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WHAT HAPPENED TO THAI COMMERCIAL BANKS IN THE PRE-ASIAN CRISIS PERIOD: MICROECONOMIC ANALYSIS OF THAI BANKING INDUSTRY[1]

HIDENOBU OKUDA

Graduate School of Economics, Hitotsubashi University
Kunitachi, Tokyo 186-8601, Japan
hokuda@econ.hit-u.ac.jp

AND

FUMIHARU MIENO

Faculty of Economics, Hosei University
Machida, Tokyo 194-0298, Japan
fmieno@mt.tama.hosei.ac.jp

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Abstract

In this paper, it is discussed from the microeconomic perspective how the production activities of Thai domestic commercial banks changed under the progress of the financial liberalization policy during the 1985-1994 period. First, using the microeconomic data on Thai domestic banks, we sketch their major business activities. Next, we formally estimate the cost functions of Thai domestic banks and demonstrate that financial liberalization policies promoting market competition helped create more efficient business operions of banks. Our estimation study also suggests that the the medium-sized banks, which were the first to fail during the economic crisis in 1997, were deeply involved in unsound business operations and engaged in excessive lending and that appropriate prudential regulations are essential for improving production efficiency while maintaining the sound business operations of banks.

Key Words: Economies of scale; Cost function; Banking; Thailand; Financial liberalization
JEL classification: G21; G28; O16

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I. *Introduction*

The Thai financial system was under relatively strict control by the government until the early 1980s. However, as in other ASEAN countries, a series of financial reform measures based on the "financial liberalization policy," were rapidly adopted since the late 1980s. These reform policies intended, by efficient resource allocation through the market mechanism, to develop a highly functional financial system with efficient financial institutions that could provide a wide range of financial services at low cost. Toward that end, the Thai government pursued policies that promoted market competition based on the self responsibility of financial institutions. The competitive market environment was expected to give the financial institutions strong incentives to expand their business operations responding to the customers demands and, at the same time, to choose the most efficient technology to minimize their operational costs.

The Thai financial sector achieved startlingly rapid growth since the latter half of the 1980s, assisted by the favorable macroeconomic performance and the financial liberalization policy. However, when the Asian economic crisis occurred in 1997, discussion turned to the fragility of the Thai financial sector as one of the major causes of the economic crisis and as one of its aggravating factors, and the direction of the financial liberalization policy was reconsidered. The liberalization policy had indeed created a competitive financial market, however, it still lacked the transparency and market discipline. Under the unfavorable market circumstances, the business operation of financial institutuions was now criticized as being unsound and inefficient.

It can be said that, whenever the Thai economic crisis is discussed, the fragility of its financial sector and the inappropriateness of the financial liberalization policy are pointed out. However, how the Thai financial liberalization policies affected the business operations of financial institutions has seldom been discussed in the formal analytical setting. Although Thai financial liberalization policies have been examined by several studies, such as Nijathaworn (1993) and Vichyanond (1994) in Thailand and Aoki (1991) and Okuda (1993) in Japan, these focus on the macroeconomic effects of the reform policies on the Thai economy, paying scant attention to the microeconomic changes in the market environment and business operations of Thai financial institutions. Similarly, although the business operations of Thai financial institutions and their operational efficiency have been examined by such previous works as Dhanwattanachai (1990) and Phaiboon (1994), these have not discussed the changes in the operational efficiency of Thai financial institutions in relation to the recent financial liberalization policies.

The purpose of this paper is to discuss the effects of the Thai financial reform policies in the late 1980s and early 1990s on the financial market environment and the efficiency of Thai financial institutions from the microeconomic perspective. The study focuses on the business activities of Thai domestic commercial banks, which are the core of the Thai financial system. The analytical period in this paper is from 1985 to 1993, during which the fragility of Thai banks was recognized to be augmented under the financial liberalization.

In this paper, we first summarize the development of Thai financial liberalization policies since the late 1980s and explain how they have strengthened the market competition among

Thai domestic commercial banks (in section 2). Then, using the financial data of Thai domestic commercial banks, we sketch their major business activities and discuss how their business operations have changed in the process of financial liberalization (in section 3). Next, we formally estimate the cost functions of Thai domestic commercial banks and demonstrate that their operational efficiency has been changing (in section 4). Finally, we summarize our discussion and derive policy implications for further development of the Thai banking sector (in section 5).

II. *Recent Financial Reform Policies and Change in The Market Environment Surrounding Commercial Banks*

1. Recent Development of Financial Reform

Although the process of Thai financial liberalization started in the early 1980s, it was not until the late 1980s that the Thai government accelerated the liberalization process in earnest (see Table 1). The financial reform policies became intense with the first three-year plan in 1990. The major objectives of this plan were to transform the economy into a more market-oriented system, to promote savings mobilization and the efficient allocation of resources, to strengthen Thai competitiveness, and to prepare the financial community for future challenges with more openness and integration into the global system.

The plan's four major components were: deregulation of the financial system, improvement of supervision and examination of financial institutions, development of financial instruments, and improvement of the payment system. On the one hand, the plan was designed to promote greater market competition through deregulation measures, which would result in the development of new financial instruments and the reduction in financial inter-mediation cost. The deregulation measures included interest rate liberalization, relaxation of constraints on portfolio management of financial institutions, and expansion of financial institution business operations. On the other hand, the plan was designed to supplement the greater market competition by strengthening the prudential regulations, in order to sustain the stability of the financial system. The adoption of the capital adequacy guidelines of BIS and the improvement of supervision and examination of financial institutions were two major components of the supplementary measures for maintaining the stability of a liberalized financial system.

Following the first three-year plan, the second three-year plan was launched in 1993, aiming at the further expansion of the policy measures pursued in the first three-year plan. In addition, the second three-year plan encompassed mobilizing savings, extending financial services to rural areas, and developing Bangkok as a regional financial center. These liberalization policies were intended to create a financial system which can provide broader and more efficient services at lower cost. Such a financial system was recognized to be crucial to the further growth of the Thai economy where most investment projects were being undertaken by the private sector based on the market mechanism without government help.

TABLE 1. CHRONOLOGY OF MAJOR FORMS OF FINANCIAL REFORM IN THAILAND: 1989-1995

Abolition of interest rate control	
1989 June	Abolition of interest rate ceiling on commercial banks' time deposits with maturity exceeding 1 year.
1992 Jan.	Abolition of the interest rate ceiling on savings deposits at commercial banks
1992 June	Removal of ceilings on lending and borrowing rates of finance and credit foncier companies. Remaining ceiling on bank lending rates was removed.
1993 Oct.	Commercial banks are required to announce the Minimum Loan Rate (MLR), the Minimum Retail Rate (MRR) and maximum margin to be added to MRR as a reference rate for customers other than those eligible for MLR.
Foreign exchange liberalization	
1990 May	The official acceptance of obligations under article VIII of the Articles of Agreement of the IMF.
1991 March	Exporters can receive payments in baht from non-resident baht accounts in addition to those in foreign currencies and are allowed to use such foreign currency receipts either to pay for imports or to reduce foreign liabilities to nonresidents. Residents can withdraw from their foreign currency accounts to repay debt on behalf of their subsidiaries, or transfer to creditors' foreign currency accounts at commercial banks.
1991 April	Expatriates working temporarily in Thailand are allowed to purchase foreign currencies to deposit in their foreign currency accounts at commercial banks in Thailand.
1992 April	Government departments, government organizations, state enterprises or juristic persons established by specific laws are permitted to purchase, exchange, borrow or withdraw from their foreign currency accounts in all cases and are able to deposit an unlimited amount of foreign notes and coins in their foreign currency accounts. (The limit was formerly set at US $2,000 per day.)
1993 March	Permission given to 46 commercial banks to operate international banking business known as BIBF.
1994 Feb.	Enlarging the limit on the amount of baht that can be taken out to countries sharing contiguous border with Thailand and Vietnam from B 250,000 to 500,000. Abolishing the limit on the amount of foreign currencies that can be taken out when traveling abroad. Enlarging the limit on the amount of foreign investment by Thai residents from US $5 million to $10 million without seeking prior approval. Residents allowed to use foreign exchange originating from abroad to service external obligation without surrendering or depositing in domestic accounts.
1994 May	BIBF allowed to open branches outside Bangkok and the vicinity. The regional branches of the BIBF are allowed to take deposits in both baht and foreign currency from in and outside the country but are allowed to grant credit only in Baht currency in the regional area. BIBF also allowed to operate foreign exchange activities.
1994 Nov.	The ceiling of commercial banks' net position on foreign assets and liabilities to capital reduced to 20% and 15% respectively.

Scope of operations of financial institutions

1992 March	Expansion of the scope of operations of financial institutions to allow greater competition in the supply of financial services. Commercial banks are permitted to act as selling agents for public debt instruments, as arranger, underwriter and dealer in debt instruments, and to act as financial adviser in mergers, acquisition and take-over cases. Financial companies and finance and securities companies are permitted to operate leasing services, act as selling agents for public debt instruments, as well as to act as arranger, underwriter and dealer in debt instruments, and to act as a mutual fund supervisor.
1992 July	Allowing commercial banks to issue NCDs with minimum maturity of 3 months and maximum maturity of 3 years and minimum face value of not less than B 500,000 and subsequent denomination and multiples of B 100,000.
1992 Oct.	Commercial banks allowed to operate ATM 24 hours a day. (Commercial banks allowed to provide ATM service at any branch without prior approval in May 1988.)
1993 March	Permission given to 46 commercial banks to operate international banking business known as BIBF.
1993 May	Lifting of the requirement for commercial banks to hold government bonds to fulfill the branch opening requirement.
1994 June	Commercial banks allowed to invest in equity of more than 20% of their total capital.
1994 August	Guideline to separate Finance Business and Security Business.
1995 June	Five new commercial banks granted licenses for commence banking business.

Prudential regulations and others

1993 Jan.	Adoption of the BIS standard for commercial banks. Commercial banks are required to maintain 7% of capital to risk asset ratio (the rate will be increased to 8% by January 1995). Foreign bank branches required to maintain 6% of tier 1 capital to risk asset ratio.
1993 July	The first credit rating agency The Thai Rating and Information Service (TRIS) established.
1994 August	Guideline to separate Finance Business and Security Business.
1994 Nov.	The ceiling of commercial banks' net position on foreign assets and liabilities to capital reduced to 20% and 15% respectively.

Source: Hataiseree, Rungsun (1995) and Bank of Thailand, *Annual Economic Report* various issues.

2. The Changing Market Environment Surrounding Domestic Banks

Until the late 1980s, the Thai financial system was under relatively strict government control, which was a major cause for the market segmentation between the domestic banking sector and other domestic and foreign financial institutions. First, before financial liberalization, the domestic banking sector was separated from the competition with financial markets abroad as well as foreign banks in Thailand. Although foreign companies had strong access to financial sources abroad, Thai domestic companies had significant difficulty in accessing them because of their weak creditworthiness in the international financial markets. Moreover, foreigners hesitated to invest their money in Thailand, due to the strict control of the foreign exchange market.

Second, under the controlled financial system in the early- and mid- 1980s, the Thai domestic banking sector faced little competition from other domestic institutions and markets. For the households sector, bank deposits were dominantly important financial assets with no favorable substitutes. For the corporate business sector, bank loans were the predominant source of external funds and the role of other fund-raising measures was marginal. Since the capital market was underdeveloped, issuing stocks or bonds in the market was possible only for exceptionally large companies. Although either commercial banks or financial companies could extend loans to companies, since the maximum amount of loans from financial companies was regulated, they could not play a major role in the loan market for large companies.

From the late 1980s, the financial liberalization policies strengthened market competition among domestic commercial banks, not only in their fund-raising activities but also in their loan extending activities. The segmentation between the domestic banking sector and financial markets abroad was weakened by the financial reforms of the late 1980s. The deregulation on foreign exchange control promoted the fund-raising activities of Thai companies in the markets abroad. In addition, the launch of Thai off-shore banking units (BIBF) in 1993 increased the inflow of funds from abroad through foreign financial institutions and, in effect, the domestic banking sector was facing increasing competition from these foreign financial institutions (see Table 2).

The financial liberalization policies promoted both the diversification of fund-raising activities of the companies and the portfolio diversification of Thai residents, which strength-

TABLE 2. NET PRIVATE CAPITAL MOVEMENT

Billions of Baht

	1981	1983	1985	1987	1989	1991	1993
Bank		15.5	-14.5	6.1	-7.6	-6.5	45.2
Non-Bank	21.1	18.3	19.6	16.5	159.9	268.8	233.6
Direct Investment	6.4	8.2	4.4	4.7	44.4	47.1	34.5
Other Loans	17.7	4.2	2.1	-16.0	46.9	143.7	-45.6
Portfolio Investment	0.0	0.3	3.9	12.9	36.6	3.8	122.6
Non-resident Baht A/C	3.0	5.3	10.8	10.6	28.1	52.4	107.3
Trade Credits	-6.1	0.4	-2.0	3.7	3.1	19.0	13.6
Other Capital	0.1	-0.2	0.5	0.6	0.7	2.7	1.1
Total		33.7	5.1	22.7	152.3	262.3	278.7

Source: Bank of Thailand, *Financial Institutions and Markets in Thailand*, various issues.

TABLE 3. HOUSEHOLD SAVINGS AT FINANCIAL INSTITUTIONS

(%)

	1983	1985	1987	1989	1991	1993
Commercial banks	73.20	74.35	73.20	73.39	73.91	70.88
Financial companies	12.06	9.54	7.49	9.73	11.20	14.82
Life insurance Companies	2.48	2.62	2.54	2.54	2.49	2.51
Savings cooperatives	1.76	2.02	2.59	2.63	2.55	2.77
Government Savings banks	8.71	9.22	12.05	8.86	6.65	5.65
Government Housing banks	0.38	1.16	0.97	1.60	1.87	1.88
Others	1.41	1.09	1.15	1.24	1.33	1.50
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Bank of Thailand, *Financial Institutions and Markets in Thailand*, various issues.

ened the competition between the domestic banking sector and other domestic financial institutions and markets. As household portfolios were diversified, the position of bank deposits lost dominance, which implies that the banking sector faced increased competition in mobilizing households savings (see Table 3). Commercial banks still retained the dominant position in the 1990s over other competing institutions such as financial companies and life insurance companies, while they played more important roles than before. However, the portion of savings mobilized by the stock market grew rapidly, while the importance of bank deposits as the financial intermediaries decreased (see Table A-1 in Appendix 1). The share of commercial banks deposits to the principal domestic financial assets dropped from around 70% in the mid 1980s to about 40% in 1993, while that of market capitalization of the stock exchange rose from around 10% in 1986 to more than 50% in 1993. As the companies diversified their fund-raising measures, bank loans lost dominance, which increased the competition of the banking sector with the capital market and financial companies. Especially for the fund-raising activities of large-sized companies, the role of stock markets and foreign funds was more important than before.

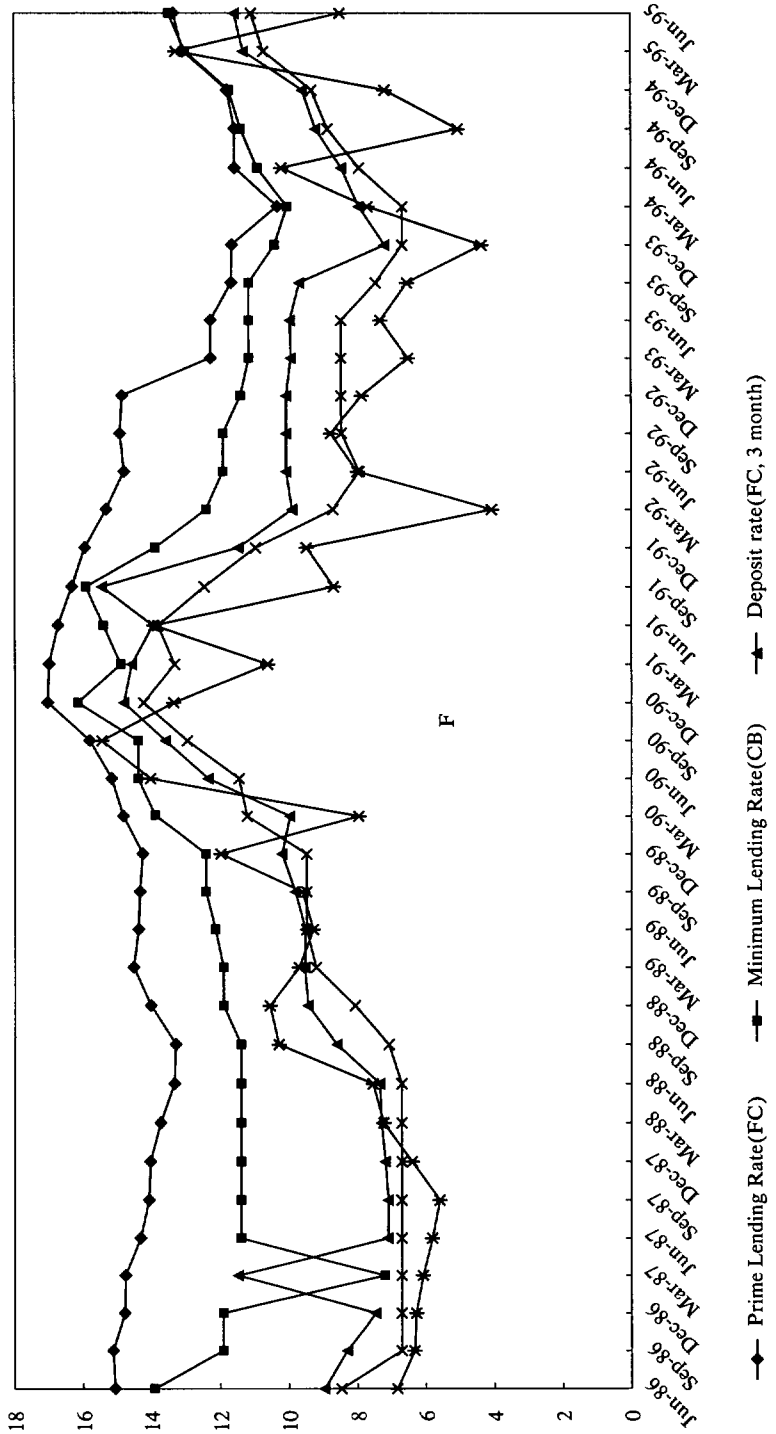
3. The Intensifying Market Competition for Domestic Banks

These changes in the market environment surrounding domestic commercial banks could be recognized from the movements of major interest rates in Thailand (see Figure 1). In the figure, the interest rate differentials between domestic banks and financial companies represent the degree of the segmentation in the lending markets between domestic banks primary customers, which are large-sized companies, and financial companies primary customers, which are small- and medium-sized companies. The Thai money market interest rate and LIBOR (London inter-bank offered rate) represent the level of interest rates in the domestic and international financial markets, respectively. The interest rate differentials between the two represents the international financial linkage. The interest rates on bank deposits and financial companies promissory notes represent the fund-raising cost of banks and financial companies. The larger the interest rate differentials between the two, the weaker their substitution in the portfolio.

Before the financial liberalization policies intensified in the late 1980s, the lending interest rates differed substantially between banks and financial companies, which implies that the lending market of banks to large-sized companies was considerably segmented from that of financial companies to small- and medium-sized companies. Similarly, the interest rate differentials between bank deposits and financial companies' promissory notes was substantial, which implies that substitutability between deposits and promissory notes was weak and banks had little competition against non-bank financial institutions. Furthermore, domestic lending rates of banks were substantially higher than LIBOR, reflecting some segmentation between Thai and foreign financial markets.

Since the late 1980s, the market segmentation has been weakening due to the acceleration of competition among domestic and foreign financial institutions. The lending interest rate differentials between domestic banks and financial companies have been decreasing, which reflects the intensifying competitive relationship between the two. Similarly, the recent reduction in the interest rate differentials between bank deposits and financial company's promissory notes shows the increasing substitutability between the two. Moreover, the interest

FIGURE 1. MAJOR INTEREST RATES



rate differentials between banks and financial companies were reduced rapidly after BIBF opened in 1993, which shows that the competition between foreign financial institutions and financial companies was intensified. While the interest rate differentials between domestic money market rates and LIBOR was still substantially large, the correlation between the two has been strengthening and the international financial market has been more influential in the determination of Thai domestic interest rates.

Reflecting the intensifying competition in the financial markets, the market structure of Thai commercial banks has been changing. During the period from 1981 to 1993, Bangkok Bank lost its market share measured in terms of total assets by 11.5%, while The Siam Commercial Bank, The Thai Military Bank, and Bank of Ayudhya increased their shares by more than 4.8%, 3.5%, and 1.9%, respectively. During the period from 1981 to 1993, Herfinder's Index has consistently decreased from 0.18 to 0.13, which is another clue suggesting the intensifying competition (see Table A-2 and Table A-3 in Appendix 1).

III. *Changes in Production Activities of Domestic Commercial Banks*

1. Production Activities of Banks

Before we estimate the cost function of Thai domestic commercial banks in the next section, using the analytical framework of microeconomics, we will examine their business activities and clarify how they have changed since the financial liberalization policies were accelerated in the last several years. Similar to other industries, banks are generally recognized to be organizations which make use of a set of inputs to produce a set of financial services. The inputs used in the production process of banks are raised funds, physical capital, and labor. The outputs of banks are financial services provided through various business operations of banks such as extending loans, issuing deposits, and dealing with foreign exchanges. Here, we categorize these financial services into two: those accompanying traditional bank loan business, and all other services, including investment in the securities and the so-called "fee business."

According to Kasuya (1993), the production activities of a bank can be summarized by the production function F: $R_3 \rightarrow R_2$. Q_1, Q_2, and Q_3 represent the amounts of raised funds, physical capital, and labor, respectively. Y_1 and Y_2 are the amounts of traditional loan service and other services.

$$(1) \qquad (Y_1, Y_2)=F(Q_1, Q_2, Q_3)$$

The financial services produced by banks are measured by the "income" which is equalized to the market value of these services. For instance, the total market value of financial services produced by a bank is measured by the current income, and the market value of financial services accompanying loan business is measured by the income from loans and deposits. Although the physical amounts of financial services are not measurable, if the unit prices of these services are assumed to be constant, various "incomes" correspond to the physical indices based on divisia indexes. Therefore, we assume that Y_1 is measured by the interest income from loans and deposits and Y_2 is measured by total non-interest income, that is, current income minus interest income.

In the process of production, Q_1, Q_2, and Q_3 are measured respectively by the total amount of raised funds, the total market value of physical capital such as buildings and equipment, and number of workers. Letting P_1, P_2, and P_3 represent the price of each factor of production, total production cost C is given by equation (2), where P_1Q_1, P_2Q_2, and P_3Q_3 are expenses for raising funds, physical capital, and workers, which roughly correspond to total interest expense, equipment expense, and payroll expense, respectively.

$$C=C(Y_1, Y_2, P_1, P_2, P_3)=P_1Q_1+P_2Q_2+P_3Q_3 \quad (2)$$

2. The Changes in Outputs of Domestic Banks

The gross current income of Thai domestic banks consists of the income from traditional loan businesses such as interest income from loans (and deposits) and discount fees and the non-interest income earned from investments in securities and various fee business. The former corresponds to the output of loan business service Y_1 and the latter corresponds to the output of other financial services Y_2.

As expected in the financial reform policies, the diversification of business activities of banks has been progressing steadily, which is represented by the increase in the ratio of non-interest income to the total income (see Table 4). However, the gross current incomes of Thai domestic banks depend heavily on the interest income from traditional loan business. The share of non-interest income exceeds 10% even for the large-sized banks, which have expanded the non-interest income more steadily compared with medium- and small-sized banks.

The speed of diversifying business operations differs among different-sized banks. In the following discussions, we classify Thai commercial banks into three categories, large, medium, and small banks, according to the size of their total assets: five large-sized banks, five small-sized banks, and the remaining five medium-sized banks. For the large-sized banks, while the initial level of business diversification was lowest in 1985, the ratio of non-interest income steadily progressed, which reflects the persistent efforts to diversify their business operations to

TABLE 4. SHARE OF NON-INTEREST INCOME TO TOTAL INCOME

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Large	3.52%	4.2%	5.66%	6.26%	6.54%	7.04%	8.11%	7.86%	10.48%	10.85%
Medium	4.77%	5.71%	5.67%	5.8%	9.5%	6.66%	6.22%	7.46%	8.46%	12.25%
Small	5.64%	3.03%	5.95%	6.94%	10.47%	7.66%	8.91%	9.56%	8.78%	7.95%

Source: Bank of Thiland, *Commercial Banks in Thailand*, various issues

TABLE 5. LABOR CAPITAL RATIO Q_3/Q_2

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Large	4.82	4.65	4.46	4.58	4.57	3.59	2.96	3.01	1.75	1.19
Medium	4.63	4.38	4.00	4.02	4.17	3.71	3.32	3.57	2.77	2.08
Small	4.63	3.69	3.54	3.52	3.55	2.92	1.70	2.29	1.59	1.15

Source: Bank of Thiland, *Commercial Banks in Thailand*, various issues
Bangkok Bank, *Statistical Data on Commercial Banks in Thailand*, various issues

meet the needs of customers. On the other hand, the share of non-interest income to total income fluctuates more widely for medium- and small-sized banks. Different from the

large-size banks which can diversify their lending among wide varieties of numerous customers, the customers of small- and medium-sized banks are narrow and industry-specific. Consequently, the loan business of small- and medium-sized banks is easily affected by the fluctuation in business circumstances in specific industries. The wide fluctuation of their interest income is reflected in the wide fluctuation in the share of non-interest income to total income.[2]

3. The Changes in Factor Inputs

Since the mid 1980s, significant changes in factor inputs have been observed in the Thai banking sector. One of the most important changes, for all groups of banks, is the consistent decrease in the ratio of labor to physical capital Q_3/Q_2 (see Table 5). In other words, over the last decade, the Thai banking sector has been a more capital-intensive industry, substituting physical capital for labor. However, the speed of reduction of the labor physical capital ratio differs between different-sized banks and the factor intensity has been diverted for different-sized banks. While the level of factor intensity was almost the same between banks in the mid 1980s, the large- and small-sized banks chose more capital-intensive production and the medium-sized banks chose more labor-intensive production.

TABLE 6. FACTOR PRICE INDEXES

Average Cost of Raising Funds: Total Interest Expense/Total Liabilities

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Large	14.40%	7.96%	5.50%	5.52%	5.67%	6.07%	9.82%	7.39%	6.57%	5.61%
Medium	9.20%	8.66%	5.88%	5.88%	6.10%	7.12%	10.01%	7.79%	7.22%	6.34%
Small	9.42%	8.27%	6.18%	5.83%	7.07%	8.35%	10.58%	8.04%	7.12%	6.12%

Average Cost of Equipment Expense: Equipment Expense/Fixed Assets

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Large	0.1251	0.1524	0.1603	0.1815	0.2699	0.2466	0.2598	0.2541	0.1709	0.1251
Medium	0.0752	0.0724	0.0888	0.0967	0.1677	0.1608	0.1665	0.1939	0.1733	0.1546
Small	0.0998	0.0839	0.1058	0.1148	0.1917	0.1751	0.1704	0.2225	0.1737	0.1234

Average Wages: Payroll Expense/Number of Employees (1000 Baht)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Large	1264	1261	1345	1435	1513	1706	1952	2162	2449	2778
Medium	951	890	1055	1152	1229	1410	1554	1726	1879	2136
Small	957	978	1072	1166	1312	1567	1666	1979	2146	2549

Average Expenses for Equipment per branch: Equipment Expense/Number of Branches

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Large	1.9842	2.2635	2.3998	2.5262	2.6133	3.0045	3.9524	3.7424	4.1650	4.5691
Medium	1.1040	1.1218	1.3186	1.3700	1.3458	1.4555	1.8953	2.1686	2.5825	3.0153
Small	1.1273	1.4566	1.9239	2.1451	1.8312	2.1971	3.3843	3.3784	4.2466	4.2992

Source: Bank of Thiland, *Commercial Banks in Thailand*, various issues
Bangkok Bank, *Statistical Data on Commercial Banks in Thailand*, various issues

[2] In the figure of 1994, however, the medium-sized banks were the highest in diversification. The reason is not obvious.

The changes in the labor capital ratio correspond to the changes in the relative price of factors (see Table 6). While the wages of employees at banks have been steadily increasing reflecting the rapid growth of the Thai economy, the prices of business machines such as computers have been rapidly falling because of technological progress. As a result, the relative price of labor to physical capital such as building and business machines has been steadily rising, which leads to substituting physical capital for expensive labor. Furthermore, financial liberalization and the resultant intensifying competition among financial institutions accelerated the large investment in computerization to meet financial modernization.

The speed of changes in the labor-capital ratio differs among different-sized banks, which reflects the differences in factor prices among them. For the cost of raising funds, the large-sized banks have always enjoyed lower costs than the medium- and small-sized banks. This feature has been observed unchanged since the acceleration of financial liberalization. The low fund-raising cost for the large-sized banks is recognized to reflect their strong ability to mobilize savings in the form of deposits using well-developed branch networks. On the other hand, since the small- and medium-sized banks with small branch networks must cover shortages of funds by borrowing at high cost, their fund-raising costs become higher than those of large-sized banks.

For all groups of banks, the average equipment expense per branch has increased. That level is the highest for the large-sized banks, and the lowest for the medium-sized banks. The high level for the large-sized banks reflects their active investment for modernization and expansion of business operations.

The average payroll expense per worker has also increased for all groups of banks. The average wages at large-sized banks have always exceeded those at medium- and small-sized banks. While the average wages for the medium- and small-sized banks were almost at the same level in the mid-1980s, those for the small-sized banks have exceeded those at the medium-sized banks in the last several years.

TABLE 7. AVERAGE PRODUCTIVITY OF INPUTS

Productivity of Funds: Y_1/Q_1

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Large	0.08	0.06	0.05	0.05	0.09	0.10	0.13	0.12	0.10	0.10
Medium	0.07	0.06	0.05	0.05	0.09	0.10	0.12	0.12	0.10	0.09
Small	0.07	0.06	0.05	0.05	0.09	0.11	0.13	0.13	0.10	0.10

Productivity of Physical Capital: Y_1/Q_2

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Large	6.48	5.33	4.77	5.69	6.84	7.73	8.02	7.45	4.36	3.34
Medium	4.95	3.80	3.37	3.97	5.60	7.59	9.09	10.10	7.99	6.01
Small	4.52	3.07	3.01	3.35	4.52	5.09	3.98	4.32	3.29	2.50

Productivity of Labor: Y_1/Q_3

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Large	1.34	1.15	1.07	1.24	1.48	2.14	2.75	2.46	2.54	2.79
Medium	1.07	0.87	0.84	0.99	1.31	1.95	2.58	2.58	2.71	2.93
Small	0.98	0.83	0.85	0.95	1.30	1.82	2.29	1.94	2.04	2.27

Source: Bank of Thiland, *Commercial Banks in Thailand*, various issues
Bangkok Bank, *Statistical Data on Commercial Banks in Thailand*, various issues

The features of factor input are reflected in the change in the productivity of factors of production, using average productivity of each factor of production, that is, productivity of funds Y_1/Q_1, productivity of physical capital Y_1/Q_2, and productivity of labor Y_1/Q_3 (see Table 7). First, no clear difference in the productivity of funds is observed between the different-sized banks. Secondly, for the average productivity of physical capital, the level of the small-sized banks has been lower than those for the large- and medium-sized banks. While the level for the large-sized banks was higher than that for the medium-sized banks until the late 1980s, since the large-sized banks expanded the investment in fixed capital, the order was reversed in the 1990s. Finally, regarding the productivity of labor, the level of the large-sized banks was the highest, and that of the small-sized banks was the lowest before 1991. While the average productivity for medium-sized banks was as low as the level of the small-sized banks in the mid-1980s, it has been improved steadily and has risen to even more than the level of the large-sized banks recently.

The large-sized banks have taken the strategy of using of extensive branch networks to mobilize funds at low cost, and increasing investment in physical and human capital with high quality. They have been actively expanding business operations, making the best use of their highly qualified workers and modern business equipment. For medium-sized banks, while their average income levels per worker and per branch are lower than those for the larger-sized banks, these weaknesses are partially offset by their low outlays for workers and equipment. The branch networks of small-sized banks are quite sparse, which is the major cause of their high fund-raising costs. However, in contrast to the strategy of the medium-sized banks, they have been actively responding to the new market environment by rapidly increasing their investments in physical and human capital.

TABLE 8. RATIOS OF OPERATIONAL COSTS

Ratio of Fund-raising Expense to Interest Income: P_1Q_1/Y_1

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Large	0.7783	0.7743	0.6825	0.6574	0.6991	0.7184	0.7771	0.6590	0.6389	0.5890
Medium	0.8110	0.9427	0.7495	0.7452	0.7991	0.7894	0.8326	0.7210	0.7279	0.6731
Small	0.8031	0.8343	0.7183	0.6910	0.7601	0.7666	0.8365	0.7105	0.6928	0.6208

Ratio of Equipment Expense to Interest Income: P_2Q_2/Y_1

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Large	0.0331	0.0434	0.0510	0.0469	0.0393	0.0308	0.0325	0.0350	0.0376	0.0383
Medium	0.0317	0.0390	0.0470	0.0418	0.0324	0.0238	0.0224	0.0260	0.0278	0.0297
Small	0.0348	0.0514	0.0704	0.0658	0.0461	0.0358	0.0394	0.0493	0.0507	0.0515

Ratio of Payroll Expense to Interest Income: P_3Q_3/Y_3

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Large	0.0940	0.1099	0.1259	0.1154	0.0906	0.0730	0.0682	0.0845	0.0934	0.0992
Medium	0.0890	0.1026	0.1253	0.1167	0.0966	0.0768	0.0648	0.0740	0.0762	0.0799
Small	0.0981	0.1174	0.1261	0.1222	0.1116	0.0913	0.0789	0.1018	0.1087	0.1155

Source: Bank of Thiland, *Commercial Banks in Thailand*, various issues
Bangkok Bank, *Statistical Data on Commercial Banks in Thailand*, various issues

4. The Change in Operational Costs and Profits

Among the components of operational expenses, for all groups of banks, expense for raising funds is the largest, followed by payroll expense and equipment expense. Regarding the ratio of fund-raising expense to interest income P_1Q_1/Y_1, the large-sized banks have kept their dominant position over the medium- and small-sized banks even after the financial liberalization policies were adopted (see Table 8). For the ratio of equipment expense to interest income P_2Q_2/Y_1, the ratio for the medium-sized banks has been at the lowest level and that for the small-sized banks has been at the highest level recently. Similarly, for the ratio of payroll expense to interest income P_3Q_3/Y_1, the medium-sized banks have had the lowest ratio and the small-sized banks have had the highest ratio in recent years.

According to these observations, the small-sized banks have the highest ratios of expenses for all categories of factors, which shows that their operational costs are the highest among all groups of banks. Comparing the large-sized with medium-sized banks, the former have the lowest costs of fund-raising and the latter have the lowest levels of wages. For the ratio of total operational costs to income, the large-sized banks have the lowest level among all groups of banks, which reflects their strong position in fund raising activities at a low cost. Following the large-sized banks, the medium-sized banks have the second lowest ratio of operational cost to income, which has the merit of low equipment expense and wages.

Since there is no significant difference in the income structure among the different groups of banks, the differences in structuring of operational costs determine almost directly the gap in profit ratios among banks (see Table 9). The large- sized banks have had the highest ratio of profit to total assets since the mid- 1980s, mainly due to their strong fund-raising ability at low cost based on their widespread branch networks. Their business operations are characterized by low costs and high profit. Medium-sized banks have been endeavoring to reduce their operational costs by employing cheap labor and saving on equipment expenditures. Their operations are characterized by both low costs and low income. For small-sized banks, although their averaged operational cost relative to total assets is high, their averaged operational income to total assets is also high. Their operation is characterized by high costs and high income.

TABLE 9.

Ratio of Income per Total Assets (Total Income/Total Assets) (%)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Large	14.08%	12.21%	10.51%	11.14%	8.92%	10.65%	12.79%	11.95%	10.54%	9.79%
Medium	13.12%	9.30%	9.41%	9.49%	8.87%	10.25%	11.95%	15.09%	10.07%	9.95%
Small	13.30%	11.07%	9.91%	10.52%	9.58%	11.43%	12.55%	12.99%	10.42%	9.88%

Ratio of Profit (Total Net Income/Total Assets) (%)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Large	0.74%	0.53%	0.79%	0.90%	1.00%	1.43%	1.47%	2.20%	2.33%	2.43%
Medium	0.45%	-0.69%	0.38%	0.53%	0.76%	0.85%	0.81%	1.33%	1.55%	1.89%
Small	0.47%	0.29%	0.63%	0.37%	0.63%	0.70%	0.62%	0.14%	1.43%	1.07%

Source: Bank of Thiland, Commercial Banks in Thailand, various issues

5. Reactions to the Changing Market Environment

Thai domestic commercial banks have been adjusting to the new market environment resulting from the financial liberalization polices which have been accelerating since the late 1980s. The large-sized banks have taken the strategy of using extensive branch networks to mobilize funds at low cost, and increasing investment in physical and human capital of high quality. They have been actively expanding business operations, making the best use of their highly qualified workers and modern business equipment. Their operations are characterized by low costs and high profit.

Medium-sized banks have been passively adjusting to the new environment and endeavoring to reduce their operational costs by employing cheap labor and saving on equipment expenditures. While their average income levels per worker and per branch are lower than those of the larger-sized banks, these weaknesses are partially offset by their low outlays for workers and equipment. The degree of expansion in the business operations of medium-sized banks lags behind that of larger banks. Their operations are characterized by both low costs and low income.

The branch networks of small-sized banks are quite sparse, which is the major cause of their high fund-raising costs. However, in contrast to the strategy of the medium-sized banks, they have been actively responding to the new market environment by rapidly increasing their investments in physical and human capital. Although their average operational cost relative to total assets is high, their averaged operational income to total assets is also high. Their operations are characterized by high cost and high income.

IV. *The Estimation of Domestic Bank Cost Functions*

1. The Method of Estimation

In order to investigate how the liberalization described in the last section affects the management of the banking sector, we estimated the cost functions of Thai commercial banks. Our estimation focuses on the degree of economies of scale and technological progress as well as efficiency in the Thai banking sector, which is one of the major policy objectives in the recent financial reforms. As mentioned by Leyland and Pyle (1977), since production of the banking industry is characterized by large fixed cost and decreasing average cost of production, the economies of scale and scope are expected to be observed when banks minimize their cost of production under the competitive market circumstances. According to Tsutsui (1992), the degree of economies of scale in the city banks in Japan increased as the financial liberalization policies promoted market competition in the 1970s.

The estimation method used in our study basically follows Kasuya (1993, ch5). The cost function we adopt is the ordinal type of trans-log function with one product and three factor prices. Estimation is conducted by the panel data covering the 1985-1994 period.

Here, since the diversification of business operations are still at the beginning stage in the

Thai banking sector as shown in the previous section,[3] we assume that the i-th commercial bank produces the single composite product at each time t, which is measured in terms of the total income, Y_{it}, through the most efficient use of the three factors, namely, raised funds, physical capital, and labor. Then, the production activities of the i-th bank can be summarized by the following production function (3). Y_{it} is the amount of total income at time t, Q_{1it}, Q_{2it}, and Q_{3it} represent the amounts of raised funds, physical capital, and labor, respectively.

$$Y_{it}=G(Q_{1it}, Q_{2it}, Q_{3it}) \tag{3}$$

We assume that the cost function of the i-th commercial bank at time t is represented by the following trans-log function (4). The degree of inefficiency in business operations for the i-th commercial bank is represented by stochastic variable μ_i with $\mu_i \geqq 0$, $Ver(\mu)=\sigma^2$. T ($T=0$ *for 1985*) is the time dummy representing the effects on the costs caused by the change in time.

$$\begin{aligned}\ln C_{it}=&a_0+a_1\ln Y_{it}+\frac{1}{2}a_2(\ln Y_{it})^2+\sum_k^3 b_k\ln P_{kit}+\frac{1}{2}\sum_l^3\sum_m^3 c_{lm}\ln P_{li}\ln P_{mi}\\&+d_1T+d_2T^2+\frac{1}{2}\sum_1^3 e_n T\ln P_{nit}+\mu_i+\nu_{it}\ (i=1, 2,\cdots, N)\end{aligned} \tag{4}$$

We assume the four additional conditions which the ordinal cost function must satisfy, which correspond to (5a) through (5d) respectively: symmetry between intersect terms (5a), monotonicity with respect to production and factor prices (5b), linear homogeneity on factor prices (5c), and the second order condition for cost minimization (5d).

$$c_{lm}=c_{ml} \quad (l, m=1, 2, 3) \tag{5a}$$

$$a_j>0\ (j=1, 2),\ b_k>0\ (k=1, 2, 3) \tag{5b}$$

$$\sum_k^3 b_k=1\ (j=1, 2, 3),\ \sum_l^3 c_{lm}=0 \quad \sum_j^3 e_j=0\ (l, m, j=1, 2, 3) \tag{5c}$$

$$H_p\left[\frac{\partial^2 C}{\partial P_l \partial P_m}\right]\leq 0 \quad (l, m=1, 2, 3) \tag{5d}$$

In general, for estimating the cost function (4) with these constraints, we have to specify the distribution of μ_i. However, it is known that using the "within-estimation", method of estimation by the values of deviation from averages of each bank, we can estimate the unbiased estimates of parameters, a_j, b_k, c_{lm}, d_q, e_n, without specifying the distribution of μ_i (Kasuya 1993, ch.5). That is, first, we rewrite the cost function as equation (4) by using the "within-conversion." Then, estimating the converted cost function (4) with the constraints by the Seemingly Unrelated Regression (SUR) of Zellner(1962) simultaneously with cost share functions,[4, 5] we have the unbiased estimates of parameters, a_j, b_k, c_{lm}, d_q, e_n. In order to handle

[3] We conducted a preparative estimation under which the output is divided to the two components, "interet income" and "non-interest income" together with the test of "economies of scope". Any meaningful results, however, were not gained from the estimation. Please refer to Mieno(1999) for detail.

[4] Under perfect competition, cost share functions are derived by Shepherd's Lemma. It is represented as follows in the case of trans-log cost functions.

$$\frac{P_i X_i}{C}=b_i+\sum_k^3 c_{ij}\ln P_i+\frac{1}{2}\sum_1^3 c_i T\ln P_m\ (i=1, 2, 3)$$

[5] Regarding the endogenous nature of the output in this model, we should adopt the system estimation including the determinant equation of it. According to Mieno (1999), however, the results of estimations are little different.

the constraints, first we estimate (4) with (5a) and (5c), and then check the remaining conditions (5b) and (5d)[6] from the estimated parameters of the "within-converted" cost function (5).

From the estimated parameters, a_j, b_k, c_{lm}, d_q, e_n, the estimate of the inefficiency of the i-th bank combined with the constant term, $a_0+\mu_i$, is given by (6) where upper bars of variables represent average levels of the i-th bank. The relative inefficiency of the i-th bank λ_i is represented by (7). We will examine the average level of inefficiency, given by $\bar{\lambda} \equiv \sum_{1}^{N-1} \exp(\lambda_i)/(N-1)$.[7]

$$(6) \quad a_0+\mu_i=\ln C_{it}-\left[\hat{a}_1 \overline{\ln Y_{it}}+\frac{1}{2}\hat{a}_2(\overline{\ln Y_{it}})^2+\sum_{k}^{3}\hat{b}_k \overline{\ln P_{kit}}\frac{1}{2}\sum_{l}^{3}\sum_{m}^{3}\hat{c}_{lm}\overline{\ln P_{li}\ln P_{mi}}+\hat{d}_1\bar{T}+\hat{d}_2\bar{T}^2+\frac{1}{2}\sum_{1}^{3}\hat{e}_n\bar{T}\overline{\ln P_{nit}}\right]$$

$$(7) \quad \lambda_i \equiv (a_0+\mu_i)-(a_0+\mu)^* \quad \text{for } (a_0+\mu)^*=\min(a_0+\mu_i)\ (i=1, 2,, N)$$

The total elasticity of scale on production is represented by the following formula (8) for the cost function $C=C(zY, P_1, P_2, P_3)$ to be used for judging the existence of "economies of scale." In other words, the economies of scale exist if the value of the formula is strictly less than unity.

$$(8) \quad \frac{\partial C}{\partial z}=\frac{\partial \ln C}{\partial \ln Y}=a_1+a_2 \ln Y$$

From the commercial banks' production function (3), the rate of technological progress in the banking sector is defined by $\Psi \equiv \frac{\partial \ln Y}{\partial t}$. For the cost function (4), Ψ is represented by the following formula (9). Here, d_1 is the rate of technological progress at time $t=0$ (base year *1985*) , and $d_2=\frac{\partial^2 \ln C}{\partial T^2}$ is the rate of change in the technological progress rate. e_n are called the bias in technological progress (in the sense of Hicks) and if $e_n=0$, technological progress is considered to be neutral.

$$(9) \quad \Psi \equiv -\frac{\partial \ln Y}{\partial T}=-(d_1+2d_2T+\frac{1}{2}\sum_{1}^{3}e_n \ln P_n)$$

2. Data Used

The data used in the estimation are basically available from *Commercial Banks in Thailand* provided by Bank of Thailand. The data on numbers of bank employees is based on *Statistical Data on Commercial Banks in Thailand* from Bangkok Bank. The value of individual variables used in the estimation are calculated as follows (for details, see Table A-

[6] We checked the second order condition by observing eigen value of the Hessian of the formulation. Five out of six cases satisfied the condition.

[7] $u_i=\exp(\lambda_i)$ is the measure of the inefficiency in accordance with the assumption.
1) The smallest of the μ_i is asymptotically zero.
2) $C=C(\cdot)\lambda_i$, $1 \leq \lambda_i < \infty$, which means $\ln C=\ln C(\cdot)+\mu_i$.

TABLE 10. RESULT OF ESTIMATION

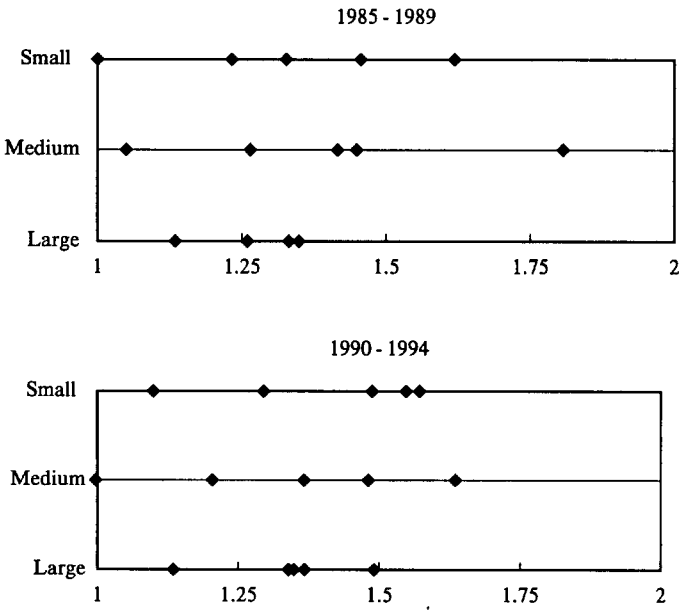
Parameter	1985-1994, All Banks		1985-1989, All Banks		1990-1994, All Banks	
	Estimate	t-statistic	Estimate	t-statistic	Estimate	t-statistic
a_1	0.8589	25.7538	1.0313	16.8762	0.4410	3.5289
a_{11}	-0.3197	-3.7177	0.9581	2.7909	0.2273	0.3251
b_2	0.0194	7.6765	0.0169	5.5218	0.0350	4.3862
b_3	0.1216	22.7932	0.1090	15.7497	0.0731	8.2842
c_{23}	-0.0081	-3.3331	-0.0092	-2.2159	-0.0043	-1.0523
c_{33}	0.0186	2.9631	0.0186	2.0572	0.0314	3.4682
c_{22}	0.0047	3.1588	0.0098	3.5973	0.0029	0.7391
d_1	0.0363	3.6681	-0.0322	-1.8524	0.0062	0.2562
d_2	-0.0079	-3.0769	0.0113	1.3741	-0.0086	-0.7626
e_{21}	-0.0016	-1.4415	-0.0095	-3.9046	-0.0124	-2.8614
e_{22}	0.0032	7.7793	0.0049	5.4784	0.0033	1.4137
e_{23}	-0.0016	-1.8624	0.0047	2.3593	0.0091	3.6199
Inefficiency	1.2937		1.3342		1.3608	
Economies of Scale	0.8589		1.0313		0.4410	
Technological Progress	0.0363		-0.0322		0.0062	

Parameter	1985-1994, Large-sized Banks		1985-1994, Medium-sized Banks		1985-1994, Small-sized Banks	
	Estimate	t-statistic	Estimate	t-statistic	Estimate	t-statistic
a_1	0.9959	22.0790	0.6441	10.2300	1.0409	20.4995
a_{11}	-0.1932	-1.2287	-0.3759	-2.9698	-0.1382	-0.9284
b_2	0.0230	8.2188	0.0194	4.1329	0.0152	4.0177
b_3	0.1338	18.7193	0.1257	11.8908	0.1039	13.3068
c_{23}	-0.0182	-5.6557	-0.0006	-0.1322	-0.0120	-2.8645
c_{33}	0.0288	2.8545	0.0375	3.3153	-0.0243	-2.2816
c_{22}	0.0036	2.1398	0.0049	1.8028	0.0050	1.7873
d_1	0.0518	4.0518	0.0094	0.4820	0.0545	3.6655
d_2	-0.0138	-4.3375	0.0009	0.1704	-0.0147	-3.8444
e_{21}	-0.0005	-0.3128	0.0024	1.1128	-0.0077	-5.0434
e_{22}	0.0034	7.1047	0.0016	2.1276	0.0052	8.3383
e_{23}	-0.0030	-2.3828	-0.0040	-2.3759	0.0025	1.9842
Inefficiency	1.1707		1.3127		1.2689	
Economies of Scale	0.9959		0.6441		1.0485	
Technological Progress	0.0518		0.0094		0.0545	

4 in Appendix 1). Some of the data are converted into the real term by the divisia index method (see Appendix 2 for detail).

Y_1 = (Income from loans and deposits)
Y_2 = (Total non-interest income) − (Gain on exchange)
P_1 = (Total interest expense)/{(Deposits) + (Due to financial institutions) + (Other liabilities payable on demand) + (Borrowings) + (Banks liability under acceptances) + (Other liabilities)}

FIGURE 2. INEFFICIENCY INDEXES OF BANK OPERATIONS



P_2 = {(Equipment expenses) + (Premise expenses)}/(Fixed assets)
P_3 = (Payroll expenses)/(Number of employees)
C = (Total interest expenses) + (Equipment expenses) + (Premise expense) + (Payroll expenses)

3. Results of Estimation

The results of the estimation using annual data during the period from 1985 to 1994, are given by Table 10. Estimations were conducted based on three different periods: the 1985-1989 period, the 1990-1994 period, and the 1985-1994 period. Estimations are also conducted with the samples classified by size of banks. The first and second term moments of λ_t around average value, the elasticity of scale and the technological progress are also included in the table. For the three periods, while t-values are small for some c_{lm}, d_q, the signs of coefficients for major variables $\ln Y$, $(\ln Y)^2$, $\ln P$, T, T^2, $T \ln P$ are consistent with the expected values and their t-values are satisfactory. Comparing the results for the different periods, the estimated results in Table 10 are found to be robust. Judging from these results, the estimated results of the cost function are fairly satisfying.

Economies of scale, that is, $a_1 + a_2 \ln Y < 1$, were observed in the 1985-1994 period at a high degree, which fundamentally supports the estimation results in Phaiboon (1994) and Mori and Tsutsui (1993). Particularly, the result of the estimation based on 1990-1994 samples indicates the extremely high level of economies of scale. This implies that economies of scale deepened in the period of financial liberalization. On the other hand, a slight degree of

diseconomies of scale is observed in the period of 1985-1989. And our estimations indicate that economies of scale existed in large- and medium-sized banks for the entire 1985-1994 period.

For the 1985-1994 period, the index for the relative operational inefficiency of Thai commercial banks $\overline{\lambda_i}$ is around 1.29. Interestingly, the index of the inefficiency seems to increase in the 1990's, compared with the 1980's, which implies the efficiency of banks varies with the process of financial liberalization. The level of the operational inefficiency also varies between banks of different sizes. For the 1985-1994 period, the index of inefficiency was the lowest for the large-sized banks and highest for the medium- sized banks. Figure 2 plots the index of inefficiency of individual banks. This also represents that efficiency is most varied for the medium-sized banks.

During the 1985-1994 period, $\Psi > 0$ was observed for the all commercial banks, which implies that technology was steadily progressing in the banking sector. On the other hand, it seems that the speed of technological progress differed among banks. Seemingly, technological progress was slower for the medium-sized banks than for the large- and small-sized banks. It is worth noting that in the 1985-1989 period when the real economy in Thailand was at the peak of its boom but financial reform was not yet implemented, a significant degree of retrogression of technology was observed.

For the sample in the 1985-1994 period, $e_3 < 0$ was observed to be significant, which implies that the technological progress was a labor-saving one. The labor-saving technological progress was commonly shared by large- and medium-sized banks, whereas, in the estimations of small-sized banks samples, we had the adverse result.

V. *Concluding Remarks*

1. Observed Facts

In Thailand, the financial liberalization policy was launched in a full-scale manner starting at the end of the 1980s. This made the market environment more competitive for commercial banks, which were the core financial institutions in Thailand. According to our analysis, the following three facts were observed in the production behaviors of banks in response to the emergence of the more competitive market environment.

First, a change that was recognized the rational approach from a microeconomic perspective in response to the new market environment occurred in the production activities of commercial banks. Services produced by banks became more diversified, in response to the liberalization of business regulations. Also, with regard to banks' production technology, investment in physical capital such as computers, on-line systems and ATMs was actively carried out in response to a hike in wages as well as advancement of electronics and communication technology. As a result, together with the production technology of domestic Thai banks becoming more capital intensive, the economies of scale, which banks are said to naturally possess, came to be more strongly observed in the 1990s than before.

Second, during the process of change in the production structure of domestic Thai banks, a definite technological progress was observed. In particular, the trend became strong as the financial liberalization policy became more fully implemented and competition in the market

environment was intensified. According to our econometric analysis, whereas technological progress was so small as to be neglected in the late 1980s, it became significantly large in the 1990s. It was observed that, when the competitive environment in the market grew stronger, production activities became more efficient and production costs were substantially reduced.

However, differences can be seen in the above changes in Thai banks' production activities, depending on the size of the bank, that is to say, depending on whether the bank is in the large-, medium-, or small-sized groups. The response of bank operations to change in the market environment differed depending on the size of the bank. This is the third feature that was observed in our analysis.

Attention should be paid to the fact that, in the area of production technology, the medium-sized banks differed conspicuously from the large- as well as small- sized banks. While medium-sized banks outperformed large- and small-sized banks in terms of economies of scale, technical progress was positive for large- and small-sized banks but negative for medium-sized banks. In addition to this, looking at the bias in technical progress, whereas large- and small-sized banks are labor- and fund-saving, medium-sized banks alone are labor-saving but funds-using. At the same time, the operational inefficiency of these banks is substantially large in comparison with large- and small-sized banks. The inefficiency indexes of medium-sized banks are higher than others in terms of average value as well as its variance.

The difference in inefficiency and technological progress among commercial banks is consistent with our observations in the previous section. According to our financial analysis conducted in section 3, preparing for intensifying market competition, large-sized banks have eagerly expanded their business operations and increased their investments in modernization, while medium-sized banks have not placed emphasis on the new businesses and investments. The efforts made by the large-sized banks affected their operational efficiency in a good direction for large-sized banks in this stage of 1994.[8]

2. Policy Implications

Conclusions drawn from these observations mentioned above provide a number of policy implications which are related to the effects of the Thai financial liberalization policy in the 1990s on the soundness of bank management and the durability of the financial sector. In this final section, we would like to conclude this paper by enumerating some of these policy implications.

First, even if there was a problem with the operational structure of Thai commercial banks in the 1990s, the financial liberalization policy was significant in improving the management of commercial banks in Thailand. As the market environment was more intensified, it seemed that economies of scale had been emerging in the Thai banking sector. During the same period, technology progress was clearly observed in the banking sector. These observations support the idea that financial liberalization policies helped create more efficient financial systems. It implies also that, in order to further improve the efficiency of the Thai financial system, policy measures promoting market competition should continue to be

[8] From the estimation of the samples of 1985-1993, we had the results that the inefficiency was lowest in medium-sized banks and highest in large-sized banks. It suggests that in the stage of 1993, the effort of diversification made by large-sized banks were adversely affected their operational efficiencies.

pursued.

Second, if the larger banks enjoy higher profits, the growth in market share of the large banks will accelerate. The economies of scale has a tendency to lead to a monopolistic market structure, which becomes an obstacle to efficient resource allocation and will hamper further development of the Thai economy. In order to avoid malfunctions of the market mechanism caused by a monopolistic market structure, and, meet the requirement to keep the banking sector in a "competitive" environment, the entry of new banks must be allowed. In this sense, opening the Thai banking sector to foreign banks was a desirable policy to keep the banking sector competitive.

Under the steady progress of financial liberalization, the profit ratios of Thai domestic banks increased in the 1990s. However, the Thai commercial banks eagerly expanded their investments for modernization in preparation for greater market competition. The increase in profits which accompanied the announcement of the opening up the domestic banking sector may have given domestic banks a positive incentive to restructure their operations to prepare for the coming competition with foreign banks. This may be an important lesson for the policy makers in their intended pursuit of financial liberalization.

Third is the fact that appropriate ALM (asset and liability management) is extremely important in a competitive market environment for improving production efficiency while maintaining the sound business operations of banks. The characteristics of production technology of medium-sized banks, which were the first to fail during the economic crisis in 1997, strongly suggests unsound business operation and excessive lending behavior. Interestingly, our examination reveals that Thai banks business activities became unsound substantially before BIBF was established in 1993 and thereafter a huge amount of short-term foreign capital was poured into Thailand.[9]

The unnaturally large economies of scale of medium-sized banks can be explained by excessive lending based on overly-lenient lending decisions during the prosperity of the early 1990s. It is likely that, under the favorable macroeconomic environment, excessive lending actually produced high returns and this made medium-sized banks appear outstanding, and as a result, their economies of scale appeared large. The peculiarity of the negative technological progress of medium-sized banks can also be explained by excessive lending. To expand lending, procurement of funds also had to necessarily be expanded, resulting in increased fund raising costs and higher operating expenses. So, higher fund raising costs may have caused an increase in production cost, and this in turn may have caused decay in medium-sized banks' technological progress.

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[9] It was in the 1990-1994 period that the unsound business operations of medium-sized banks, centering on the excessive lending activities accompanied by high a fund-raising cost, was observed in our examination. When we consider the cause-effect relation between the unsoundness of bank management and the function of BIBF, it can be said that our analysis gives additional important information of concern.

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APPENDIX 1

TABLE A-1. DEPOSITS CLASSIFIED BY FINANCIAL INSTITUTIONS

(%)

	1986	1990	1991	1992	1993
Commercial banks	70.8	58.5	56.2	49.1	36.8
Financial companies	10.1	10.6	9.8	10.1	8.0
Life insurance companies	0.8	0.8	0.8	0.7	0.5
Mutual funds	0.1	0.4	0.3	0.7	1.3
Government savings banks	9.6	4.6	3.9	3.2	2.2
Stock exchange	8.6	25.2	29.1	36.2	51.2
Total	100.0	100.0	100.0	100.0	100.0

Source: Bangkok Bank, *Annual Report 1993.*

TABLE A-2. TOTAL ASSETS OF DOMESTIC BANKS

(Billions of Bahts)

	1985	1987	1989	1991	1993	1994
Bangkok Bank	261	301	413	196	783	904
Bangkok Bank of Commerce	29	34	48	79	121	144
Bangkok Metropolitan Bank	33	39	55	75	112	134
Bank of Asia	15	25	36	55	70	83
Bank of Ayudhya	39	55	92	149	201	286
First Bangkok City Bank	28	38	56	98	153	180
Krung Thai Bank	95	148	218	337	425	557
Laem Thong Bank	5	5	6	10	19	23
Nakoronthon Bank	6	8	14	24	37	45
Siam City Bank	28	36	56	83	126	163
Siam Commercial Bank	69	88	138	225	325	368
Thai Danu Bank	8	11	19	38	51	67
Thai Farmers Bank	105	132	200	304	442	509
Thai Military Bank	38	55	85	126	193	228
Union Bank of Bangkok	15	16	23	34	41	46

Source: Bangkok Bank, *Statistical Data on Thai Commercial Bank*, various issues.

TABLE A-3 HERFINDER'S INDEX

	1981	1983	1985	1987	1989	1991	1993	1994
Herfinder's Index	0.18	0.18	0.17	0.15	0.14	0.14	0.13	0.13

Source: Bangkok Bank, *Statistical Data on Thai Commercial Bank*, various issues.

TABLE A-4. SOURCE OF DATA USED

Items	Source
Income from loans and deposits Total non-interest income Gain on exchange Total interest expense Payroll expenses Equipment expenses Premise expenses	Statement of Income (for the year ended December 31) in Bank of Thailand, *Commercial Banks in Thailand.*
Deposits Due to financial institutions Other liabilities payable on demand Borrowings Banks liability under acceptances Other liabilities Fixed assets	Summary Statement of Liabilities and Assets (for the year ended December 31) in Bank of Thailand, *Commercial Banks in Thailand.*
Number of employees	Bangkok Bank, *Statistical Data on Commercial Banks in Thailand*

APPENDIX 2

We converted the data Y, and P_l into real terms by the divisia index method as follows:

1) Y (The Product)

$Y=$(Nominal Income)$\cdot P_g \cdot P_{yit}$

Where P_g is GNP deflator, P_{yit} is the price index of the i th bank at the period t calculated by the devisia aggregation.

P_{yit} is calculated from this formulation.

$$P_{yit}=Exp\left(\sum_j\left(\frac{1}{2}\left(S_{yitj}+S_{yit(t-1)j}\right)+\ln\left(P_{yitj}/P_{yit(t-1)j}\right)+\ln\left(P_{yij(t-1)}\right)\right)\right)$$

Subscript j represents the assets consisting the product. That is,

$j=1$: Security Investment, 2: Inter Bank Lending, 3:Deposit, 4:Loan.

The prices for each working asset (P_{yit}) are as follows:

$j=1$: Yield of governmental bond, 2: Lending rate of inter bank, 3:Deposit rate (more than 3 month, less than 6), 4:Lending rate.

S represents the share of the each asset out of the total working assets.

Since it is impossible to identify the yield for the each working asset by the individual banks, we adapted the assumption that yields are the same for all the banks.

The values at the first period are average price of loan (interest income / total amount of loan).

2) P_l (Price of fund raising)

$P_{lit}=P_g \cdot P_{rlit}$, where P_g is GNP deflater, P_{rlit} is the price index of the i-th bank at the period t, calculated by the devisia aggregation.

P_{rlit} is calculated from this formulation.

$$P_{ylit}=Exp\left(\sum_j\left(\frac{1}{2}\left(S_{litj}+S_{lit(t-1)j}\right)\cdot\ln\left(P_{litj}/P_{lit(t-1)j}\right)+\ln\left(P_{lij(t-1)}\right)\right)\right)$$

Subscript of j represents the method of raising fund for banks.

$j=1$: Issuing bond, 2: Inter bank borrowing, 3: Deposits

The prices for each fund raising method ($P_{r_l jt}$) are as follows:

$j=1$: Yield of governmental bonds, 2: Lending rate of inter bank, 3: Deposit rate (more than 3 month, less than 6).

S represents the share of the fund raising method out of total raised fund.

The values at the first period are average price of fund raising. (interest expense / total amount of raised fund).