thailand implemented a number of measures with the aim of increasing the liquidity of the banking system. The important measures included the reduction in the bank rate of the loan window for commercial banks and finance companies, which declined from 12.5% to 7% in February, to 5.5% in June, and then to 4% in July. Also, there was a reduction of the liquidity reserve requirement from 2% to 1% of deposits and short-term foreign borrowings, which resulted in a 3.6% increase in money supply (M2) at the end of 2000[5]. Meanwhile, there was a recapitalisation of two Thai banks in which foreign banks had 75% of their total shares. First, Radanasin Bank

[3] Radanasin Bank was established in January 1998.
[4] There are five categories of on- and off-balance sheet items under the new classification: pass, special-mentioned, sub-standard, doubtful and loss. Their provisioning requirements are 1%, 2%, 20%, 50% and 100%, respectively.
[5] As indicated in http://www.bbl.co.th/eco_inc/14_1ymoney.htm

was acquired by the United Overseas Bank of Singapore and, second, NKB was sold to Standard Chartered Bank.

There is now (2001) a growing trend of mergers and acquisitions in the Thai banking system. This is because the industry suffers from information asymmetries with respect to the quality of banks' assets that raise the costs of external capital, and thus makes raising capital problematical for many banks. It is expected that mergers and acquisitions can improve the efficiency and productivity of the target bank and/or the combined post-merger entity, because they provide opportunities to improve bank operating performance. For instance, a number of important operations such as information systems and investments can be conducted centrally. The fixed costs of these operations can be spread over a broader base, and revenue may be increased.

Another benefit of mergers and acquisitions is that scale economies can be improved. Chapter 7 showed that some of the efficient foreign banks were too small and had opportunities to become more efficient through growth. The combined bank can increase market share and productivity in core lines of business or diversify into new product markets or geographical regions.

9.3 Limitations of this research

The main criticism of this research relates to the small sample size due to the fact that there were only 29 commercial banks (up until 1997) in Thailand. It was not possible to select banks from other countries which perfectly matched the Thai economic, financial and supervisory system. With this problem in mind, a sample of the FSIs (finance and specialised institutions) was included. Although there were some differences in institutional characteristics, these institutions were deregulated at the same time as commercial banks.

Another limitation is also due to the lack of availability of data: the most recent data were for 1997 at the time this research was started. Therefore, only the immediate impact of the 1997 crisis was reflected in the analysis. Inclusion of 1998 (and 1999) data would have given a fuller picture of the effects of the crisis. In particular, the loan loss provisions published by some of the banks at the end of 1997 now seem to have been rather optimistic (see, for example, the analysis of TFB in Casserley and Gibb, 1999 and Leung *et al.*, 1999)

Another possible problem with this study was the estimation of cost efficiency, which requires the price of inputs of each DMU under investigation. Data on the number of employees of FSIs were not available, and therefore their respective prices of labour are not known. To alleviate this problem, the figures had to be estimated from the average price of labour of Thai and foreign banks. A sensitivity analysis using the estimated lower quartile, mean, and upper quartile prices was conducted, and the results suggested no difference either in the number of efficient banks or the efficient DMUs (see, Appendix IV). This was the underlying reason for choosing the estimated mean price of labour for the FSIs.

Next, the DEA methodology used in this study can also be subject to criticisms. Firstly, the results are influenced by the sample size and by the chosen number of inputs and outputs. By computing the efficiency of Thai banks relative to the grand frontier and to the Thai banks' own frontier, it is observed that average efficiency scores obtained from the Thai banks' own frontier are higher than those from the grand frontier, as expected. However, the main findings do not change: Thai banks, on average, demonstrate a relatively high allocative efficiency, but low technical efficiency. This research does not make case-by-case assumptions about input and output combinations. Therefore, the results should be seen as relating to the specific case: where banks are considered to produce two outputs (net total loans and other earning assets) by using three inputs (labour, physical capital and purchased funds).

A second limitation to the DEA approach is that it assumes that there is no statistical noise and random error, and that the efficiency of a bank depends wholly on the management of bank inputs and outputs (see, for example, Berger and Humphrey, 1997). Also, it is possible that a part of the variation in the calculated efficiencies can remain unaccounted for in a second stage regression using OLS and Tobit models (Bhattacharyya *et al.*, 1997). This research has adopted the Bhattacharyya *et al.* (1997)'s approach to explain the efficiency effects of financial deregulation. Chapter 7 showed that the regression results are robust.

There are a number of ways in which this research could be extended. On possibility is to use different definitions and measurement of bank inputs and outputs. This would highlight whether the choice of a different approach influences the findings. Another possibility is to investigate whether different estimation techniques (e.g., SFA, DFA, and TFA) would yield similar results. Finally, a longer series of observations of the Thai banking industry would allow the closer investigation of productive efficiency and productivity change in pre-, concurrent, and post-deregulation periods.

The various limitations, which have been underlined in this section, suggest that the findings in this study should be interpreted with caution. The specific goals of this research are stated at the outset, which do not pretend to cover all aspects of bank performance. However, this study represents an attempt to examine empirically evidence on the impact of financial deregulation on bank efficiency and productivity in an emerging economy that until now has attracted little attention from researchers. Further empirical evidence on the effects of financial deregulation would undoubtedly be welcome for both bank managers and regulators.

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APPENDIX I Studies of productive efficiency in banking firm

Author(s); technique; approach	Inputs	Outputs	Sample	Average annual efficiency estimate
Sherman and Gold (1985); DEA; production	Labour, office space, supply costs	Loan applications, new passbook loans, life insurance sales, new accounts, closed accounts, travellers checks sold, bonds sold, bonds redeemed, deposits, withdarwals, checks cashed, treasury checs issued, B5 checks, loan payments, passbook loan payments, life insurance payments, mortgage payments	14 US bank branches	0.96
Charnes et al. (1990); DEA; intermediation	Interest expenses, non-interest expenses, provision for loan sales	Interest expenses, non interest income, allowance for loan losses, total loans	US Banks	n.a.
Oral and Yolalan (1990); DEA; production	Personnel, on-line terminals, commercial accounts, saving accounts, credit applications	Time spent on service transactions, on credit transactions, on deposit transactions, and on foreign exchange transactions	Turkish Bank branches	0.87, 0.53
Aly et al. (1990); DEA; user cost	Labour, physical capital, loanable funds	Real estate loans, commercial loans, consumer loans, other loans, demand deposits	322 US banks, 1986	0.75, 0.81
Elyasiani and Mehdian (1990a); DEA; intermediation	Labour, physical capital, demand eposits, time and saving deposits	Securities held, real estate loans, commercial loans, other loans	191 US banks, 1980	0.90, 0.78
Elyasiani and Mehdian (1990b); SFA; intermediation	Labour, capital, demand and time deposits, large certificate of deposits	Loans, investment	144 US banks, 1985	0.88
Ferrier and Lovell (1990); DEA and SFA; production	Labour, occupancy costs, expenditure on material	Number of: demand deposit accounts, time and saving deposit accounts, real estate loans, instalment loans, commercial loans	575 US banks, 1984	0.83, 0.79
Berger and Humphrey (1991); TFA; intermediation	Labour, physical capital, purchased funds	Demand deposits, time and saving deposits, real estate loans, commercial and industrial loans, installation loans	US banks, 1984	0.81, 0.84
Yue (1992); DEA; intermediation	Interest expenses, non-interest expenses, transaction deposits, non-transaction deposits	Interest income, non-interest income, total loans	60 US banks, 1984-1990	n.a.
Elyasiani and Mehdian (1992); DEA; intermedation	CDs, times and savings deposits, demand deposits, capital, labour	Commercial and industrial loans, real estate loans, other loans, investment securities	80 minority-owned US banks, 1988	0.89

APPENDIX I Studies of productive efficiency in banking firm (continued)

Author(s); technique; approach	Inputs	Outputs	Sample	Average annual efficiency estimate
Berg et al (1992), DEA, value added	Labour, material	Short term loans, long term loans, deposits	Norwegian banks, 1980-89	0.57, 0.78, 0.53
English et al (1993), DEA, asset approach	Interest bearing small deposits, labour, occupancy expenses, purchased funds	Real estate loans, commercial loans, consumer installment loans, investment securities	442 US banks , 1982	0.75, 0.76
Pi and Timme (1993), SFA, intermediation	Labour, capital, deposits	Commercial and industrial loans, consumer loans, real estate loans, service charges	112 US banks, 1988-1990	0.87
Newman and Shrieves (1993), DFA, intermediation	Labour, capital, non interest expense	Interest income, non interest income	1730 US banks, 1988	n.a.
Fukuyama (1993); DEA, intermediation	Labour, capital, customer funds	Revenue from loans, revenue from other business activities	143 Japanese banks, 1990	0.86
Berger et al (1993a), DFA, intermediation	Labour, purchased funds	Business loans, customer loans	US banks, 1984-1989	0.52, 0.65, 0.66
Berg and Kim (1994), TFA; value-added	Labour, building capital, materials	Investments, home loans, other loans, deposits	173 Norwegian banks, 1988	0.81, 0.81
Kwan and Eisenbeis(1994), SFA; intermediation	Labour, capital, loanable funds	Book value of: investment securities, real estate loans, commercial and industrial loans, consumer loans, and off balance sheet commitments and contingencies	254 US banks, 1986-91	0.88, 0.85, 0.84, 0.84, 0.88, 0.88
Kaparakis et al. (1994); SFA, intermediation	Labour, physical capital, interest bearing deposits under $100,000, non interest bearing deposits, purchased funds	Loans to individuals, real estate loans, commercial loans, fed funds sold, securities held, securities and other assets in trading accounts	5548 US banks, 1986	0.90
Grabowski et al (1994), DEA, intermediation	Labour, capital, loanable funds	Real estate loans, commercial and industrial loans, consumer loans, demand deposits, securities	669 US banks, 1979, 1983, and 1987	0.74, 0.76, 0.73
Hunter and Timme (1995); DFA, intermediation	Labour, physical capital, purchased funds, transaction accounts, non transaction accounts under $100,000	Commercial and security loans, consumer loans, other loans, interest income	371 US banks, 1985-90	0.84, 0.77, 0.78
Favero and Papi (1995), DEA, intermediation and asset	Labour, capital, loanable funds, financial capital	Loans to other banks and non financial institutions, investment in securities and bonds, non interest income	174 Italian banks, 1991	0.88,0.91, 0.79, 0.84

APPENDIX I Studies of productive efficiency in banking firm (continued)

Author(s); technique; approach	Inputs	*Outputs*	Sample	Average annual efficiency estimate
Elyasiani and Mehdian (1995); DEA; intermediation	Large CDs, time and saving deposits, demand deposits, capital, labour	Investment, real estate loans, commercial and industrial loans, other loans	150 US banks, 1979 and 1986	0.97, 0.95, 0.95, 0.96
Fukuyama (1995); DEA; intermediation	Labour, capital, customer funds	Revenue from: loans, investment	462 Japanese banks, 1989-1991	0.46, 0.46, 0.44
Zaim (1995); DEA; intermediation	Number of employees, interest expenditures, depreciation expenditures, expenditures on materials	Total balance of: demand deposits, time deposits, short-term loans, long-term loans	95 Turkish banks, 1981 and 1990	0.83, 0.94
Clark (1996); TFA; value-added	Labour, premises and equipment, funds	Commercial and industrial loans, consumer and real estate loans, total securities, core deposits	440 US banks, 1988-1991	0.73, 0.90
De Young and Nolle(1996); DFA; intermediation	Purchased funds, labour, core deposits, physical capital	Total loans, total securities	1812 US banks, 1985-1990	0.56, 0.73
Grifell-Tatjé and Lovell (1996); DEA; value added	Number of employees, expenditure on materials, expenditure on buildings	Number of: loan accounts, checking accounts, saving accounts, branch offices	419 Spanish saving banks, 1986-1991	0.76, 0.75, 0.75, 0.80, 0.78, 0.80
Miller and Noulas (1996); DEA; intermediation	Total transaction deposits, total non-transaction deposits, total interest expense, total non-interest expense	Commercial and industrial loans, consumer loans, real estate loans, investments, total interest income, total non-interest income	201 US banks, 1984-1990	0.97
Lang and Welzel (1996); DFA; intermediation	Labour, physical capital, deposits	Short-term loans to non-banks, long-term loans to non-banks, interbanking assets, fee and commissions, revenues from sales of commodities	757 German Cooperative banks, 1989-1992	0.54, 0.61
Mahajan et al. (1996); TFA; intermediation	Labour, capital, purchased deposits	Total loans, demand deposits, government securities	US multinational banks, 1987-1990	0.77, 0.88
Mester (1996); SFA; intermediation	Labour, physical capital, deposits	Real estate loans, loans to individuals, other loans	US banks, 1991-1992	0.86
Berger and De Young (1997); SFA; production	Labour, physical capital	Commercial loans, consumer loans, real estate loans, transaction deposits, and fee based income.	US banks, 1985-1994	0.92, 0.94, 0.95, 0.91, 0.93, 0.91, 0.91, 0.91, 0.93, 0.95
Berger et al. (1997);DFA; intermediation and production	Labour, physical capital	Consumer transaction accounts, consumer nontransactions accounts, business transactions accounts, business nontransactions accounts, number of: deposit accounts, debits, credits, account opened, account closed, and loans originated	832 US bank branches, 1989-1991	0.94, 0.79

APPENDIX I Studies of productive efficiency in banking firm (continued)

Author(s); technique; approach	Inputs	Outputs	Sample	Average annual efficiency estimate
Resti (1997); DEA and SFA; user cost	Fixed capital, labour	Loans to customers, *customer deposits, non-interest* income	270 Italian banks, 1988-1992	0.74, 0.76, 0.74, 0.75, 0.73,0.69, 0.70, 0.70, 0.70, 0.70
Berger and Mester (1997); DFA; intermediation	Purchased funds, core deposits, labour	Consumer loans, business loans, securities	5949 US banks, 1990-95	0.87, 0.55, 0.46
Humphrey and Pulley (1997); TFA; intermediation	Labour, core deposits and purchased funds, physical capital	Payment, liquidity and safekeeping services, intermediation and loan services	683 US banks, 1977-80, 1981-84, and 1985-88 average data	0.81, 0.82, 0.85
Bhattacharyya et al. (1997); DEA; value added	Interest expense, operating expense	Advances, deposits, investments	70 Indian banks, 1986-1991	0.82, 0.79, 0.79, 0.79, 0.80, 0.80, 0.80
Altunbas et al. (1997); SFA; intermediation	Labour, physical capital, total funds	The dollar value of total aggregate: mortgage loans, public loans, other loans, securities, off-balance sheet activities	4659 German banks, 1988-1995	0.95, 0.93, 0.93, 0.94, 0.94, 0.93, 0.94, 0.94
Mester (1997); SFA; intermediation	Labour, physical capital, borrowed money	Real estate loans, loans to individuals, other loans	6630 US banks, 1991-92	0.93, 0.92, 0.85, 0.87, 0.89, 0.88, 0.86, 0.85
Altunbas and Molyneux (1997); SFA; intermediation	Labour, physical capital, total funds	Total aggregate loans, total aggregate securities, off-balance sheet activities	13603 European banks, 1988-1995	0.75, 0.75, 0.73, 0.72, 0.76, 0.76, 0.74, 0.75
Peristiani (1997); DFA; intermediation	Labour, capital, borrowed funds	Commercial and industrial loans, personal loans, real estate loans, retail and saving deposits	US banks, 1980-1990	0.79, 0.79, 0.77, 0.81, 0.81, 0.77
Casu and Girardone (1998); SFA and DEA; intermediation	Labour, physical capital, deposits	Total loans, other earning assets	110 Italian banks, 1995	0.93, 0.95
De Young et al. (1998); SFA; intermediation	Labour, physical capital, borrowed funds	Commercial loans, consumer loans, real estate loans, transaction deposits, fee based income	3997 US banks, 1992	0.66
De Young (1998); TFA; intermediation	Labour, physical capital, deposits	Loans, transaction services, fee based activities	1214 US banks, 1993	0.71, 0.74
Kraft and Tiruroglu (1998); SFA; intermedition	Labour, capital, loanable funds	Total value of: loans, deposits	86 Croatian banks, 1994 and 1995	n.a.
Rogers (1998); SFA; intermediation	Labour, physical capital, time and saving deposits, purchased funds	Demand deposits, time and savings deposits, real estate loans, other loans, net non-interest income	US banks, 1991-1995	n.a.

APPENDIX I Studies of productive efficiency in banking firm (continued)

Author(s); technique; approach	Inputs	Outputs	Sample	Average annual efficiency estimate
Bergendahl (1998); DEA; bank objective	Costs of personnel, costs of material, volume of credit losses	Volume of loans, volume of deposits, gross revenues	48 Nordic banks, 1992-1993	n.a.
Gilbert and Wilson (1998);DEA; user cost	Labour, physical capital, purchased funds	Demand deposits, loans with domestic currency, loans with foreign currency, loans by trust account	Korean banks, 1980-1994	n.a.
Leightner and Lovell (1998); DEA; bank objective	Personnel expense, premise and equipment expense, provision for loan loss	Net interest income, non-interest income, credit granted, investment in securities	31 Thai banks, 1989-1994	0.42, 0.51, 0.55, 0.58, 0.66, 0.69
Altunbas et al. (1998); SFA; intermediation	Labour, physical capital, total funds	The dollar value of total aggregate: loans, securities, off-balance sheet activities	European banks, 1988-1995	0.75, 0.75, 0.73, 0.73, 0.76, 0.76, 0.74, 0.75

Notes: DEA = Data Envelopment Analysis, SFA = Stochastic Frontier Approach, DFA = Distribution Free Approach, TFA = Thick Frontier Approach, IN = Index approach.
Sources: Berger and Humphrey (1997) and author's own updates.

APPENDIX II A list of 5 specialised institutions and 27 finance companies

The followings are detail of finance and specialised institutions (FSIs) included in the study sample between 1990 and 1997.

Table A1 Study sample of finance and specialised institutions, 1990-1997

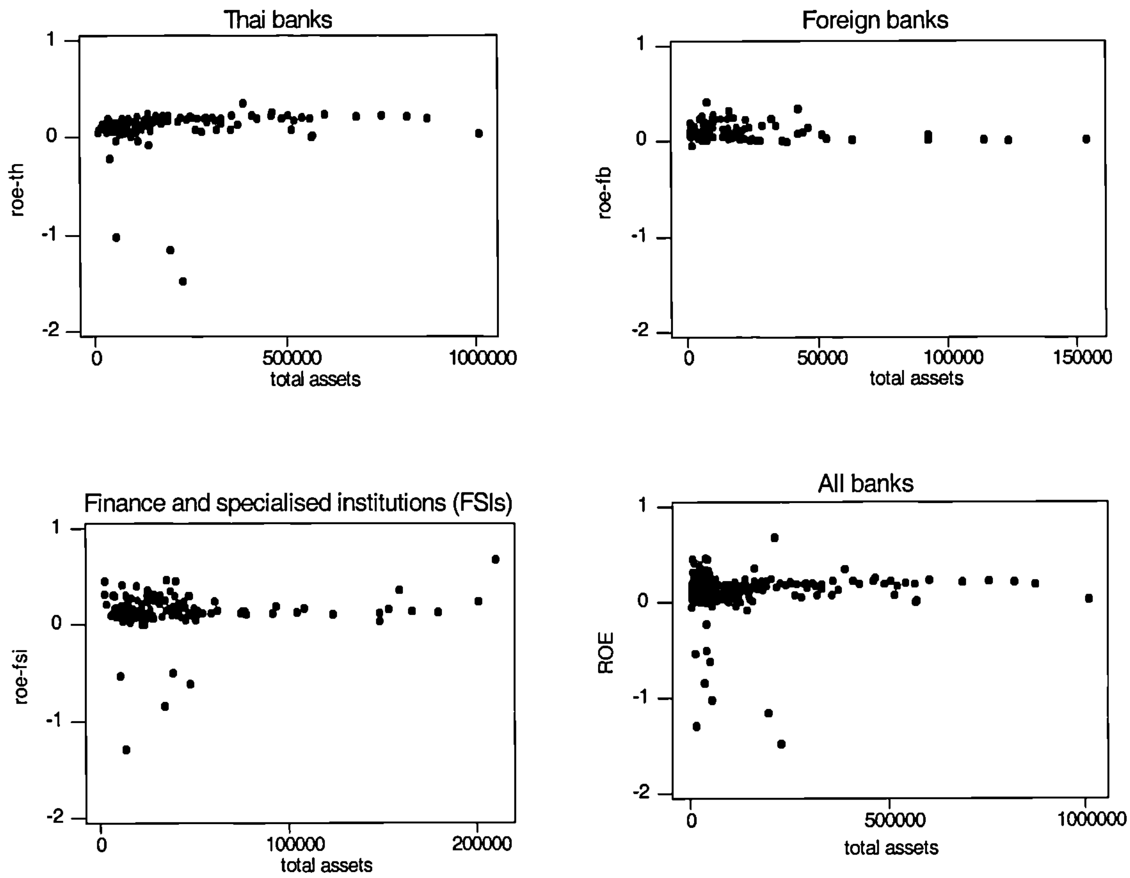
	1990	1991	1992	1993	1994	1995	1996	1997
Specialised institutions								
1.Government Housing Bank							*	*
2.Government Savings Bank					*	*	*	*
3.Bank for Agriculture and Agricultural Co-operatives				*	*	*	*	*
4.Industrial Finance Corporation of Thailand			*	*	*	*	*	*
5.Export-Import Bank of Thailand					*	*	*	*
Finance companies								
1.Asia Credit PCL				*	*	*	*	*
2.Bangkok First Investment & Trust PCL				*	*	*	*	
3.Cathay Finance and Securities PCL				*	*			
4.Cathay Trust Co. Ltd					*	*		
5.CMIC Finance and Security PCL		*	*	*	*	*	*	
6.Dhana Siam Finance & Securities		*	*	*	*	*	*	
7.Finance One PCL			*	*	*	*	*	
8.General Finance and Securities Ltd.		*	*	*	*	*	*	
9.IFCT Finance and Securities PCL						*	*	*
10.ITF Finance and Securities PCL				*	*	*	*	
11.Kiatnakin Finance and Securities PCL					*	*		
12.Krungthai Thanakit PCL			*	*	*	*	*	*
13.Multi-Credit Corporation of Thailand PCL		*	*	*	*	*	*	
14.National Finance & Securities PCL		*	*	*	*	*	*	*
15.Nava Finance & Securities PCL				*	*	*	*	
16.Nithipat Capital PCL				*	*	*		
17.Phatra Thanakit PCL			*	*	*	*	*	*
18.SCF Finance and Securities PCL					*	*	*	
19.Siam City Credit Finance and Securities PCL				*	*	*	*	
20.Siam Sanwa Industrial Credit PCL		*	*	*	*	*	*	*
21.SITCA Investment and Securities PCL			*	*	*	*	*	
22.SRI Dhana Finance and Securities PCL						*	*	
23.Thai Investment and Securities PCL			*	*	*	*	*	
24.Thai Securities Co. Ltd					*	*		
25.Thaimex Finance and Securities PCL					*	*	*	
26.Union Asia Finance PCL	*	*	*	*	*	*	*	
27.Wall Street Finance and Securities PCL			*	*	*	*	*	

Note: (*) indicates the presence of finance and specialised institutions.
Source: The London-based International Bank Credit Analysis *Bankscope* database.

Table A1 shows the inclusion of finance and specialised institutions in this study. The presence of these institutions is activated according to the availability of data in the *Bankscope* database. The 21 DMUs of 5 specialised institutions accounted for about 57%, while 120 DMUs of 27 finance companies represented about 18% of the actual data over the 1990 to 1997 period.

APPENDIX III The relationship between bank size and financial ratios

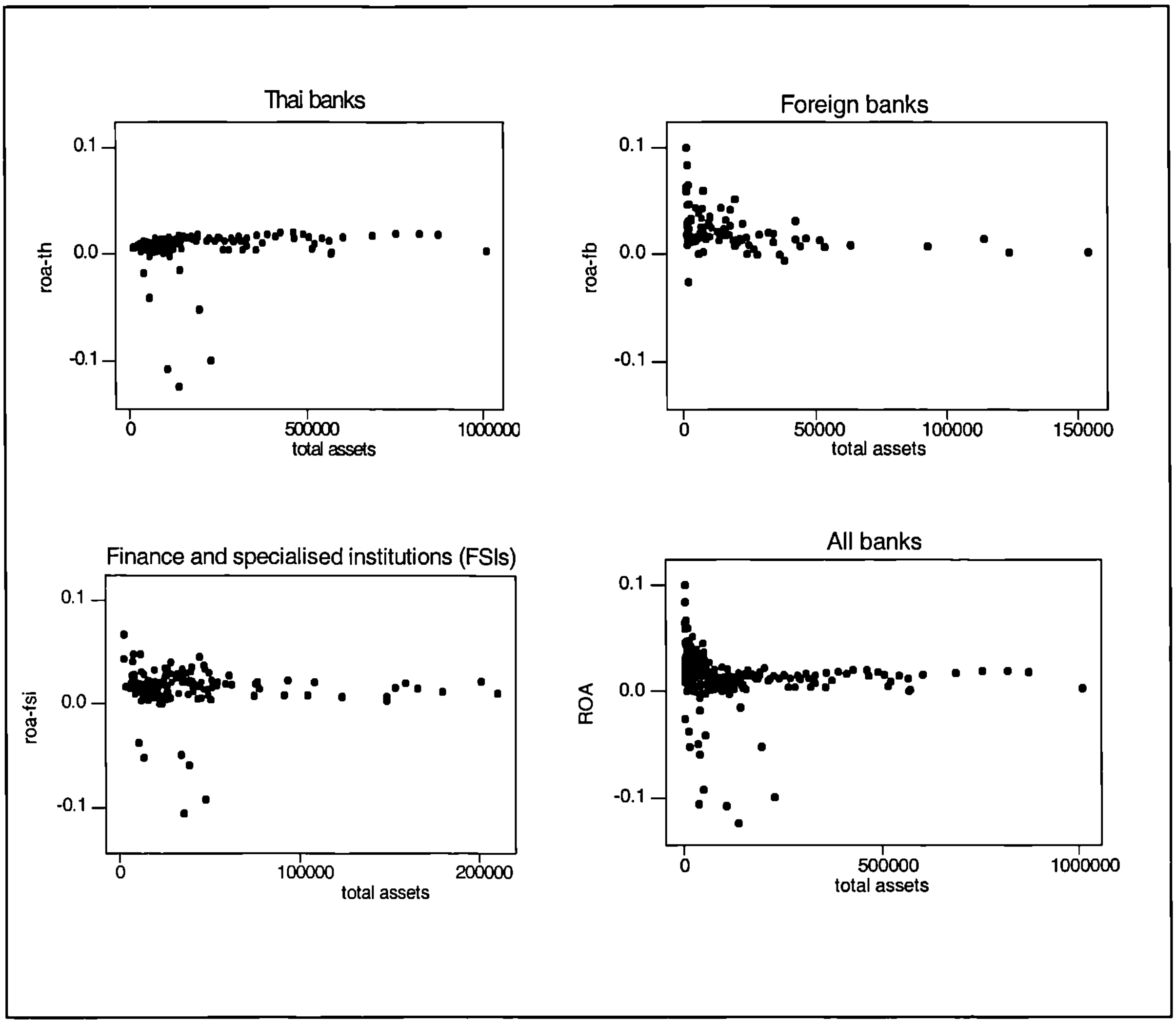
Figure A1 The relationship between bank size and ROE



Note: The plots of FSIs omitted DMU of S.G. Asia in 1997 that had ROE of –5.72.

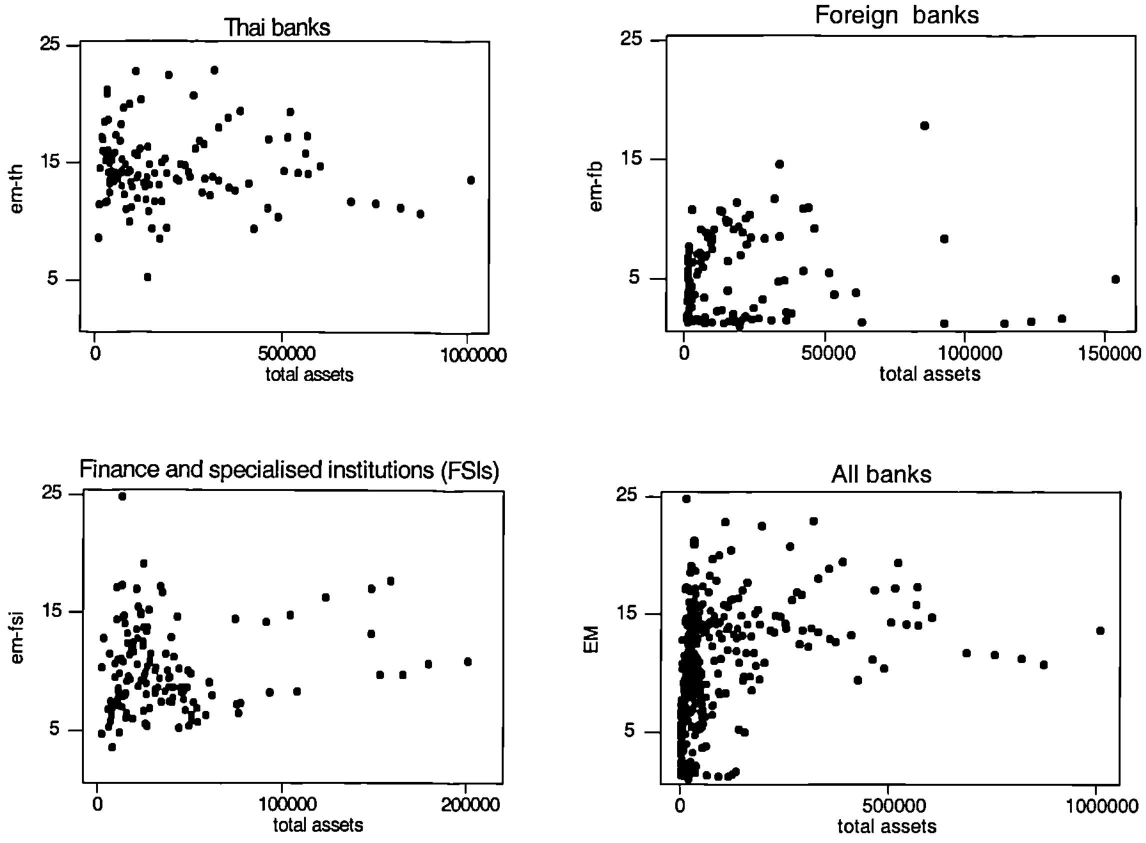
APPENDIX III The relationship between bank size and financial ratios (continued)

Figure A2 The relationship between bank size and ROA



APPENDIX III The relationship between bank size and financial ratios (continued)

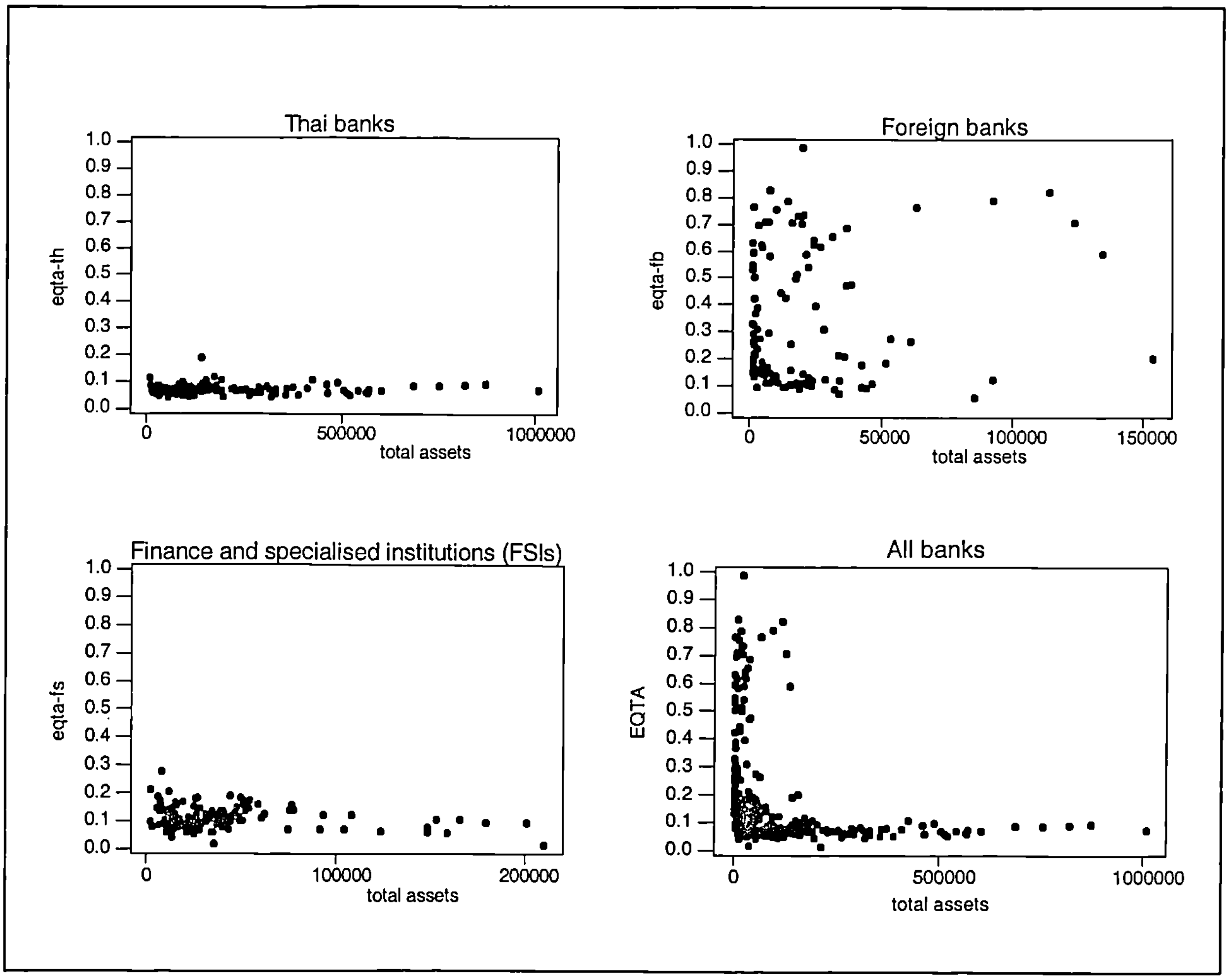
Figure A3 The relationship between bank size and EM



Note: The plots for FSIs omitted DMU of GHB in 1997 that had EM of 68.5.

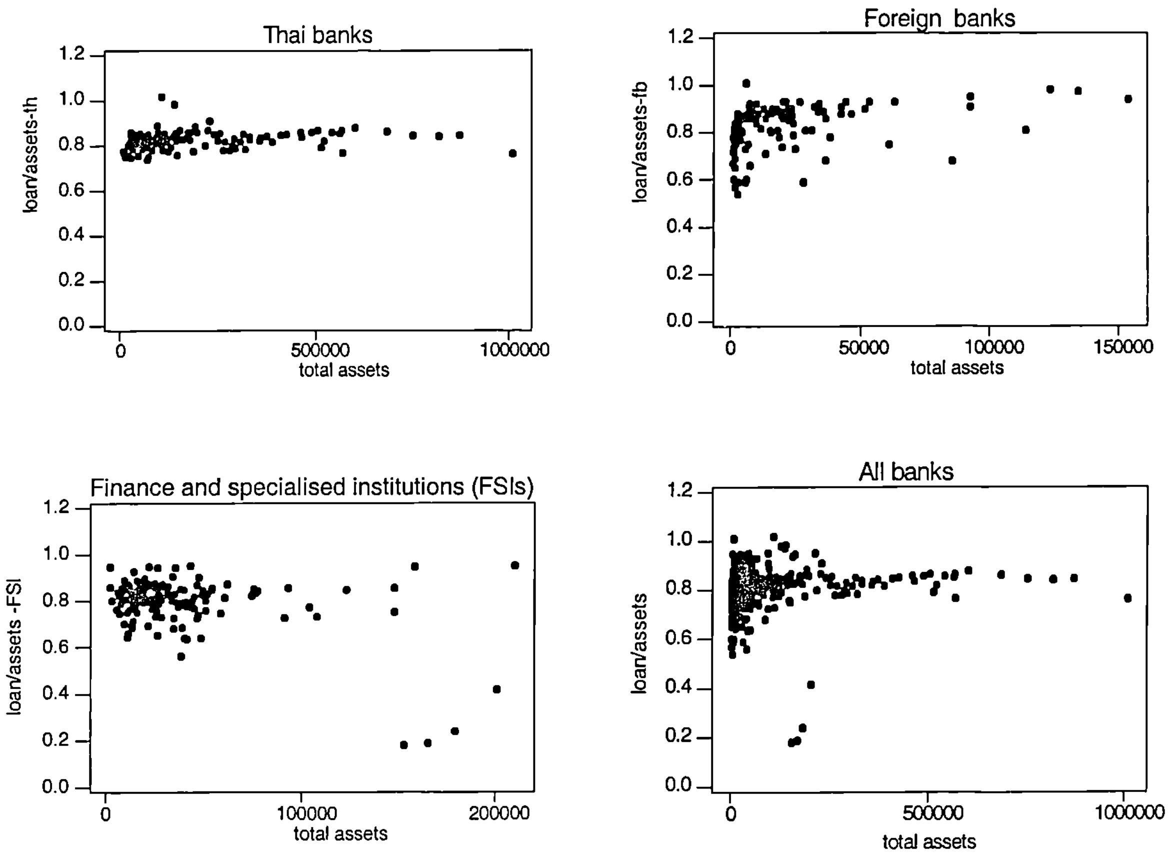
APPENDIX III The relationship between bank size and financial ratios (continued)

Figure A4 The relationship between bank size and equity to assets ratio



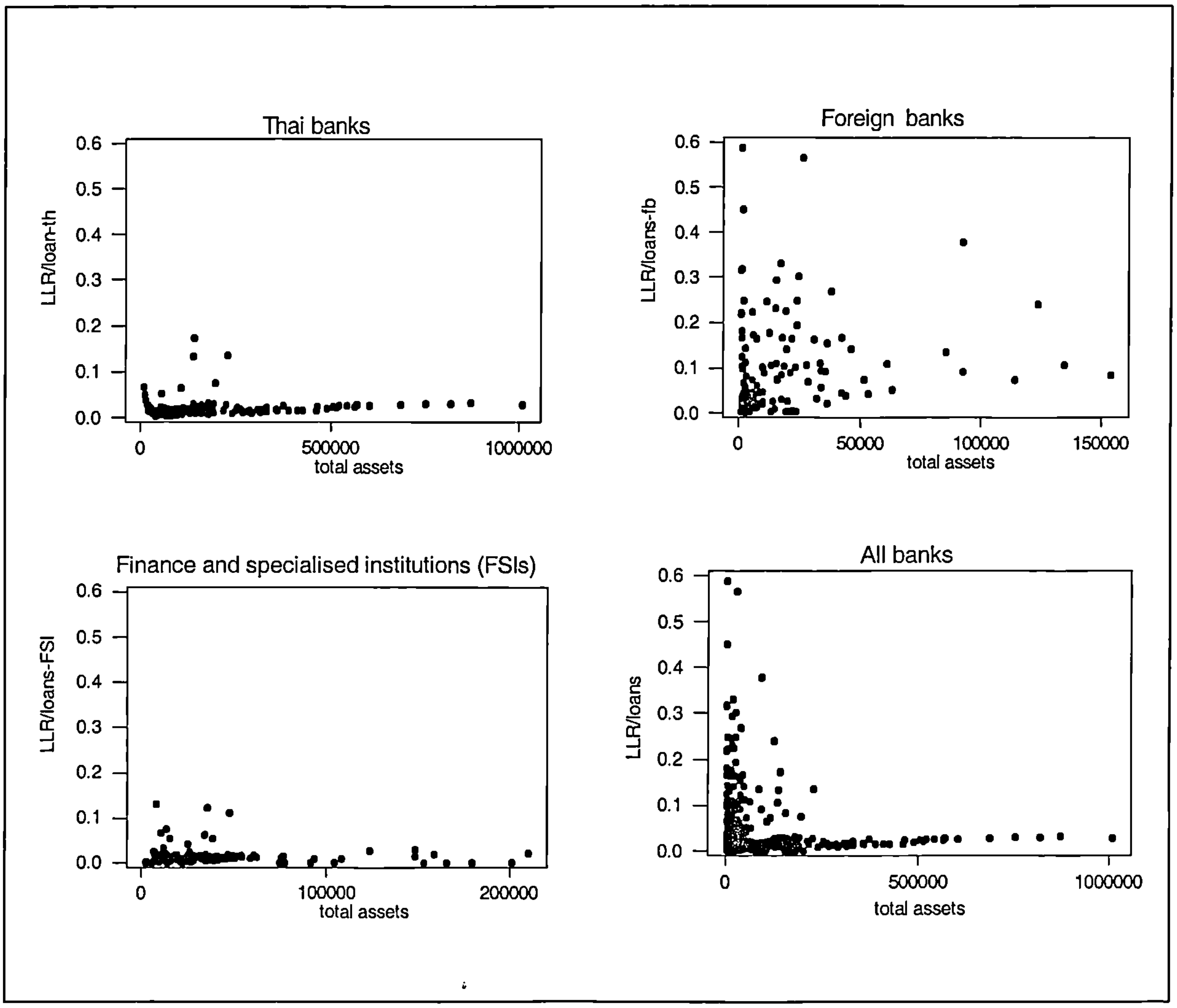
APPENDIX III The relationship between bank size and financial ratios (continued)

Figure A5 The relationship between bank size and loan to assets ratio



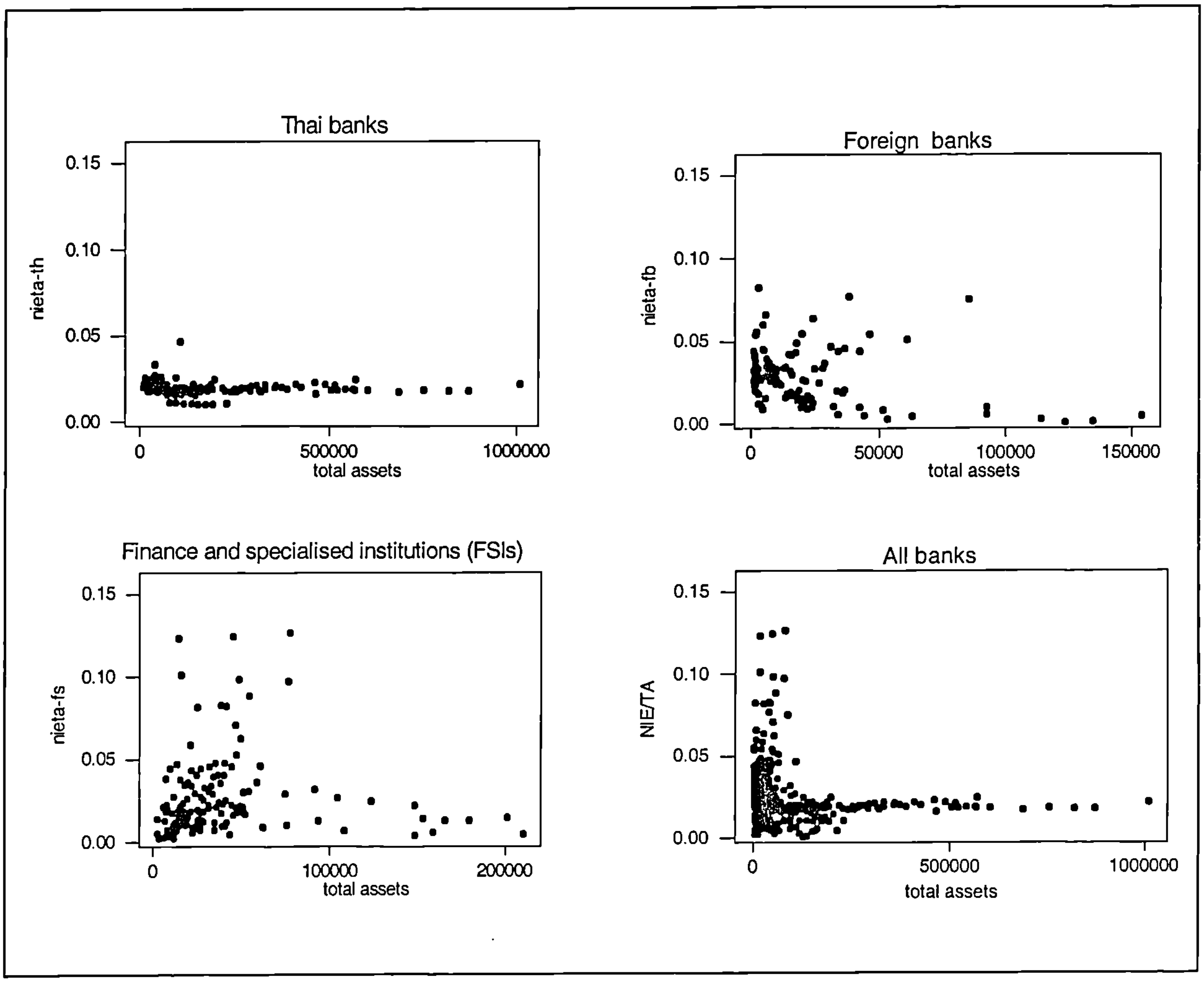
APPENDIX III The relationship between bank size and financial ratios (continued)

Figure A6 The relationship between bank size and loan loss reserve to total loans ratio



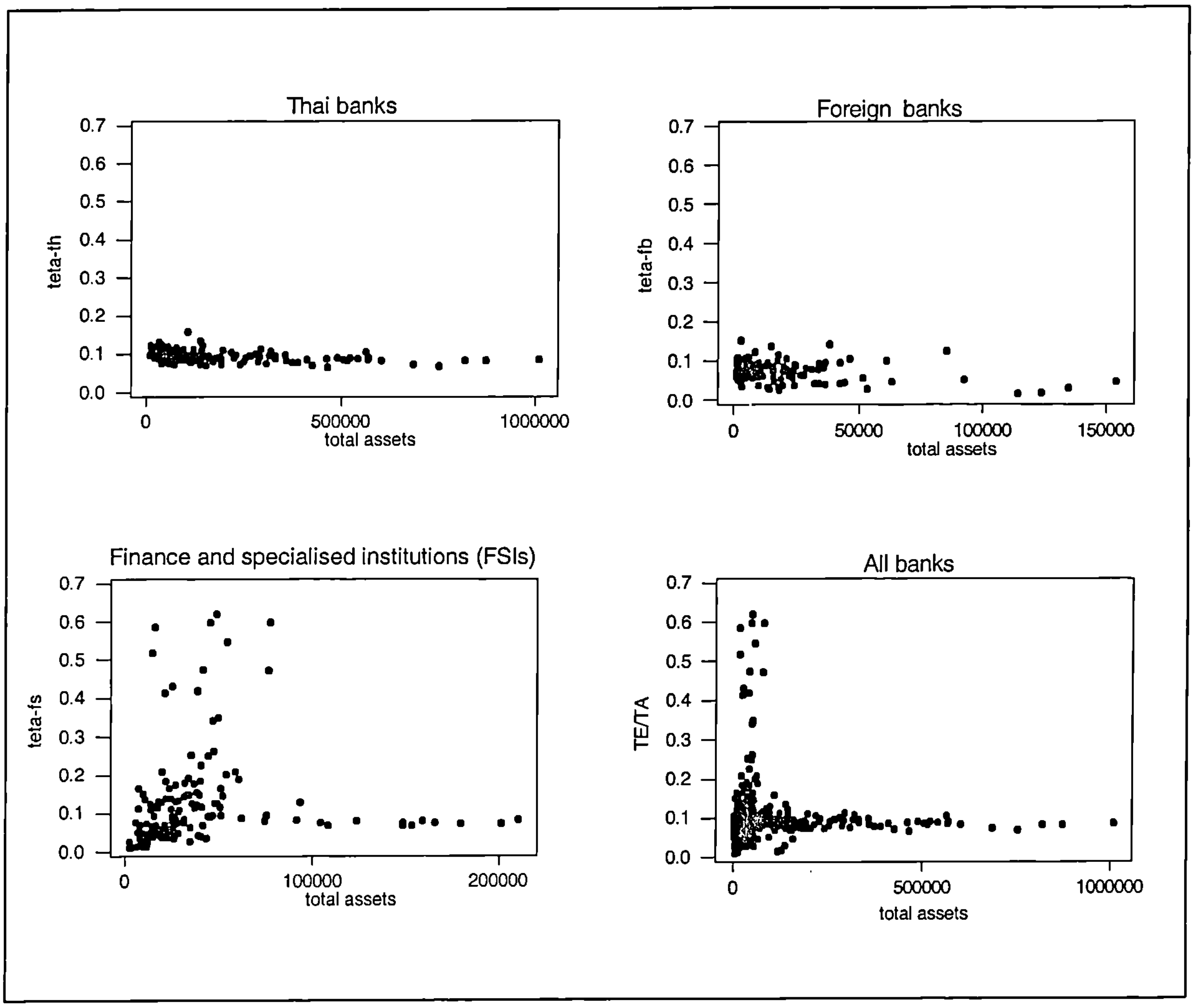
APPENDIX III The relationship between bank size and financial ratios (continued)

Figure A7 The relationship between bank size and non-interest expense to assets ratio



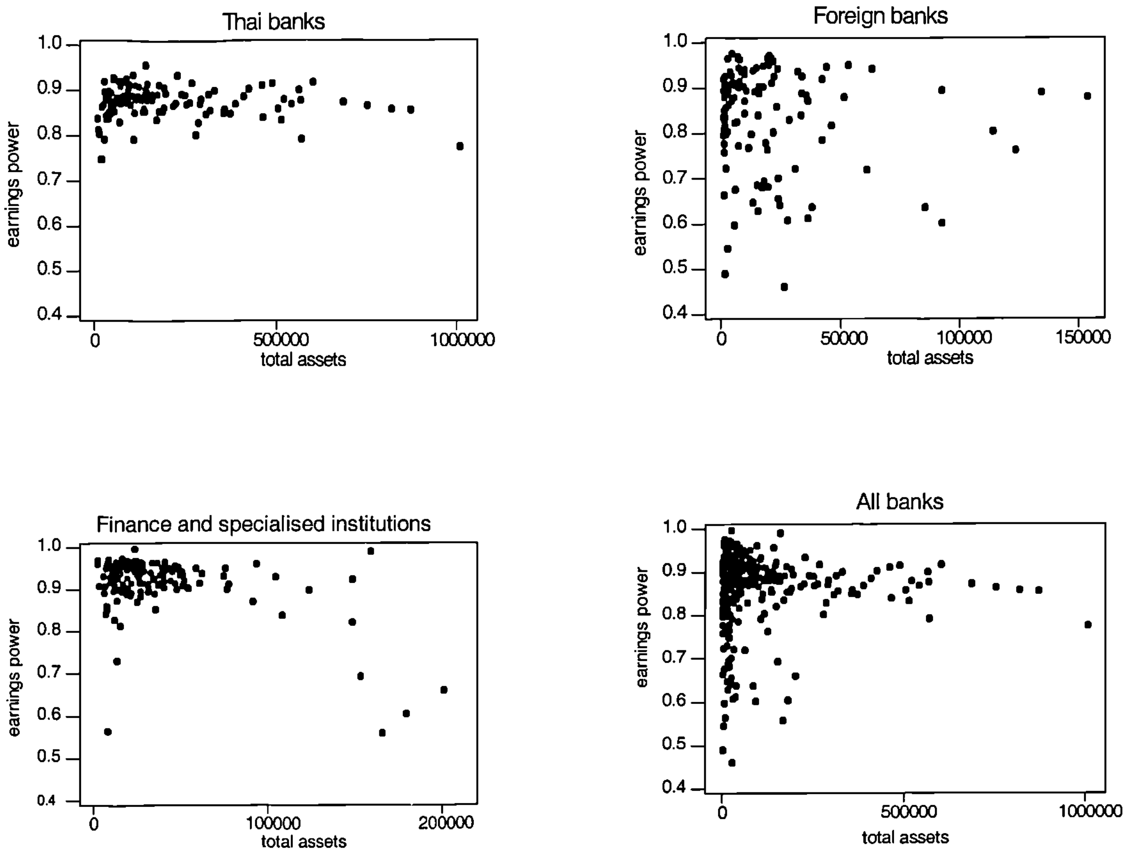
APPENDIX III The relationship between bank size and financial ratios (continued)

Figure A8 The relationship between bank size and total expense to assets ratio



APPENDIX III The relationship between bank size and financial ratios (continued)

Figure A9 The relationship between bank size and earnings power



Note: The true zero is not shown in order to enhance the clarity.

APPENDIX IV Sensitivity analysis of price of labour for the FSIs

The following Tables show the results of sensitivity analysis of price of labour for the FSIs (finance and specialised institutions). There are two objectives. First, is to examine whether the labour prices for the FSIs calculated from those of lower quartile, mean and upper quartile of Thai and foreign banks have an impact on efficiency estimates. The second objective is to examine whether the number of banks and banks which are on efficient frontier are different to the choice of labour prices for the FSIs.

Table A2 Sensitivity analysis of labour price for the FSIs: Mean cost efficiency

Year	Lower quartile price	Average price	Upper quartile price
1990	0.2942	0.2940	0.2940
1991	0.2599	0.2606	0.2610
1992	0.2548	0.2557	0.2568
1993	0.2365	0.2382	0.2401
1994	0.2515	0.2542	0.2566
1995	0.2632	0.2662	0.2679
1996	0.3116	0.3136	0.3153
1997	0.4483	0.4490	0.4499

Table A2 shows that the differences of mean cost efficiency for all banks between 1990 and 1997 are minimal. This suggests that the choice of labour prices for the FSIs has little effect on efficiency estimates.

Table A3 Sensitivity analysis of labour price for the FSIs: frontier bank DMUs by year

Bank	Category	Lower quartile price	Average price	Upper quartile price
Bangkok Bank	Thai bank	1992,1996,1997	1992,1996,1997	1992,1996,1997
GSB	Specialised bank	1995,1996	1995,1996	1995,1996
GHB	Specialised bank	1997	1997	1997
Sime Bank Berhad	Foreign bank	1990,1993	1990,1993	1990,1993
Sakura Bank	Foreign bank	1997	1997	1997
DKB	Foreign bank	1997	1997	1997
BNP	Foreign bank	1997	1997	1997
IBJ	Foreign bank	1997	1997	1997
Sumitomo Bank	Foreign bank	1997	1997	1997

Notes: GSB= Government Saving Bank, GHB= Government Housing Bank, DKB= Dai-Ichi Kangyo Bank, BNP= Banque Nationale de Paris, IBJ= Industrial Bank of Japan

Table A3 shows that there is no different to the number of efficient DMUs and banks which are cost efficient. The results suggest that the choice of labour prices for the FSIs has no effect on the best-practice banks/DMUs.

Appendix V The relationship between bank size and input prices

Table A4 Correlation analysis between bank size and input prices

Category	Price of labour	Price of funds	Price of physical capital
Pearson correlation			
Thai banks	0.535**	-0.364**	0.041
Foreign banks	0.167	0.008	-0.099
FSIs	0.366**	-0.098	-0.249**
All banks	-0.216**	-0.086	-0.297**
Rank correlation			
Thai banks	0.403**	-0.339**	0.227*
Foreign banks	0.489**	-0.081	0.001
FSIs	0.370**	-0.092	-0.302**
All banks	-0.284**	0.037	-0.563**
Mean of price by bank size			
Large bank	0.301	0.080	0.545
Medium bank	0.485	0.084	1.610
Small bank	0.447	0.085	2.675

Note: (**) and (*) indicate correlation is statistically significant respectively at 1% and 5% levels. FSIs = Finance and specialised institutions. Bank sizes are measured by total assets. Small bank is the group of banks that have total assets less than 10,000 million baht, medium bank is the group of banks that have total assets range of 10,000-100,000 million baht, while large bank refers to the group of banks that have total assets more than 100,000 million baht.

Table A4 examines whether there is a relationship between bank size and input prices. First, it shows that there is a significant and positive relationship between asset size and price of labour for Thai banks and FSIs, while foreign banks had a positive and significant rank correlation. However, we found a negative and significant relationship between asset size and price of labour for all banks combined but the means of the price for each size group suggest no relationship.

Second, we found a negative and significant relationship between asset size and price of funds for Thai banks, but no relationship for foreign banks, FSIs and all banks. The means for the three size groups show that large banks had lower price of funds.

Third, there is a negative and significant relationship between asset size and price of physical capital for FSIs and all banks, while Thai banks had a positive and significant Pearson correlation. There is no statistically significant relationship for foreign banks. The means for each size group seem to confirm the negative relationship between asset size and price of physical capital.

The plots of input prices against total assets show a wide dispersion for foreign banks and a weak correlation for Thai banks and FSIs, while the plots for all banks exhibit a L-shaped relationship (see, Figures A10, A11 and A12). We conclude that there is a weak relationship between bank size and input prices.

Figure A 10 The relationship between bank size and price of labour

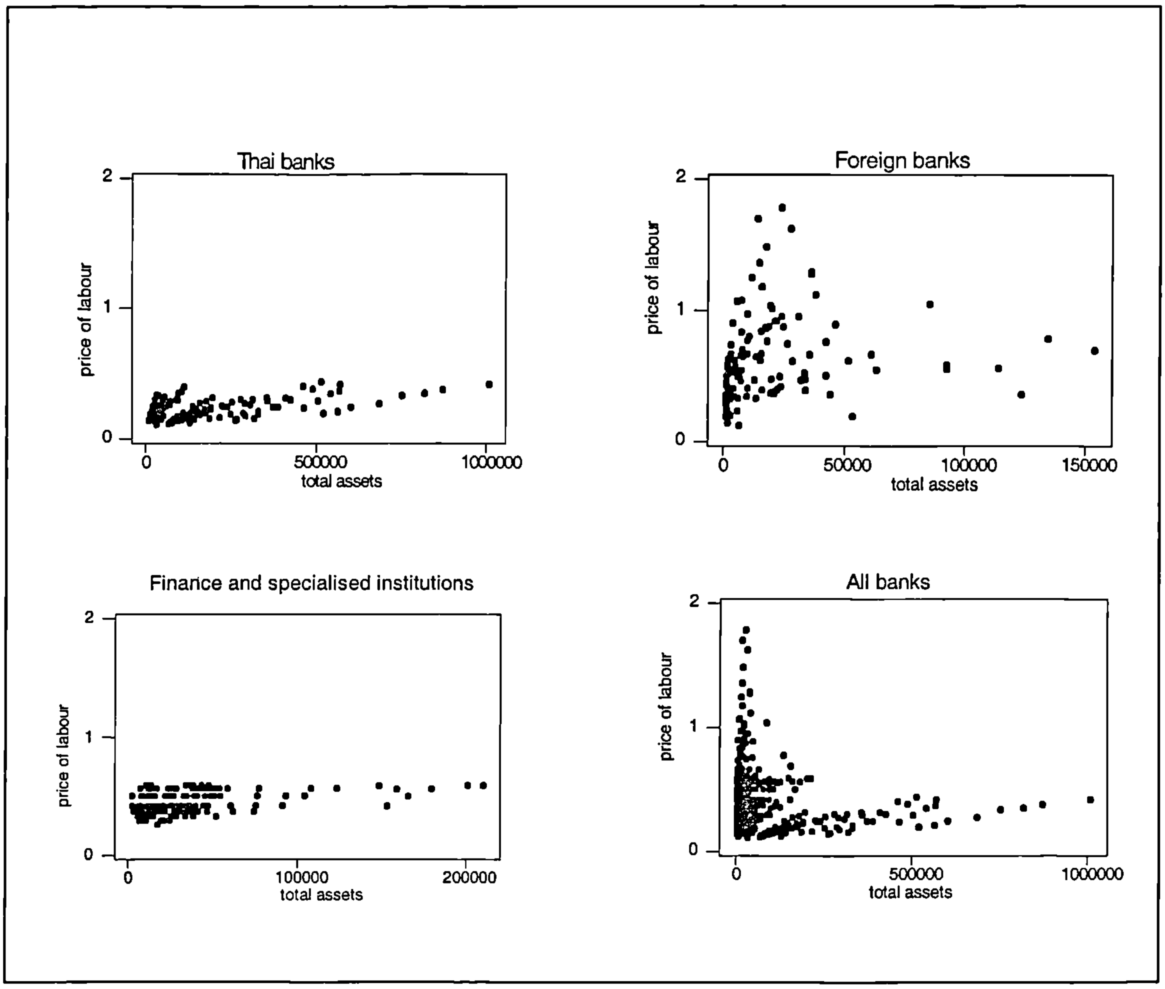
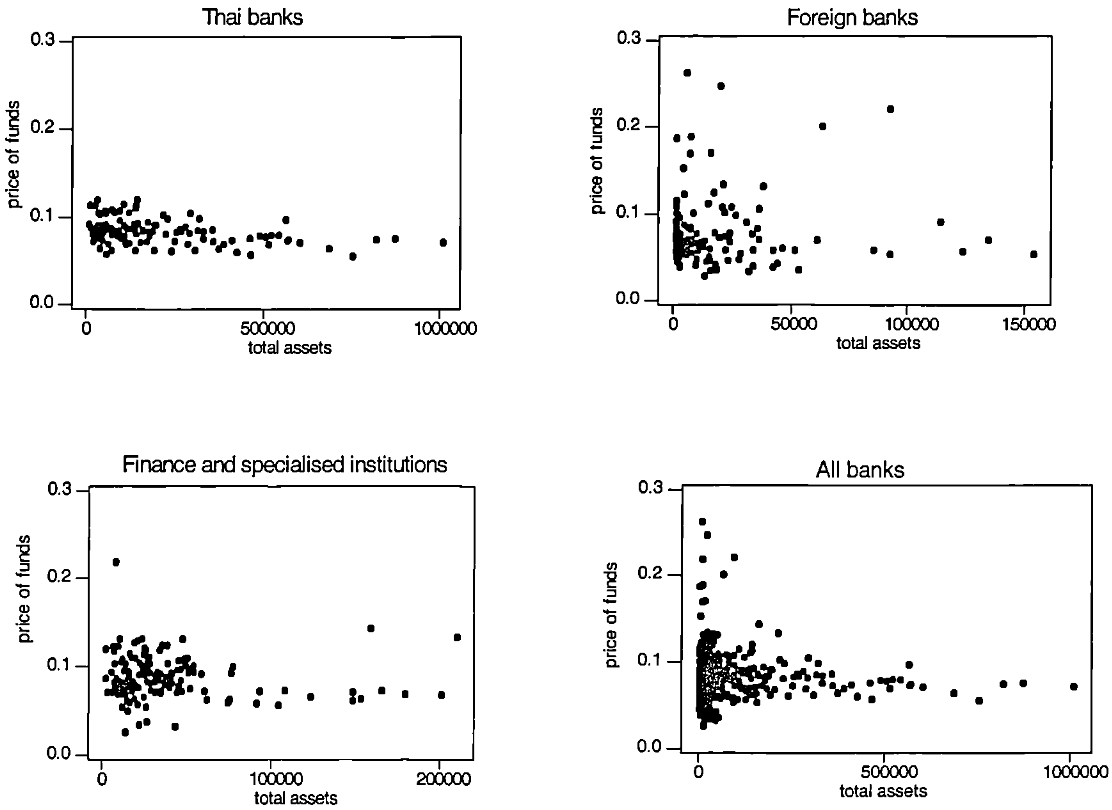
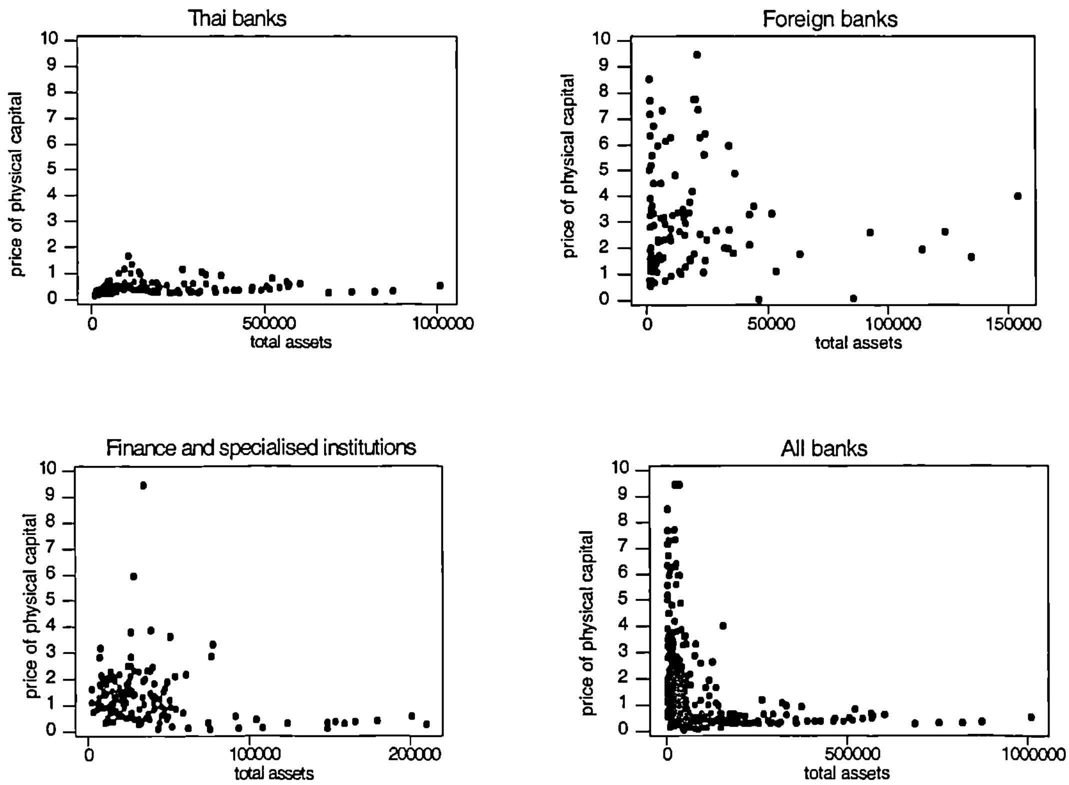


Figure A11 The relationship between bank size and price of funds



Note: the high price of BNP (2.19) in 1997 is excluded from the plots for foreign banks and all banks

Figure A 12 The relationship between bank size and price of physical capital



Note: The high prices for BNP (30.48) and IBJ (34.83) in 1997 are excluded from the plots for foreign banks and all banks.

Appendix VI The relationship between bank size and labour to capital ratio

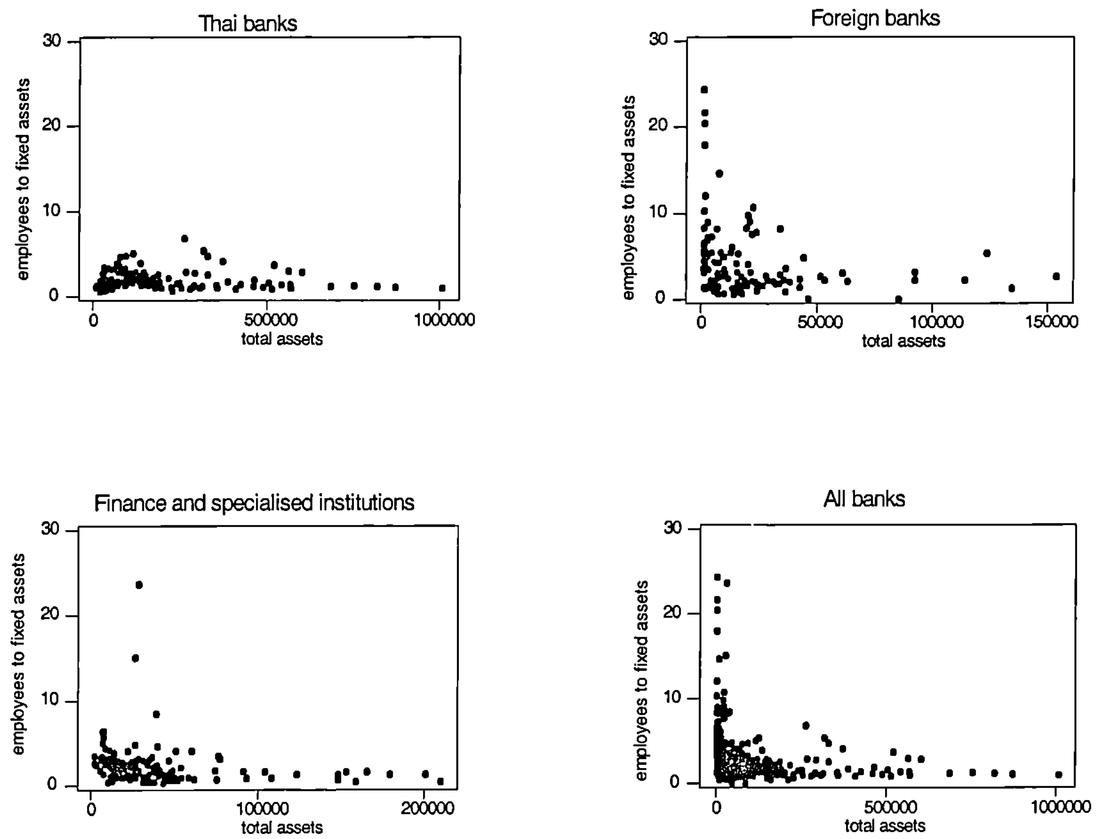
Table A5 Correlation analysis between bank size and labour to capital ratio

Category	Thai banks	Foreign banks	FSIs	All banks
Pearson correlation	-0.128	-0.240*	-0.194*	-0.176**
Rank correlation	-0.108	-0.405**	-0.436**	-0.367**
Mean of ratio by bank size	Large bank	Medium bank	Small bank	
	1.884	2.558	7.08	

Note: (**) and (*) indicate correlation is statistically significant respectively at 1% and 5% levels. FSIs = Finance and specialised institutions. . Bank sizes are measured by total assets. Small bank is the group of banks that have total assets less than 10,000 million baht, medium bank is the group of banks that have total assets range of 10,000-100,000 million baht, while large bank refers to the group of banks that have total assets more than 100,000 million baht.

Table A5 investigates the relationship between asset size and the ratio of labour to physical capital. We found a negative and significant relationship for foreign banks, FSIs and all banks, but a negative relationship for Thai banks was not significant. The means of the ratio for each size group confirms that smaller banks have higher average labour to capital ratio. However, the plots of labour to capital ratio against total assets shown in Figure A13 suggest little differences in the ratio for Thai banks and FSIs and a L-shaped relationship for foreign banks and all banks. We conclude that there is weak relationship between asset size and labour to capital ratio.

Figure A 13 The relationship between bank size and labour to capital ratio



Note: The plots for foreign and all banks do not the high ratios for Chase Manhattan Bank (42.5) and ICBC (35.4) in 1991 and Sime Bank Berhad in 1992 (34.3) and 1993 (65.1).

Appendix VII The relationship between bank size and operating ratios

Table A6 Correlation analysis between bank size and operating ratios

Category	Output/employees	Output/funds	Output/fixed assets	Cost to income
Pearson correlation				
Thai banks	0.369**	-0.076	0.028	-0.172
Foreign banks	0.726**	0.223*	0.348**	n.a.
FSIs	0.423**	0.072	-0.129	0.075
All banks	-0.122*	-0.154**	-0.217**	0.013
Rank correlation				
Thai banks	0.541**	-0.040	0.281**	-0.428**
Foreign banks	0.801**	-0.110	0.313**	n.a.
FSIs	0.432**	-0.041	-0.086	0.095
All banks	-0.090	-0.568**	-0.398**	0.143*
Mean of ratio by bank size				
Large bank	67	1.10	145	0.914
Medium bank	72	1.58	187	0.858
Small bank	37	1.60	185	0.770

Note: (**) and (*) indicate correlation is statistically significant respectively at 1% and 5% levels. FSIs = Finance and specialised institutions. Bank sizes are measured by total assets. Small bank is the group of banks that have total assets less than 10,000 million baht, medium bank is the group of banks that have total assets range of 10,000-100,000 million baht, while large bank refers to the group of banks that have total assets more than 100,000 million baht. Both of correlations and mean of ratios are calculated after removing outliers as in the notes to Figures A14, A15 and A16.

Table A6 examines whether there is a relationship between asset size and operating ratios. First, we found that there is a positive and significant relationship between asset size and the ratio of output to employees for Thai and foreign banks and FSIs, but there is a negative and significant Pearson correlation when all banks are considered. The means of the ratios for the three size groups indicate no relationship. The plots of output to employees ratio against total assets shown in Figure A14 suggest a weak positive relationship for foreign banks and FSIs, while the plots for Thai banks do not differ greatly in all asset sizes and there is an L-shaped relationship for all banks' plots.

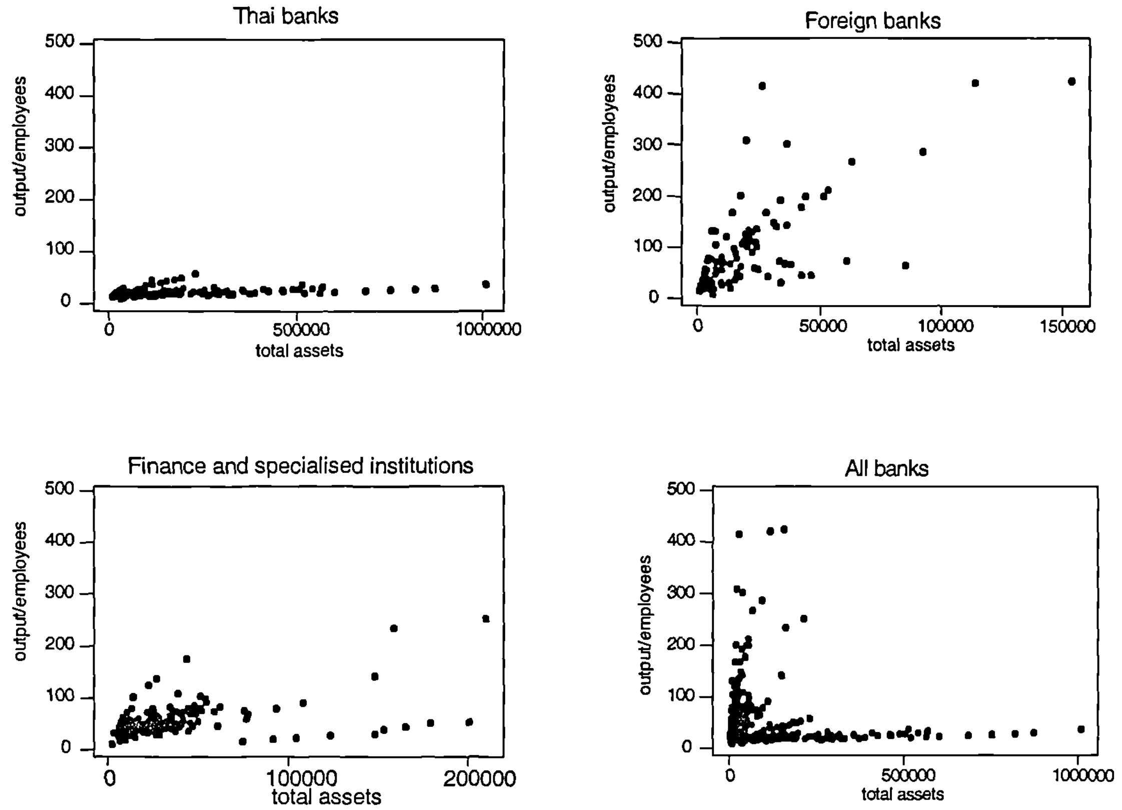
Second, there is a negative and significant relationship between asset size and the ratio of output to funds for all banks. Foreign banks had a positive and significant Pearson correlation, but the sign is in contradiction to the insignificant rank correlation. The means of the ratios for each bank size indicate that smaller banks have higher output to funds ratio. The plots of the ratio against total assets shown in Figure A15 suggest no differences in the ratio for all sizes of Thai banks and FSIs, while there is a wide dispersion of output to funds for foreign banks. The plots for all banks again indicate an L-shaped relationship.

Third, there is a positive and significant relationship between asset size and the ratio of output to fixed assets for foreign banks, and Thai banks had a positive and significant rank correlation. However, the correlations are negative and significant when all banks are considered. The means of the ratio for each bank size do not indicate any relationship. The plot of the ratio against total assets for Thai banks shows little variation, while the plot for foreign banks indicates a wide dispersion of output to fixed assets. The plots for FSIs and all banks, on the other hand, suggest an L-shaped relationship (see, Figure A16).

Finally, we found a negative and significant rank correlation between asset size and cost to income ratio of Thai banks, while FSIs had a positive but not significant relationship. There is a negative and significant rank correlation when Thai banks and FSIs are considered together. The means of the ratio for the size groups suggest that smaller banks have lower cost to income ratios. The plots of the ratio against total assets shown in Figure A17 indicate an L-shaped relationship for Thai banks, FSIs and a combined data of these two groups.

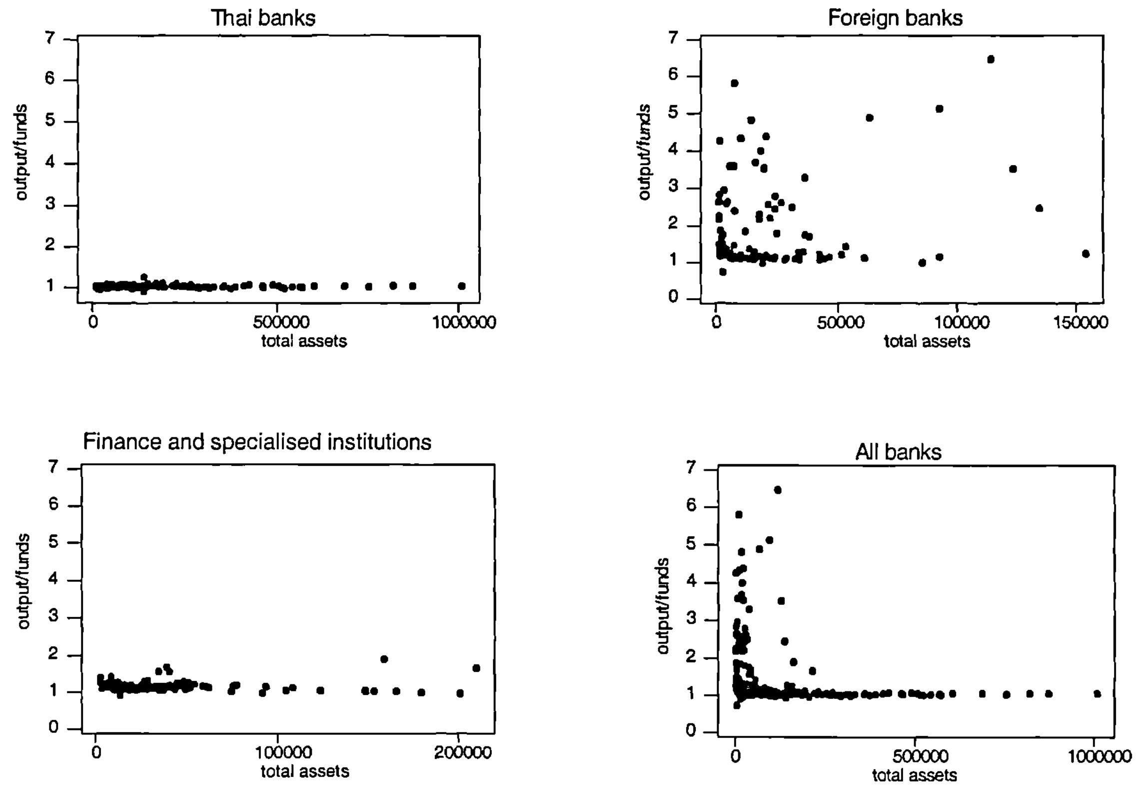
Overall, the analysis suggests no strong relationship between bank size and operating ratios.

Figure A14 The relationship between bank size and output to employees ratio



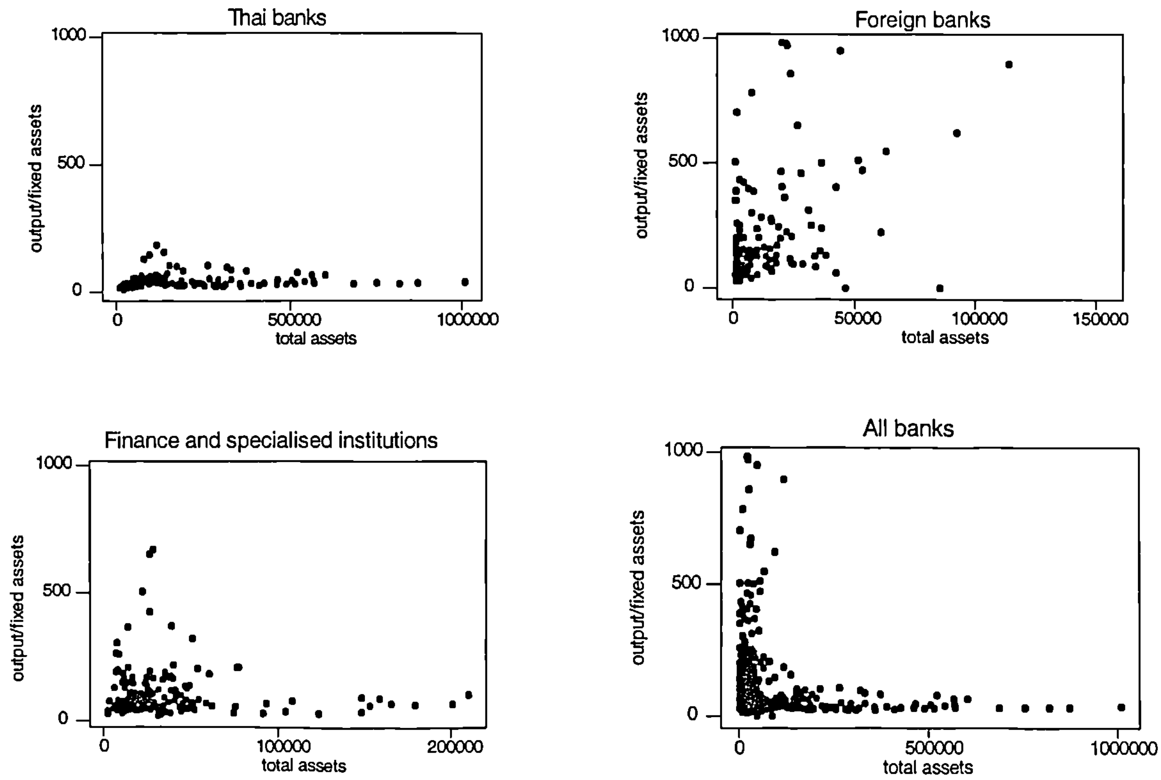
Note: The plots for foreign and all banks do not include high ratio of DKB (1125), Sumitomo Bank (1610) and IBJ (1082) in 1997.

Figure A15 The relationship between bank size and output to funds ratio



Note: The high ratio of BNP (60.15) in 1997 is excluded from the plots for foreign and all banks.

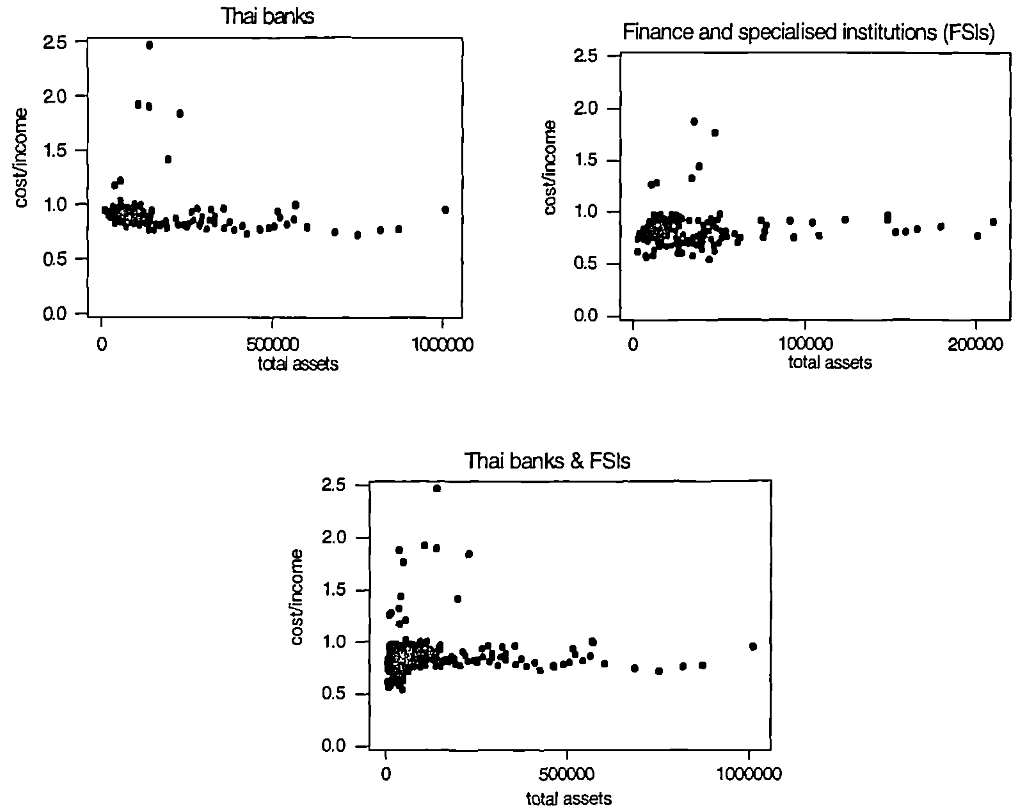
Figure A16 The relationship between bank size and output to fixed assets ratio



Note: 1) The plots for foreign and all banks do not include high ratio of Sakura Bank in 1990 (1046), 1991 (1199) and 1993(1589) and four banks in 1997: Bank of Tokyo (1102), DKB (5905), Sumitomo Bank (1984) and IBJ (3398).

2) The plots for FSIs and all banks do not include the high ratio of Thai Investment and Securities (1270) in 1994.

Figure A 17 The relationship between bank size and cost to income ratio



Note: The plots of foreign banks are not shown here because of data unavailability.

APPENDIX VIII The sensitivity analysis of environmental variables

Table A7 R-square adjusted of controlled versus uncontrolled models

Model	Technical efficiency	Allocative efficiency	Cost efficiency
a) including BDTD and LOGTA	66.6	51.1	66.2
b) excluding BDTD	33.7	49.4	40.9
c) excluding BDTD and LOGTA	32.3	26.7	30.1

Table A7 examines the possibility of how the results could have been biased if BDTD and LOGTA were included in the second-stage regression analysis. The OLS regressions with dependent variables including technical, allocative and cost efficiency upon environmental variables shown in Table 6.34 are carried out. The R-square adjusted shown in Table A7 indicates that the uncontrolled models, which include BDTD and LOGTA, reported relatively higher R-square adjusted than those of controlled models. The results support that BDTD and LOGTA should not be included in the second-stage regression analysis.

APPENDIX IX The relative efficiencies for Thai banks

Table A8 Average and variability of relative efficiencies for Thai banks

	1990	1991	1992	1993	1994	1995	1996	1997
Technical efficiency								
mean	0.9219	0.9047	0.9010	0.9080	0.9105	0.9311	0.9357	0.9211
STDEV	0.0608	0.0566	0.0580	0.0634	0.0512	0.0626	0.0565	0.0697
CV	0.0660	0.0626	0.0644	0.0698	0.0562	0.0672	0.0604	0.0757
Allocative efficiency								
mean	0.9657	0.9701	0.9619	0.9469	0.9356	0.9577	0.9599	0.9523
STDEV	0.0161	0.0173	0.0297	0.0407	0.0454	0.0323	0.0261	0.0293
CV	0.0167	0.0178	0.0309	0.0429	0.0486	0.0337	0.0272	0.0307
Cost efficiency								
Mean	0.8910	0.8781	0.8673	0.8609	0.8527	0.8926	0.8988	0.8781
STDEV	0.0684	0.0635	0.0699	0.0845	0.0732	0.0776	0.0722	0.0833
CV	0.0767	0.0723	0.0806	0.0981	0.0858	0.0869	0.0803	0.0949

Notes: STDEV = standard deviation, CV = coefficient of variation.

Table A8 shows the average and variability of relative efficiencies estimated from the grand frontier of Thai banks. It confirms that Thai banks had high mean allocative efficiencies during 1990-97.

APPENDIX X The efficiency estimates for data of 373 DMUs

Table A9 shows the average and variability of relative efficiencies for Thai and foreign banks and FSIs estimated after excluding 6 new foreign banks in 1997.

Table A9 Average and variability of relative efficiencies after excluding 6 new foreign banks

	1990	1991	1992	1993	1994	1995	1996	1997
			TECHNICAL EFFICIENCY					
Thai banks								
Mean	0.3403	0.3595	0.3899	0.4099	0.4493	0.5049	0.5311	0.5263
STDEV	0.2951	0.2985	0.3015	0.3065	0.3051	0.3097	0.3179	0.3307
CV	0.8670	0.8304	0.7734	0.7478	0.6790	0.6134	0.5986	0.6284
Foreign bank branches								
Mean	0.5851	0.6089	0.6126	0.6155	0.6851	0.7046	0.7396	0.7509
STDEV	0.2817	0.2556	0.2665	0.3017	0.2938	0.2772	0.2526	0.2825
CV	0.4814	0.4198	0.4350	0.4901	0.4289	0.3934	0.3415	0.3762
Finance and specialised institutions (FSIs)								
Mean	n.a.	0.2269	0.2849	0.2619	0.2961	0.3281	0.3645	0.4875
STDEV	n.a.	0.0496	0.1429	0.1307	0.2091	0.1947	0.2306	0.2518
CV	n.a.	0.2187	0.5016	0.4991	0.7061	0.5934	0.6326	0.5165
			ALLOCATIVE EFFICIENCY					
Thai banks								
Mean	0.8835	0.8963	0.8577	0.8542	0.8577	0.8831	0.8951	0.8958
STDEV	0.0378	0.0407	0.0506	0.0474	0.0713	0.0553	0.0550	0.0690
CV	0.0427	0.0454	0.0590	0.0555	0.0831	0.0626	0.0615	0.0770
Foreign bank branches								
Mean	0.6836	0.6358	0.6673	0.6804	0.6691	0.7237	0.7268	0.6684
STDEV	0.1966	0.2032	0.1767	0.1790	0.1901	0.1821	0.2037	0.2103
CV	0.2876	0.3196	0.2648	0.2631	0.2841	0.2516	0.2802	0.3146
Finance and specialised institutions (FSIs)								
Mean	n.a.	0.8474	0.8301	0.8387	0.8419	0.7873	0.7644	0.6941
STDEV	n.a.	0.1196	0.1252	0.1257	0.1247	0.1391	0.1434	0.1864
CV	n.a.	0.1412	0.1508	0.1498	0.1482	0.1767	0.1876	0.2685
			COST EFFICIENCY					
Thai banks								
Mean	0.3017	0.3241	0.3441	0.3587	0.3997	0.4588	0.4893	0.4907
STDEV	0.2632	0.2729	0.2863	0.2833	0.2939	0.3012	0.3138	0.3315
CV	0.8724	0.8422	0.8321	0.7897	0.7355	0.6566	0.6413	0.6757
Foreign bank branches								
Mean	0.3813	0.3699	0.3889	0.4000	0.4475	0.5066	0.5375	0.4944
STDEV	0.2254	0.2010	0.1943	0.2201	0.2480	0.2513	0.2474	0.2561
CV	0.5910	0.5433	0.4996	0.5503	0.5541	0.4960	0.4603	0.5180
Finance and specialised institutions (FSIs)								
Mean	n.a.	0.1874	0.2252	0.2073	0.2366	0.2487	0.2762	0.3625
STDEV	n.a.	0.0146	0.0791	0.0577	0.1508	0.1591	0.2094	0.2862
CV	n.a.	0.0782	0.3513	0.2781	0.6373	0.6396	0.7580	0.7894

Notes: STDEV = standard deviation, CV = coefficient of variation.

APPENDIX XI Geometric means of Malmquist indices

		1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	7-year geometric mean
Thai banks									
BBL	E	0.884	0.996	0.790	0.563	0.830	0.810	1.120	0.8399
	T	1.194	1.041	1.089	1.826	1.209	1.238	1.198	1.2370
	M	1.056	1.037	0.860	1.028	1.004	1.002	1.342	1.0390
	P	1	1	1	1	1	1	1	1.0000
	S	0.884	0.996	0.79	0.563	0.83	0.81	1.12	0.8399
KTB	E	0.814	1.057	1.054	0.479	0.876	0.711	0.783	0.8012
	T	1.221	1.011	0.907	1.694	1.123	1.403	1.263	1.2089
	M	0.993	1.068	0.957	0.812	0.983	0.997	0.989	0.9684
	P	1	1	1	1	1	1	1	1.0000
	S	0.814	1.057	1.054	0.479	0.876	0.711	0.783	0.8012
TFB	E	0.775	1.044	0.881	0.550	0.825	0.814	0.837	0.8057
	T	1.240	1.003	1.089	1.867	1.181	1.210	1.253	1.2408
	M	0.961	1.047	0.960	1.027	0.975	0.985	1.048	0.9998
	P	1	1	0.991	1.009	1	1	0.902	0.9854
	S	0.775	1.044	0.889	0.545	0.825	0.814	0.927	0.8175
SCB	E	0.843	0.998	0.649	0.586	0.842	0.957	0.726	0.7871
	T	1.238	1.005	1.303	1.739	1.268	1.089	1.318	1.2632
	M	1.043	1.003	0.846	1.019	1.068	1.042	0.957	0.9943
	P	1.01	1	1	0.961	1.027	0.967	0.998	0.9945
	S	0.835	0.998	0.649	0.61	0.82	0.99	0.728	0.7917
AYD	E	0.864	0.981	0.830	0.552	0.822	0.825	0.756	0.7941
	T	1.235	1.004	1.202	1.836	1.160	1.249	1.269	1.2596
	M	1.067	0.985	0.998	1.014	0.954	1.030	0.960	1.0005
	P	1.023	0.995	1.005	0.942	0.973	0.993	0.94	0.9811
	S	0.844	0.986	0.826	0.586	0.845	0.83	0.805	0.8093
TMB	E	0.802	1.023	0.737	0.564	0.835	0.874	0.761	0.7884
	T	1.242	1.006	1.222	1.786	1.212	1.136	1.305	1.2549
	M	0.996	1.030	0.900	1.008	1.013	0.993	0.993	0.9896
	P	0.966	1.022	1.013	0.926	1.017	0.896	0.859	0.9551
	S	0.830	1.001	0.727	0.61	0.821	0.976	0.886	0.8257
FBC	E	0.935	0.972	1.081	0.658	0.753	0.557	0.796	0.8033
	T	1.122	1.048	0.900	1.419	1.360	1.779	1.263	1.2432
	M	1.050	1.018	0.972	0.933	1.024	0.991	1.005	0.9984
	P	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.0000
	S	0.935	0.972	1.081	0.658	0.753	0.557	0.796	0.8033
SCIB	E	0.832	1.044	0.921	0.486	0.830	0.803	0.795	0.7980
	T	1.244	1.004	1.035	1.862	1.131	1.137	1.290	1.2187
	M	1.034	1.048	0.953	0.905	0.939	0.914	1.026	0.9725
	P	1	0.997	0.993	0.96	0.972	0.855	0.824	0.9405
	S	0.832	1.047	0.927	0.506	0.854	0.94	0.965	0.8485
BMB	E	0.855	1.030	0.903	0.539	0.828	0.778	0.713	0.7928
	T	1.244	1.009	1.077	1.890	1.124	1.278	1.263	1.2450
	M	1.063	1.039	0.973	1.020	0.931	0.995	0.900	0.9872
	P	1.051	1.036	0.944	0.975	0.977	0.777	0.585	0.8908
	S	0.813	0.994	0.957	0.553	0.847	1.002	1.219	0.8900
BBC	E	0.808	0.979	0.887	0.633	0.838	0.816	0.626	0.7889
	T	1.248	1.004	0.988	1.731	1.247	1.380	1.263	1.2458
	M	1.008	0.984	0.877	1.096	1.044	1.126	0.790	0.9828
	P	0.979	0.992	1.051	1	1	0.906	0.232	0.8026
	S	0.826	0.988	0.844	0.633	0.838	0.9	2.694	0.9828
BOA	E	0.861	1.038	0.822	0.584	0.902	0.716	0.803	0.8068
	T	1.243	1.004	1.161	1.887	1.124	1.429	1.266	1.2777
	M	1.070	1.043	0.954	1.101	1.015	1.023	1.017	1.0310
	P	1.033	1.015	0.943	0.924	0.996	0.635	0.493	0.8358
	S	0.833	1.023	0.871	0.631	0.906	1.128	1.629	0.9651

APPENDIX XI Geometric means of Malmquist indices (continued)

		1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	7-year geometric mean
TDB	E	0.804	0.987	0.627	0.620	0.922	0.936	0.783	0.7993
	T	1.239	1.007	1.455	1.696	1.245	1.163	1.263	1.2800
	M	0.996	0.994	0.913	1.052	1.148	1.089	0.988	1.0232
	P	1.006	0.987	0.96	0.879	1.036	0.569	0.389	0.7901
	S	0.799	1	0.654	0.705	0.89	1.645	2.01	1.0116
NKB	E	0.811	1.054	0.755	0.529	0.861	0.894	0.741	0.7916
	T	1.235	1.003	1.216	1.797	1.195	1.128	1.315	1.2511
	M	1.001	1.057	0.919	0.950	1.029	1.008	0.975	0.9903
	P	1.030	1.046	0.958	0.767	0.96	0.343	0.738	0.7902
	S	0.787	1.008	0.788	0.689	0.897	2.603	1.004	1.0014
UBB	E	0.794	0.997	0.697	0.578	0.882	0.896	0.773	0.7916
	T	1.254	1.021	1.258	1.725	1.216	1.118	1.316	1.2574
	M	0.996	1.018	0.877	0.997	1.072	1.002	1.017	0.9954
	P	0.989	1.015	0.943	0.761	0.994	0.329	0.781	0.7852
	S	0.802	0.981	0.739	0.759	0.887	2.721	0.99	1.0076
LTB	E	0.800	0.974	0.794	0.467	0.886	1.041	0.856	0.8097
	T	1.232	1.009	1.317	1.938	1.282	0.948	1.263	1.2538
	M	0.986	0.983	1.046	0.904	1.136	0.987	1.081	1.0151
	P	1.006	0.966	1.042	0.407	1.252	0.497	0.9	0.8110
	S	0.795	1.009	0.761	1.146	0.708	2.094	0.951	0.9980
Geometric means for Thai banks									
	E	**0.831**	**1.011**	**0.819**	**0.557**	**0.848**	**0.820**	**0.785**	**0.7997**
	T	**1.228**	**1.012**	**1.138**	**1.775**	**1.203**	**1.233**	**1.274**	**1.2491**
	M	**1.021**	**1.023**	**0.932**	**0.988**	**1.020**	**1.011**	**1.000**	**0.9988**
	P	**1.006**	**1.005**	**0.989**	**0.882**	**1.012**	**0.738**	**0.725**	**0.8998**
	S	**0.826**	**1.007**	**0.828**	**0.631**	**0.838**	**1.112**	**1.083**	**0.8889**
Foreign banks									
Tokyo	E	0.984	1.016	0.966	1.035	1.000	1.000	1.000	0.9999
	T	0.999	0.971	1.054	1.106	1.158	1.299	1.632	1.1570
	M	0.982	0.987	1.018	1.145	1.158	1.299	1.632	1.1569
	P	1	1	1	1	1	1	1	1.0000
	S	0.984	1.016	0.966	1.035	1	1	1	0.9999
Sakura	E	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.0000
	T	1.066	0.880	1.370	0.728	0.782	1.591	1.537	1.0867
	M	1.066	0.880	1.370	0.728	0.782	1.591	1.537	1.0867
	P	1	1	1	1	1	1	1	1.0000
	S	1	1	1	1	1	1	1	1.0000
Citibank	E	1.097	0.924	0.842	0.620	0.724	0.795	1.110	0.8565
	T	1.090	1.013	1.028	1.585	1.248	1.138	1.347	1.1931
	M	1.196	0.937	0.866	0.983	0.904	0.904	1.495	1.0221
	P	1.059	1	0.966	0.774	0.881	0.501	2.779	0.9958
	S	1.036	0.924	0.871	0.802	0.822	1.588	0.399	0.8601
Deutsche	E	0.960	0.969	0.997	0.860	1.291	0.928	1.077	1.0041
	T	1.023	1.010	1.137	1.380	1.322	1.532	1.335	1.2351
	M	0.982	0.978	1.134	1.188	1.707	1.422	1.438	1.2403
	P	0.95	0.977	1.064	0.863	1.195	0.957	1.045	1.0026
	S	1.011	0.991	0.937	0.998	1.08	0.97	1.031	1.0017
STCB	E	0.924	1.056	1.096	0.596	1.147	1.255	0.628	0.9243
	T	1.140	1.005	1.270	1.654	1.258	0.770	1.020	1.1317
	M	1.054	1.061	1.392	0.985	1.443	0.966	0.640	1.0458
	P	1.145	1	1	0.578	1.359	1.272	0.502	0.9238
	S	0.807	1.056	1.096	1.030	0.844	0.986	1.250	1.0001
Indosuez	E	0.986	1.090	0.870	0.980	1.015	0.886	0.773	0.9376
	T	1.092	1.091	0.928	1.348	1.154	1.108	1.259	1.1332
	M	1.077	1.189	0.808	1.321	1.171	0.981	0.974	1.0626
	P	1.017	1.053	0.884	1.030	0.952	0.917	0.773	0.9420
	S	0.970	1.035	0.984	0.951	1.067	0.967	1.001	0.9957

APPENDIX XI Geometric means of Malmquist indices (continued)

		1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	7-year geometric mean
HSBC	E	0.787	0.991	1.198	0.608	0.942	0.645	0.721	0.8198
	T	1.246	1.035	0.887	1.328	1.227	1.583	1.661	1.2549
	M	0.981	1.025	1.062	0.808	1.156	1.021	1.198	1.0288
	P	0.954	0.916	1.103	0.629	1.154	0.514	0.731	0.8262
	S	0.825	1.082	1.086	0.968	0.817	1.255	0.987	0.9926
Chase	E	0.905	1.105	1.000	1.000	1.000	0.917	0.876	0.9692
	T	1.105	1.038	1.233	1.681	1.429	1.104	1.628	1.2949
	M	1.000	1.147	1.233	1.681	1.429	1.012	1.426	1.2550
	P	0.956	1.046	1	1	1	1	1	1.0000
	S	0.947	1.056	1	1	1	0.917	0.876	0.9692
America	E	0.896	0.888	1.173	1.071	1.000	1.000	0.450	0.8921
	T	1.173	1.098	1.069	1.962	1.228	0.884	1.220	1.1997
	M	1.051	0.976	1.254	2.102	1.228	0.884	0.549	1.0705
	P	0.919	0.88	1.206	1.026	1	1	0.583	0.9259
	S	0.976	1.009	0.972	1.044	1	1	0.771	0.9634
ABN	E	1.075	1.000	1.000	1.000	1.000	1.000	0.610	0.9415
	T	1.242	1.062	1.106	1.365	1.444	0.785	1.393	1.1778
	M	1.335	1.062	1.106	1.365	1.444	0.785	0.850	1.1089
	P	1.061	1	1	1	1	1	0.793	0.9756
	S	1.013	1	1	1	1	1	0.770	0.9651
Bharat	E	0.839	1.211	0.832	0.821	0.747	1.175	0.804	0.9031
	T	1.132	0.999	1.127	1.275	1.311	1.035	1.413	1.1763
	M	0.950	1.210	0.937	1.046	0.979	1.216	1.136	1.0620
	P	1	1	1	0.979	1.021	1	1	0.9999
	S	0.839	1.211	0.832	0.838	0.731	1.175	0.804	0.9029
ICBC	E	1.025	0.807	0.763	0.547	1.094	1.101	0.754	0.8473
	T	1.140	0.891	1.331	1.829	1.176	1.183	1.325	1.2420
	M	1.168	0.719	1.015	1.000	1.286	1.303	0.999	1.0521
	P	1	0.934	0.966	0.809	1.150	1.039	1.016	0.9829
	S	1.025	0.864	0.789	0.676	0.952	1.060	0.742	0.8620
Sime	E	1.000	1.000	1.000	1.000	1.000	1.000	0.684	0.9472
	T	0.953	0.826	1.566	0.584	1.158	0.719	0.674	0.8786
	M	0.953	0.826	1.566	0.584	1.158	0.719	0.462	0.8324
	P	1	1	1	1	1	1	1	1.0000
	S	1	1	1	1	1	1	0.684	0.9472
OCBC	E	0.796	1.023	1.154	1.033	1.091	0.559	1.065	0.9362
	T	1.260	1.009	0.925	1.279	1.294	1.323	1.295	1.1877
	M	1.003	1.032	1.067	1.321	1.413	0.740	1.379	1.1121
	P	0.960	1.050	1.001	1	1	1	1	1.0013
	S	0.830	0.974	1.152	1.033	1.091	0.559	1.065	0.9350
Geometric mean of foreign banks									
	E	**0.944**	**1.001**	**0.984**	**0.847**	**0.994**	**0.928**	**0.801**	**0.9256**
	T	**1.115**	**0.992**	**1.131**	**1.304**	**1.217**	**1.111**	**1.309**	**1.1635**
	M	**1.052**	**0.993**	**1.112**	**1.104**	**1.209**	**1.030**	**1.048**	**1.0763**
	P	**1.000**	**0.989**	**1.011**	**0.892**	**1.045**	**0.917**	**0.934**	**0.9683**
	S	**0.944**	**1.013**	**0.973**	**0.949**	**0.951**	**1.012**	**0.857**	**0.9557**
Geometric mean for all banks									
	E	**0.884**	**1.006**	**0.895**	**0.682**	**0.915**	**0.871**	**0.793**	**0.8583**
	T	**1.172**	**1.002**	**1.134**	**1.529**	**1.210**	**1.172**	**1.291**	**1.2068**
	M	**1.036**	**1.009**	**1.015**	**1.042**	**1.107**	**1.020**	**1.023**	**1.0356**
	P	**1.003**	**0.997**	**1.000**	**0.887**	**1.027**	**0.820**	**0.820**	**0.9324**
	S	**0.881**	**1.010**	**0.895**	**0.768**	**0.891**	**1.062**	**0.967**	**0.9204**

Notes: E= efficiency change, T= technological change, M= Malmquist productivity index, P= pure technical efficiency change, S = scale efficiency change

APPENDIX XII Cumulative results of Malmquist indices

		1990/91	1990/92	1990/93	1990/94	1990/95	1990/96	1990/97
Thai banks								
BBL	E	0.884	0.880	0.696	0.392	0.325	0.263	0.295
	T	1.194	1.243	1.354	2.472	2.988	3.699	4.432
	M	1.056	1.095	0.942	0.968	0.972	0.974	1.307
	P	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	S	0.884	0.880	0.696	0.392	0.325	0.263	0.295
KTB	E	0.814	0.860	0.907	0.434	0.381	0.271	0.212
	T	1.221	1.234	1.120	1.897	2.130	2.988	3.774
	M	0.993	1.061	1.015	0.824	0.810	0.808	0.799
	P	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	S	0.814	0.860	0.907	0.434	0.381	0.271	0.212
TFB	E	0.775	0.809	0.713	0.392	0.323	0.263	0.220
	T	1.240	1.244	1.354	2.529	2.986	3.614	4.528
	M	0.961	1.006	0.966	0.992	0.967	0.953	0.998
	P	1.000	1.000	0.991	1.000	1.000	1.000	0.902
	S	0.775	0.809	0.719	0.392	0.323	0.263	0.244
SCB	E	0.843	0.841	0.546	0.320	0.269	0.258	0.187
	T	1.238	1.244	1.621	2.819	3.575	3.893	5.131
	M	1.043	1.046	0.885	0.902	0.963	1.004	0.960
	P	1.010	1.010	1.010	0.971	0.997	0.964	0.962
	S	0.835	0.833	0.541	0.330	0.271	0.268	0.195
AYD	E	0.864	0.848	0.703	0.388	0.319	0.263	0.199
	T	1.235	1.240	1.490	2.736	3.174	3.965	5.031
	M	1.067	1.051	1.049	1.064	1.015	1.045	1.003
	P	1.023	1.018	1.023	0.964	0.938	0.931	0.875
	S	0.844	0.832	0.687	0.403	0.340	0.283	0.227
TMB	E	0.802	0.820	0.605	0.341	0.285	0.249	0.189
	T	1.242	1.249	1.527	2.727	3.305	3.755	4.900
	M	0.996	1.026	0.923	0.931	0.943	0.936	0.930
	P	0.966	0.987	1.000	0.926	0.942	0.844	0.725
	S	0.830	0.831	0.604	0.368	0.302	0.295	0.262
FBC	E	0.935	0.909	0.982	0.646	0.487	0.271	0.216
	T	1.122	1.176	1.058	1.502	2.042	3.633	4.589
	M	1.050	1.069	1.039	0.969	0.993	0.984	0.989
	P	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	S	0.935	0.909	0.982	0.646	0.487	0.271	0.216
SCIB	E	0.832	0.869	0.800	0.389	0.323	0.259	0.206
	T	1.244	1.249	1.293	2.407	2.722	3.095	3.993
	M	1.034	1.084	1.033	0.935	0.878	0.802	0.823
	P	1.000	0.997	0.990	0.950	0.924	0.790	0.651
	S	0.832	0.871	0.808	0.409	0.349	0.328	0.317
BMB	E	0.855	0.881	0.795	0.429	0.355	0.276	0.197
	T	1.244	1.255	1.352	2.555	2.872	3.670	4.635
	M	1.063	1.104	1.075	1.096	1.020	1.015	0.914
	P	1.051	1.089	1.028	1.002	0.979	0.761	0.445
	S	0.813	0.808	0.773	0.428	0.362	0.363	0.442
BBC	E	0.808	0.791	0.702	0.444	0.372	0.304	0.190
	T	1.248	1.253	1.238	2.143	2.672	3.688	4.657
	M	1.008	0.992	0.870	0.953	0.995	1.121	0.885
	P	0.979	0.971	1.021	1.021	1.021	0.925	0.215
	S	0.826	0.816	0.689	0.436	0.365	0.329	0.886
BOA	E	0.861	0.894	0.735	0.429	0.387	0.277	0.222
	T	1.243	1.248	1.449	2.734	3.073	4.391	5.560
	M	1.070	1.116	1.065	1.172	1.190	1.217	1.238
	P	1.033	1.048	0.989	0.914	0.910	0.578	0.285
	S	0.833	0.852	0.742	0.468	0.424	0.479	0.780

APPENDIX XII Cumulative results of Malmquist indices (continued)

		1990/91	1990/92	1990/93	1990/94	1990/95	1990/96	1990/97
TDB	E	0.804	0.794	0.498	0.308	0.284	0.266	0.208
	T	1.239	1.248	1.815	3.079	3.833	4.458	5.630
	M	0.996	0.990	0.904	0.951	1.092	1.189	1.175
	P	1.006	0.993	0.953	0.838	0.868	0.494	0.192
	S	0.799	0.799	0.523	0.368	0.328	0.539	1.084
NKB	E	0.811	0.855	0.645	0.341	0.294	0.263	0.195
	T	1.235	1.239	1.506	2.707	3.235	3.649	4.798
	M	1.001	1.058	0.972	0.924	0.951	0.958	0.934
	P	1.030	1.077	1.032	0.792	0.760	0.261	0.192
	S	0.787	0.793	0.625	0.431	0.386	1.006	1.010
UBB	E	0.794	0.792	0.552	0.319	0.281	0.252	0.195
	T	1.254	1.280	1.611	2.778	3.379	3.777	4.971
	M	0.996	1.014	0.889	0.887	0.950	0.952	0.968
	P	0.989	1.004	0.947	0.720	0.716	0.236	0.184
	S	0.802	0.787	0.581	0.441	0.391	1.065	1.054
LTB	E	0.800	0.779	0.619	0.289	0.256	0.266	0.228
	T	1.232	1.243	1.637	3.173	4.068	3.856	4.870
	M	0.986	0.969	1.014	0.916	1.041	1.028	1.111
	P	1.006	0.972	1.013	0.412	0.516	0.256	0.231
	S	0.795	0.802	0.610	0.700	0.495	1.037	0.986
Geometric mean of Thai banks								
	E	**0.831**	**0.840**	**0.688**	**0.383**	**0.325**	**0.266**	**0.209**
	T	**1.228**	**1.243**	**1.414**	**2.511**	**3.021**	**3.723**	**4.742**
	M	**1.021**	**1.045**	**0.974**	**0.962**	**0.982**	**0.993**	**0.993**
	P	**1.006**	**1.011**	**0.999**	**0.882**	**0.892**	**0.658**	**0.477**
	S	**0.826**	**0.832**	**0.689**	**0.434**	**0.364**	**0.405**	**0.438**
Foreign banks								
Tokyo	E	0.984	1.000	0.966	1.000	1.000	1.000	1.000
	T	0.999	0.970	1.022	1.131	1.309	1.701	2.776
	M	0.982	0.969	0.987	1.130	1.308	1.699	2.773
	P	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	S	0.984	1.000	0.966	1.000	1.000	1.000	1.000
Sakura	E	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	T	1.066	0.938	1.285	0.936	0.732	1.164	1.789
	M	1.066	0.938	1.285	0.936	0.732	1.164	1.789
	P	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	S	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Citibank	E	1.097	1.014	0.853	0.529	0.383	0.305	0.338
	T	1.090	1.104	1.135	1.799	2.245	2.555	3.442
	M	1.196	1.121	0.970	0.954	0.862	0.780	1.166
	P	1.059	1.059	1.023	0.792	0.698	0.349	0.971
	S	1.036	0.957	0.834	0.669	0.550	0.873	0.348
Deutsche	E	0.960	0.930	0.927	0.798	1.030	0.956	1.029
	T	1.023	1.033	1.175	1.621	2.143	3.283	4.383
	M	0.982	0.960	1.089	1.294	2.209	3.141	4.516
	P	0.950	0.928	0.988	0.852	1.018	0.975	1.019
	S	1.011	1.002	0.939	0.937	1.012	0.982	1.012
STCB	E	0.924	0.976	1.069	0.637	0.731	0.917	0.576
	T	1.140	1.146	1.455	2.407	3.028	2.331	2.378
	M	1.054	1.118	1.557	1.533	2.213	2.137	1.368
	P	1.145	1.145	1.145	0.662	0.899	1.144	0.574
	S	0.807	0.852	0.934	0.962	0.812	0.801	1.001
Indosuez	E	0.986	1.075	0.935	0.916	0.930	0.824	0.637
	T	1.092	1.191	1.106	1.490	1.720	1.906	2.399
	M	1.077	1.281	1.035	1.367	1.601	1.570	1.529
	P	1.017	1.071	0.947	0.975	0.928	0.851	0.658
	S	0.970	1.004	0.988	0.939	1.002	0.969	0.970

APPENDIX XII Cumulative results of Malmquist indices (continued)

		1990/91	1990/92	1990/93	1990/94	1990/95	1990/96	1990/97
HSBC	E	0.787	0.780	0.934	0.568	0.535	0.345	0.249
	T	1.246	1.290	1.144	1.519	1.864	2.951	4.901
	M	0.981	1.006	1.068	0.863	0.997	1.018	1.220
	P	0.954	0.874	0.964	0.606	0.700	0.360	0.263
	S	0.825	0.893	0.969	0.938	0.767	0.962	0.950
Chase	E	0.905	1.000	1.000	1.000	1.000	0.917	0.803
	T	1.105	1.147	1.414	2.377	3.397	3.751	6.106
	M	1.000	1.147	1.414	2.377	3.397	3.438	4.903
	P	0.956	1.000	1.000	1.000	1.000	1.000	1.000
	S	0.947	1.000	1.000	1.000	1.000	0.917	0.803
America	E	0.896	0.796	0.933	1.000	1.000	1.000	0.450
	T	1.173	1.288	1.377	2.701	3.317	2.932	3.578
	M	1.051	1.026	1.286	2.704	3.320	2.935	1.611
	P	0.919	0.809	0.975	1.001	1.001	1.001	0.583
	S	0.976	0.985	0.957	0.999	0.999	0.999	0.770
ABN	E	1.075	1.075	1.075	1.075	1.075	1.075	0.656
	T	1.242	1.319	1.459	1.991	2.875	2.257	3.144
	M	1.335	1.418	1.568	2.140	3.091	2.426	2.062
	P	1.061	1.061	1.061	1.061	1.061	1.061	0.841
	S	1.013	1.013	1.013	1.013	1.013	1.013	0.780
Bharat	E	0.839	1.016	0.845	0.694	0.518	0.609	0.490
	T	1.132	1.131	1.274	1.625	2.130	2.205	3.116
	M	0.950	1.150	1.077	1.127	1.103	1.341	1.524
	P	1.000	1.000	1.000	0.979	1.000	1.000	1.000
	S	0.839	1.016	0.845	0.708	0.518	0.608	0.489
ICBC	E	1.025	0.827	0.631	0.345	0.378	0.416	0.314
	T	1.140	1.016	1.352	2.473	2.908	3.440	4.558
	M	1.168	0.840	0.852	0.852	1.096	1.428	1.427
	P	1.000	0.934	0.902	0.730	0.839	0.872	0.886
	S	1.025	0.886	0.699	0.472	0.450	0.477	0.354
Sime	E	1.000	1.000	1.000	1.000	1.000	1.000	0.684
	T	0.953	0.787	1.233	0.720	0.834	0.599	0.404
	M	0.953	0.787	1.233	0.720	0.834	0.599	0.277
	P	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	S	1.000	1.000	1.000	1.000	1.000	1.000	0.684
OCBC	E	0.796	0.814	0.940	0.971	1.059	0.592	0.630
	T	1.260	1.271	1.176	1.504	1.946	2.575	3.335
	M	1.003	1.035	1.104	1.459	2.062	1.526	2.104
	P	0.960	1.008	1.009	1.009	1.009	1.009	1.009
	S	0.830	0.808	0.931	0.962	1.050	0.587	0.625
Geometric mean of foreign banks								
	E	**0.944**	**0.945**	**0.929**	**0.787**	**0.782**	**0.726**	**0.581**
	T	**1.115**	**1.106**	**1.251**	**1.630**	**1.983**	**2.203**	**2.884**
	M	**1.052**	**1.045**	**1.162**	**1.283**	**1.551**	**1.598**	**1.676**
	P	**1.000**	**0.989**	**1.000**	**0.892**	**0.932**	**0.855**	**0.799**
	S	**0.944**	**0.956**	**0.930**	**0.882**	**0.839**	**0.849**	**0.727**
Geometric mean of all banks								
	E	**0.884**	**0.889**	**0.796**	**0.542**	**0.496**	**0.432**	**0.343**
	T	**1.172**	**1.175**	**1.333**	**2.038**	**2.466**	**2.890**	**3.730**
	M	**1.036**	**1.045**	**1.061**	**1.106**	**1.224**	**1.249**	**1.278**
	P	**1.003**	**1.000**	**1.000**	**0.887**	**0.911**	**0.747**	**0.612**
	S	**0.881**	**0.889**	**0.796**	**0.611**	**0.545**	**0.579**	**0.560**

Notes: E= efficiency change, T= technological change, M= Malmquist productivity index, P= pure technical efficiency change, S = scale efficiency change

APPENDIX XIII Fixed and random effects model of productivity indices

Table A10 Fixed and random effects models: efficiency change index

Predictor	Fixed effects		Random effects		FEM & period effects		REM & period effects	
	Coefficient	T-ratio	coefficient	T-ratio	coefficient	T-ratio	coefficient	T-ratio
Intercept			0.608	3.333**	1.128	5.207**	0.986	4.927**
ROA	-0.835	-0.688	0.878	0.966	0.016	0.016	0.532	0.638
TCTA	1.862	2.444*	0.747	1.152	-0.059	-0.064	-1.402	-1.873
EQTA	-0.122	-1.158	0.133	1.612	-0.138	-1.417	0.021	0.258
LLRTL	-0.046	-0.159	0.227	0.968	-0.069	-0.268	0.183	0.848
TLTA	0.016	0.059	0.198	1.002	-0.278	-1.090	-0.020	-0.107
	R^2 adjusted	0.096			R^2 adjusted	0.342		
	$F_{33,169}$	1.65*			$F_{40,162}$	3.63**		

Notes: (**) and (*) indicates significant different from zero at the 1% and 5% levels (two-tailed test).

Table A11 Fixed and random effects models: technological change index

Predictor	Fixed effects		Random effects		FEM & period effects		REM & period effects	
	Coefficient	T-ratio	coefficient	T-ratio	coefficient	T-ratio	coefficient	T-ratio
Intercept			1.739	5.491**	1.107	3.561**	1.035	3.646**
ROA	2.986	1.593	0.658	0.414	1.404	0.929	-0.255	-0.225
TCTA	-4.873	-4.143**	-4.511	-4.134**	-0.659	-0.492	0.517	0.516
EQTA	0.063	0.386	-0.101	-0.703	0.133	0.953	0.050	0.462
LLRTL	-0.407	-0.912	-0.563	-1.374	-0.354	-0.963	-0.544	-1.889
TLTA	-0.339	-0.789	-0.122	-0.337	0.194	0.531	0.227	0.914
	R^2 adjusted	0.055			R^2 adjusted	0.405		
	$F_{33,169}$	1.36			$F_{40,162}$	4.44**		

Notes: (**) and (*) indicates significant different from zero at the 1% and 5% levels (two-tailed test).

Table A12 Fixed and random effects models: productivity change index

Predictor	Fixed effects		Random effects		FEM & period effects		REM & period effects	
	Coefficient	T-ratio	coefficient	T-ratio	coefficient	T-ratio	coefficient	T-ratio
Intercept			1.192	4.954**	1.362	4.331**	1.187	4.699**
ROA	1.148	0.774	0.876	0.729	1.450	0.948	0.934	0.757
TCTA	-1.995	-2.142*	-2.271	-2.707**	-1.155	-0.852	-2.190	-2.372*
EQTA	-0.060	-0.463	0.039	0.360	-0.069	-0.488	0.037	0.323
LLRTL	-0.471	-1.334	-0.351	-1.125	-0.494	-1.328	-0.348	-1.085
TLTA	-0.228	-0.668	0.060	0.222	-0.250	-0.676	0.058	0.206
	R^2 adjusted	0.060			R^2 adjusted	0.034		
	$F_{33,169}$	1.39			$F_{40,162}$	1.18		

Notes: (**) and (*) indicates significant different from zero at the 1% and 5% levels (two-tailed test).