Center for Economic Institutions

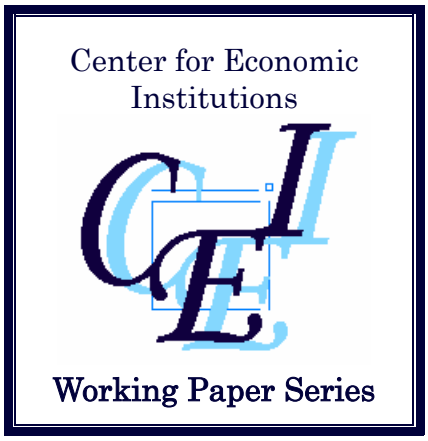
Working Paper Series

CEI Working Paper Series, No. 2004-19

Comparative Cost Study of Foreign and Thai Domestic Banks 1990–2002: Estimating Cost Functions of the Thai Banking Industry

Hidenobu Okuda

Suvadee Rungsomboon



Institute of Economic Research

Hitotsubashi University

2-1 Naka, Kunitachi, Tokyo, 186-8603 JAPAN

Tel: +81-42-580-8405

Fax: +81-42-580-8333

e-mail: cei-info@ier.hit-u.ac.jp

Comparative Cost Study of Foreign and Thai Domestic Banks 1990–2002: Estimating Cost Functions of the Thai Banking Industry [*]

Hidenobu Okuda[**]
Suvadee Rungsomboon[***]

Abstract

This paper investigates the changing cost performances of foreign and domestic banks in Thailand in relation to increased foreign bank penetration by estimating their cost functions using panel data from 27 banks during 1990–2002. Our empirical analysis suggests that production technologies of foreign bank branches are distinct from those of Thai domestic banks. After the Asian crisis, financial reforms increased operating costs of domestic banks and reduced costs of foreign bank branches. Foreign acquisition of domestic banks after the crisis modernized their business activities, reduced costs associated with fee-based businesses and improved their operational efficiency.

JEL Classification: G21, G28, G32, D24
Keywords: Cost function, Foreign Entry, Crisis, Thailand

 This is the revised version of the authors' paper presented at the 9th International Convention of the East Asian Economic Association held at Chinese University of Hong Kong on 13–14 November, 2004. This study is financially supported by a Grant-in-Aid from the Zengin Foundation for Studies on Economics (Japanese Bankers Association) and a Grant-in-Aid for Scientific Research from the Ministry of Education and Science.

** Graduate School of Economics, Hitotsubashi University. 2-1 Naka, Kunitachi-shi, Tokyo 186-8601
Tel: (042) 580-8818, Fax: (042) 580-8882. Email: hokuda@econ.hit-u.ac.jp (Corresponding Author)
*** Graduate School of Economics, Hitotsubashi University.

1. Introduction

Although foreign bank penetration has increased in many transitional and emerging market countries since the 1990s, like other ASEAN countries, foreign bank entry had been strictly regulated in Thailand before the 1997 financial crisis. Since foreign banks were not allowed to possess a branch network, they concentrated on wholesale services focusing on mother countries' companies. These restrictions were relaxed under the postcrisis financial reforms, and foreign bank penetration then increased substantially. Foreign ownership rose significantly in several large domestic banks, and some small domestic banks were acquired by foreign banks. Foreign banks have a strong influence not only on wholesale market customers but also those in retail markets. They eagerly entered the retail markets through participation in majority ownership of domestic banks. It is expected that financial deregulation will progress further under the WTO agreements, and the presence of foreign financial institutions will continue to rise. This movement is expected to be a significant catalyst for change in the domestic banking industry[1].

The optimal structure of the banking industry and the regulatory constraints that would be conducive to such a structure are critically dependent on the technological characteristics of the production process. In order to evaluate the impact of foreign penetration and to formulate the most appropriate policies to align foreign banks with the long-term goals within the Thai banking market, it is essential to investigate the differences in production technology between foreign and Thai domestic banks and the progressive changes resulting from an upturn in foreign penetration in recent years. In practice, the impacts of foreign bank penetration and the suitability of their banking policies have remained without scrutiny to date.

Although the influence of foreign banks has been increasing in Thai banking markets since the 1990s, there have been few formal economic studies evaluating the comparative performance of foreign and domestic banks in Thailand. The few studies that the authors are aware of include Leightner and Lovell (1998), Okuda and Mieno (1999), and Intarachote and Brown (2000), who investigated the efficiency and productivity of foreign and Thai banks in terms of their progress in financial liberalization in the pre-Asian crisis period. Montgomery (2003) examined the role of foreign banks in post-crisis Asia countries, including Indonesia, Korea, Malaysia, and Thailand, focusing particularly on the importance of the method of entry. However, there is no econometric analysis in his study.

As far as the authors know, Chantapong (2001, 2003) is the only academic study investigating the comparative performance of foreign and domestic banks amid deepening foreign penetration after the Asian crisis.[2] There has been no economic study investigating the production technology of foreign and Thai domestic banks relating to the overall development process of foreign entry before and after the Asian crisis.

The purpose of this paper is to conduct a microeconomic examination of commercial banks in Thailand, focusing on technological features recognized to be vital in evaluating increased foreign participation in the banking market. By applying panel data from 27 commercial banks taken from the period 1990–2002, we estimate the cost functions of

[1] See the Financial Sector Master Plan, which was submitted to the Cabinet on January 6, 2004.

[2] Some PhD' theses conduct econometric exercises examining the cost and profit performances of Thai banking markets. See, for instance, Jayapani (1997).

Thai domestic banks, foreign joint venture banks and foreign bank branches, paying attention to the impact of financial reform policies. In order to avoid *ad hoc* empirical analysis, we carefully categorize the group of banks and select the variables used in the estimated functions based on the framework of microeconomics. First and foremost, this paper will undertake a fact-finding to track business operations of Thai domestic and foreign banks from the 1990s up to 2002. Specifically, this paper focuses on the following three questions. First, did different production technology used by foreign and Thai domestic banks impact on their cost performance? Second, if so, what was the nature of major differences in production technology between Thai domestic banks and foreign bank branches? Third, how did the production technology of domestic venture banks change by foreign majority acquisition that was accelerated by financial reforms following the Asian financial crisis? Fourth, how did financial reform policies strengthening prudential regulations and modernization of the banking industry affect the performance of Thai domestic banks and foreign bank branches? Then, based on the technological characteristics of the banks identified, we will discuss the appropriateness of foreign bank entry policy in Thailand as well as its implications for future banking policies.

This paper consists of five sections. Section 2 briefly reviews related literatures and mentions the focuses of our study. Section 3 provides an overview of the development of foreign bank entry in the Thai banking market during the period 1990–2002. Section 4 presents the methodology of regression analysis of the commercial banks' cost performance in Thailand focusing on the impact of foreign participation. Section 5 discusses the results of the regression analysis, and Section 6 examines the robustness of our estimation. Finally, Section 7 summarizes the analysis and refers to the derived policy implications.

According to our empirical analysis, the cost structures of foreign bank branches differ from Thai domestic banks, meaning that the technologies describing the production process for foreign bank branches are distinct from those of domestic ones. The financial reform policies adopted after the Asian crisis increased the operational cost of domestic banks, while it reduced that of foreign bank branches. This suggests that strengthening prudential regulations and upgrading monitoring systems significantly increases the cost of credit risk management in the Thai banking business. On the other hand, new market circumstances help foreign bank branches make better use of their advanced skills and technology. Among Thai domestic banks, increased foreign ownership affects their cost structures. Foreign-acquired banks (i.e., joint venture banks with foreign majority ownership) drastically changed their business operations and introduced production technology similar to that of foreign bank branches, which helped them decrease costs associated with fee-based business and improved cost performance. Like many previous studies on emerging market economies[3], this study provides some evidence that recent financial reform policies, particularly those allowing greater foreign bank penetration, are on the right track to building a desirable banking market in Thailand.

2. Related Studies

2.1 Foreign Banks in Emerging Market Economies

[3] Chantapong (2003) on Thailand is included.

As foreign bank penetration has increased in transitional and emerging market countries since the 1990s, there has been a significant controversy regarding the effects of foreign bank entry into their banking markets. Based on their observation of banking markets in emerging economies, Pomerleano and Vojta (2001) claim that foreign banks have superiority in certain products that require a global platform as well as highly qualified human capital and advanced technology. These products include foreign exchange and derivatives trading, global underwriting bonds and equities, cross-border M&A, trade finance, multiple-currency cash management, global custody, and investment management services. The major targeted customers of these products are multinational farms and large local farms operating international trade.

In addition to competitive product advantages, foreign banks have a competitive advantage in terms of management processes and the quality of support. They carefully plan recruiting, adopt meritocracy, invest in intensive training of human resources, and provide high compensation. Foreign banks have demonstrated a competitive advantage in loan portfolio management, asset–liability management, and management of information services.

Another important feature of foreign banks is that they are motivated by profit seeking and are independent from vested interests based on the coalition with other banks exploiting excess profit. On the other hand, existing domestic banks lack effective monitoring and use preponderantly relational banking practices. It is expected that the increase in foreign penetration weakens the vested interest shared among domestic banks and helps promote market competition.

Foreign banks in emerging economies adopt diversified strategies. Some foreign banks develop local franchises that provide services to corporate and retail clients. They function within the fabric of the domestic banking market and need a wide branch network. By either purchasing existing franchises or growing organically, they expand their own franchises.[4] Other foreign banks are narrowing their targeted customer base and focusing on selected businesses such as investment banking and private banking activities. Their form of entry is determined by the choice of their operational strategy. Some of them provide services only to their home-based customers and they are not interested in having a large number of branches.

The new entrance of foreign banks has a special impact on the market environment that would not be caused by the entrance of new domestic bank. Different from the traditional effects caused by new domestic entrants, foreign entrants help introduce new technology and management skills and substantially enhance the market. Facing the new foreign entrants, domestic banks are forced to react in an effort to compete against new market entrants who are substantially different from the existing domestic banks. In this context, in addition to the change in market concentration ratio, the presence of foreign market players is significant. Separated from the impact on the market environment, when foreign investors posses the majority share of domestic banks, their business performance is expected to change significantly through drastic restructuring and

[4] When foreign banks purchase damaged local banks, they, like local domestic banks, have to direct their effort into financial restructuring plans to reduce operating costs, cut down bad-debt burdens and sharpen competitiveness.

reengineering processes. This is expected to be a significant catalyst for change in the domestic banking industry.

2. 2 Empirical Studies on Foreign Bank Performance

A number of empirical studies such as Claessens et al. (2001) have examined the effects of foreign bank entry on the banks' performance in central European and Latin American countries where intense foreign bank entry started in the early 1990s.[5] There are two ways to evaluate the bank's operational performance. One is to contrast the production technologies within the context of a cost minimization. Another is to employ a profit maximization framework. According to these studies, based on micro bank-level panel data on financial statements, foreign banks are more efficient and profitable than domestic banks. Foreign penetration influenced the positive effects on the recipient countries in the sense that they promoted market competition and improved the operational efficiency of banking. In addition, foreign banks introduce advanced skills and technology helping upgrade the business operations of banks on an overall basis.

However, despite these positive views concerning foreign bank entry, some studies such as Sabi (1996) are more skeptical about its impact on local banking markets. In their opinion, foreign banks seem to "cherry pick" the best credits and are uninterested in sharing risk management techniques with the local banking industry. Similar observations have been found by studies of banking markets in developed economies. According to Elyasiani and Rezvanian (2002) concerning the U.S. market, since foreign and domestic banks differ in their management strategies, clients, knowledge of the local market, international regulatory arbitrage, and international business platform, they have different kinds of competitiveness in the banking market and different advantages in business operations. The foreign banks' parent companies' lack of familiarity with local market knowledge and difficulties in applying home country strategies to emerging market economies hinder their efforts to penetrate markets and earn profits. Therefore, foreign and domestic banks are likely to share different market roles rather than intensively competing with each other. As pointed out by Sabi (1996), foreign banks are hesitant to expose themselves to greater liquidity and so the actual influence of foreign entry on domestic banks is relatively limited.

Comparative performance of domestic and foreign banks has been studied in developed countries especially in the U.S. where foreign bank presence has increased significantly since the 1980s. The competitive advantage of the foreign banks was first investigated by Goldberg (1992). Following this pioneering study, a large number of studies including Meinster and Elyasiani (1988), Mahajan et al. (1996), DeYoung and Nolle (1996), Elyasiani and Mehdian (1995), Jagtiani and Khanthavit (1996) have deepened the analysis. All of these studies use formal econometric analysis based on a

[5] They include Barajas et al. (2000), Claessens, S. and Jansen, M. (2000), Bhattacharaya et al. (1997), Clarke et al. (2001), Claessens et al. (2001), Denizer, C. (2000), Levine (1996), and Litan et al. (2001). These studies can be classified into two groups: studies examining the effects across countries, and studies focusing on the effects of foreign bank entry for a particular country. These studies evaluate cost efficiency by using simple regression of the cost function such as C = C (Yj ; Pk ; FOR ; BSD ; MACRO). The independent variables contain a set of foreign bank indicators FOR and other control variables that are necessary to explain the affect on bank performance. They include a vector of banking sector structure variables BSD such as market concentration ratio, and a vector of macroeconomic variables MACRO.

rigorous theoretical background of microeconomics. These studies observed that cost structure and performances differ between domestic and foreign banks since they differ in management strategies, clients, knowledge of the local market, international regulatory arbitrage, and international business platforms.

2.3 Focuses of our Study

This paper focuses on the following three respects that are recognized to be vital for investigating the effects of increased foreign bank entry on the Thai banking industry and identifying the sources of operational advantages of foreign and domestic banks.

First, we investigate the technological differences between foreign bank branches and Thai domestic banks. Wholly foreign owned banks were not allowed to have a branch network in Thailand and, as a result, their business operations focused on the wholesale markets, in particular foreign companies operating in Thailand. By contrast, Thai domestic banks have at least 50–60 branches and operate in both retail and wholesale markets. Since these two possess widely diversified operational characteristics, they may operate using different technology. These wholly foreign owned banks focus on specialized customers such as multinational corporations and large domestic corporations. They have competitive advantage in a class of products based on highly skilled human capital and a worldwide platform both of which are expensive to maintain. As a result, their products are human capital as well as physical capital intensive and their fixed cost of operations is higher than others. This hypothesis is supported by the observation that the cost function of foreign bank branches is distinctively different from those of Thai domestic banks.

Secondly, we clarify whether the production technology of foreign and Thai domestic banks changed as Thai government imposed more stringent prudential regulations on banking activities and strengthened information disclosure on corporate sectors in the postcrisis financial reforms. While the Thai economy enjoyed high economic growth and the banking sector was flourishing before the Asian crisis, banking business activities lacked prudence. The reform policies adopted after the crisis improved the transparency of information and upgraded the legal and accounting systems, which were expected to contribute to modernization of banking business and increase the operational efficiency of banks. The hypothesis is supported by the observation that the change in market circumstances caused by postcrisis financial reform has significant relation to the performance of Thai domestic and foreign banks.

Thirdly, we examine the differences in technology between the Thai domestic banks and the foreign majority acquired banks that emerged in the financial reforms following Asian crisis.[6] As described in Section 3, the entry of foreign banks has progressively increased through two stages since the late 1980s. While financial regulations on foreign capital flows were relaxed at the beginning of the 1990s, the number of foreign bank branches was strictly limited and they had to focus on the wholesale business. It was only after the Asian crisis that foreign banks were allowed to expand their branch networks and participate in the retail market. When foreign investors possess the majority share of domestic banks, their business performance is likely to change significantly through

[6] These are defined as banks with more than 50% of their shares held by foreign investors.

drastic restructuring and reengineering processes[7]. This is expected to be a significant catalyst for change in the domestic banking industry. The hypothesis is supported by the observation that the degree of foreign ownership significantly relates to the performance of banks. When foreign ownership is measured as its percentage of total shareholders, it is expected that majority foreign ownership contributes to a change in the bank performance, that is, the modernization of operation and improvement of their business efficiency.

3. Development of Foreign Bank Entry in the Thai Market

3.1 Development of Foreign Bank Entry

Before conducting estimation analysis of the Thai domestic banking market in the next section, we provide a simple overview of the main features of the changes in the Thai banking market from the beginning of the 1990s until 2002.

The Thai financial system changed considerably after the financial liberalization in the beginning of the 1990s. This comprised the following deregulation. In 1990, Thailand had accepted the IMF's Article VIII and ended foreign exchange controls on current account transactions. Then in 1991, most restrictions on capital account transactions were abandoned. In 1993, aiming to facilitate international borrowings and to encourage fund inflows, Bangkok International Banking Facilities (BIBF) was established. In 1994, regulations on outward direct investment, travel expenditures and additional channels of cross-border payments were relaxed. Along with these reforms, deregulation measures took place in Thai banking markets. Commercial banks were permitted to undertake new business and finance and securities companies were allowed to have new lines of operations. These reforms were pursued under the presumption that financial liberalization would promote market competition and enhance the Thai financial market.

However, new-entry foreign banks still do not play a major role in the financial market relative to domestic banks. Although BIBF led to a greater entry of new participants from abroad, they were not allowed to undertake the full range of financial services. The amount of lending extended from BIBF and branches of foreign banks expanded drastically and a huge amount of foreign capital flowed into the Thai economy. Market competition between Thai commercial banks and other nonbank financial institutions intensified with the liberalization measures. However, foreign penetration in the Thai banking market was limited and foreign banks were in effect segmented from other Thai domestic banks.

A significant change in the Thai financial market took place again as part of the financial restructuring program in the aftermath of financial crisis in 1997. One such change was the relaxation of the regulation on foreign shareholding limit in Thai

[7] According to the Stock Exchange of Thailand (1997), to have a controlling power over a company, the Thai corporate charter provision requires at least 25% of a company's outstanding shares. Therefore, even though banks are not majority held by foreign investors, if the ownership structure is widely diversified, the increase in foreign ownership will have substantial impact on domestic bank performance. However, since the ownership structure of Thai domestic banks was highly concentrated, foreign ownership of more than 50% was essential to control the acquired banks.

commercial banks. Thai authorities permitted foreign investors to hold more than 49% of the share in Thai banking markets for up to 10 years compared to the 25% foreign shareholding limit before the crisis.

As a result, family ownership in Thai banks, which used to dominate Thai banks, has significantly declined while the share of foreign ownership in domestic commercial banks has gradually increased. Four commercial banks were majority (owning more than 50% of total shares) held by foreign investors in 2002[8]. The rise in foreign ownership is expected to cause a greater degree of competition and affect domestic banks' performance, either positively or negatively.

An acquisition of four domestic banks by the foreign partners after the crisis is said to be the important catalyst for change in Thai domestic banking sector. Foreign-acquired banks have brought about new and advanced technologies and skills, which resulted in greater cost efficiency. New technology connected and centralized databases across the bank, allowing for more efficient internal communication and eventually delivery of consumer products (Crispin et al., 2000).

To compensate for the slow growth of loan demand and non-performing loans problems following the crisis, banks have placed more importance on fee-based services such as investment banking and mortgages. As foreign partners have specialized skills in consumer-banking businesses, foreign-affiliated banks are likely to have competitive advantages over other domestic banks.

Meanwhile, foreign-affiliated banks have placed heavy emphasis on reducing operating expenses, including decreasing branch networks, laying-off redundant staff, and adopting early retirement programs. On the other hand, a need to invest in new technology, to modernize their business and management practices can cause the higher operation costs. This may be reflected in the higher service fees. Customers are, however, expected to receive more advantages from a wide variety of services in the long run (Montreevat, 1999)

Regarding the lending practices, credit extension tasks were moved from branches to central headquarters. One reason is that branch staff could concentrate more on selling and service (Crispin et al., 2000). Another possible reason is that banks have tried to create lending standards to avoid the connected lending that tends to occur when branch staff and customers are acquainted. Loan approval practices, previously based on collateral or relationships between lenders and borrowers, have become cash flow-based, which should better reflect the borrower's real financial conditions and the ability to repay loans.

Significant changes in banking services and management have occurred, not only in banks that have taken on foreign partners, but also in the remaining domestic banks. To maintain their competitiveness and market shares in the new market environment, domestic banks have introduced new financial products and services, concentrating more on consumer and retail markets. The domestic banks have launched Internet-based banking services and provided consumer-based financial services such as asset management and mortgage lending.

3.2 Data for the Thai Banking Industry

[8] UOB Radanasin Bank, Bank of Asia (ABN AMRO), Standard Chartered Nakornthon Bank, The DBS Thai Danu Bank.

Using panel data on 28 domestic commercial banks over the period of 1990–2002, we describe below some key banking sector indicators in order to examine descriptively the effects of foreign bank presence on domestic bank performance. The names of banks are in **Table A1** in the appendix. **Table 1** describes how foreign participation evolves in Thai domestic banks. Defining foreign majority owned banks as those in which foreign investors own more than 50% of the total equity, all banks were domestically owned before the financial crisis in 1997. After the crisis, eleven banks out of fifteen banks remained domestically owned and the other four banks were acquired by foreign investors under the financial restructuring reforms resulting from the crisis. In this sense, given the legal restrictions in place before the crisis, foreign entry occurred only after 1998. Both market share and the number of foreign majority owned banks jumped just after the crisis. However, foreign investors owned equities of some domestic banks even before the financial crisis and foreign participation in some domestic banks increased substantially after the crisis.

Table 1 Evolution of Foreign Participation

Table 2 presents statistics for the principle variables, comparing between foreign bank branches and Thai domestic banks during the period 1990–2002. The data highlight the following points. First, the ratio of interest income to total incomes for foreign banks is lower than domestic banks. This suggests that foreign banks are likely to focus on the fee-based business while domestic banks rather concentrate on the tradition-banking business (i.e. deposit–loan allocation). However, due to bad loan problems, stricter regulation, and a decrease in loan demand in the aftermath of crisis domestic banks also try to seek for new sources of incomes such as investment banking to compensate for the decline in interest income.

Table 2 Operational Behaviors of Foreign and Domestic Banks

When we look at the movement of factor prices, that is the price of raised funds, wage rate and rental cost, some differences between foreign bank branches and Thai domestic banks are evident. Compared with domestic banks, foreign banks tended to have lower costs of funding particularly in the precrisis period. The possible explanation is that the main source of funds for foreign banks comes from its headquarters abroad, which is cheaper than domestic funding. However, the differences on the costs of funds between the two groups are smaller after the Asian crisis.

As for wage rates, we find higher rates for foreign bank branches relative to domestic ones. Foreign banks pay higher average wages for their highly skilled labor for their advanced technique and knowledge. On the other hand, as Thai domestic banks in general focus on the basic deposit–lending services they do not need much higher-skilled labor. As the result, domestic banks have lower wage rates.

In addition, we find higher costs of equipment renting for foreign bank branches than Thai domestic banks. The result implies that foreign bank branches are prone to invest in higher technology and new equipment, thus face higher such costs than Thai domestic banks.

The ratio of total cost to total income is a measure of bank operating efficiency. We found that foreign bank branches particularly in the crisis period show the lower ratio, implying their higher operating efficiency compared with domestic banks. Regarding the composition of total costs, interest expenses have the largest share in both domestic and foreign bank branches. Nevertheless, we find a higher proportion of interest expense for the former. Consistent with the above explanation, foreign banks show a higher fraction of personnel expenses than do domestic banks.

4. Methodology of Estimation

4.1 Choice of Output and Input

While there is no clear agreement on how to identify bank outputs and their factor inputs, generally there are two different approaches: the production approach and the intermediation approach. The production approach recognizes banks as institutions that produce financial services such as loans, deposits and investments in securities businesses using factor inputs such as labor and capital. The intermediation approach views banks as institutions that absorb funds from the public to relend them. According to this approach, loans are outputs and deposits are inputs.

In this paper, following intermediation approach, we recognize that banks combine acquired funds X_1, labor X_2 and physical capital X_3 as inputs to produce two different types of financial services as output. One is the services provided through traditional bank loan business Y_1 and the other is those provided through other businesses, including investments in securities and so-called fee-based business Y_2. Three inputs are measured by the Baht value of borrowed funds, the number of employees, and the Baht value of fixed assets and premises of the bank. The financial services produced by banks are measured by "income," which equals the market value of these services. Although the physical amounts of financial services are not measurable, if the unit prices of these services are assumed to be constant, the "incomes" correspond to the quantitative indices based on the Division index. Therefore, we assume that Y_1 is measured by the interest income from loans and deposits, while Y_2 is measured by the total noninterest income, i.e. current income minus interest income.

If bank production function $\boldsymbol{F}(Y_1, Y_2 ; Q_1, Q_2, Q_3) = 0$ has a strictly convex structure, a unique multiproduct joint cost function $\boldsymbol{C} = \boldsymbol{C}(Y_1, Y_2, P_1, P_2, P_3)$ can be constructed. Here, average wages P_1, rental rate of physical capital P_2, and the average interest rate on borrowed funds P_3 are used as input prices. Thus, $P_1 X_1$, $P_2 X_2$, and $P_3 X_3$ are expenses for acquiring funds, workers and physical capital, respectively, each roughly corresponding to the total interest expense, payroll expense and equipment expenses. Cost function $\boldsymbol{C}$ is degree one homogenous, nondecreasing and concave in input prices. Due to duality between the production function $\boldsymbol{F}$ and cost function $\boldsymbol{C}$, the two functions contain the same information about bank production technology.

4.2 Estimated Cost Function

In order to handle the problem of small samples, we compiled cross-sectional data

covering the observed period so as to estimate the cost function of commercial banks in Thailand using panel data[9]. The estimation method, in principle, is similar to Elyasiani and Rezvanian (2002)[10]. Each parameter includes a dummy shift variable taking into the account whose parameters can differ between banks with branch networks and pure foreign banks without branch network.

The t-th (t = 1,2,$\cdots$, **13**) period cost function for the i-th (i = 1,2,$\cdots$, **27**) bank is assumed to be represented by the trans-log cost function with three factors and two products (1). By normalizing the values of all variables around the mean values, the trans-log cost function can be recognized as a second order approximation of the cost function based on the mean values. The ν_{it} are random errors, assumed to be i.i.d. (Independent And Identically Distributed) and have $N\left(0,\sigma^2\right)$-distribution, independent of all explanatory variables.

In order to examine if production technologies differ among different groups of banks, two dummy variables, D_F and D_H are included in equation (1) which represent respective bank characteristics of foreign bank branches and foreign majority acquired banks, i.e., joint banks with foreign ownership of more than 50%; D_F = binary value equal to 1 if foreign bank branches, 0 if other banks, and D_H = binary value equal to 1 if foreign majority acquired banks, 0 if other banks.

Dummy variables are added to equation (1) in the two different forms, i.e. as intercept dummies and slope dummies[11]. For example, since in the equation (1) the constant term α_0 measures the intercept for Thai domestic banks, the constant term plus ϕ measures the intercept for foreign bank branches. The coefficients of slope dummy variables also indicate that the cost function for the different group of banks differ in the slope coefficients. For example, in equation (1) the coefficient α_j measure the parameter of variable $\ln Y_{jit}$ for Thai domestic banks, while the coefficient α_j plus the coefficient ϕ_{Yj} measures the coefficient of variable $\ln Y_{jit}$ for foreign bank branches.

In addition, we control other factors that may have effects on bank performance, that is, the effects of macro economic variables and the impact of financial reform policies. Macroeconomic circumstances is assessed in terms of the time dummy variables T_t for each period t (t = 1,2,$\cdots$,12). The impact of the stringent financial reforms taken by Thai government after the Asian crisis is controlled by the financial reform policy dummy; *POLICY* = binary value equal to 1 in the period of 1998–2002, 0 otherwise.

Four domestic banks were acquired by foreign investors as part of the financial rehabilitation process undertaken by the Thai authorities after the Asian crisis. Since these acquired banks were severely damaged by the crisis, the Thai government promoted the rehabilitation of these banks in order to encourage foreign acquisition of them[12]. A

[9] One other way to handle the data limitations is to reduce the number of explanatory variables matching to the level of number of data to satisfy a certain degree of freedom.

[10] Okuda and Hashimoto (2004) adopt a similar methodology in their study on the Malaysian banking industry.

[11] As Maddala (1988) explains, an intercept dummy indicates that the cost function for the different group of banks differs in the intercept term. The coefficient of the dummy variables measures the differences in the fixed cost between different groups of banks.

[12] They are sometimes called hybrid banks in the Thai business world.

substantial amount of bad loans was written off and transferred to the asset management accounts managed by the Thai government Moreover, after the acquisition, foreign investors conducted intensive rehabilitation as well as restructuring activities at substantial cost. They changed business strategies drastically and modernized their business behavior. In order to grasp these special activities of the foreign majority acquired banks, the restructuring activities dummy is added to the estimated function for foreign-acquired banks, which is the decreasing time trend variable, *RESTRA* = 3 in 1999, 2 in 2000, and 1 in 2001.

$$
\begin{aligned}
\ln C_{it} = {} & \alpha_0 + \sum_{j=1}^{2} \alpha_j \ln Y_{jit} + \frac{1}{2} \sum_{j=1}^{2} \sum_{k=1}^{2} \alpha_{jk} \ln Y_{jit} \ln Y_{kit} \\
& + \sum_{j=1}^{3} \beta_j \ln P_{jit} + \frac{1}{2} \sum_{j=1}^{3} \sum_{k=1}^{3} \beta_{jk} \ln P_{jit} \ln P_{kit} + \frac{1}{2} \sum_{j=1}^{2} \sum_{k=1}^{3} \gamma_{jk} \ln Y_{jit} \ln P_{kit} \\
& + \varsigma \ D_H + \sum_{j=1}^{2} \varsigma_{Yj} D_H \ln Y_{jit} + \frac{1}{2} \sum_{j=1}^{2} \sum_{k=1}^{2} \varsigma_{Yjk} D_H \ln Y_{jit} \ln Y_{kit} \\
& + \sum_{j=1}^{3} \varsigma_{Pj} D_H \ln P_{jit} + \frac{1}{2} \sum_{j=1}^{3} \sum_{k=1}^{3} \varsigma_{Pjk} D_H \ln P_{jit} \ln P_{kit} + \frac{1}{2} \sum_{j=1}^{2} \sum_{k=1}^{3} \varsigma_{YPjk} D_H \ln Y_{jit} \ln P_{kit} \\
& + \phi \ D_F + \sum_{j=1}^{2} \phi_{Yj} D_F \ln Y_{jit} + \frac{1}{2} \sum_{j=1}^{2} \sum_{k=1}^{2} \phi_{Yjk} D_F \ln Y_{jit} \ln Y_{kit} \qquad (1) \\
& + \sum_{j=1}^{3} \phi_{Pj} D_F \ln P_{jit} + \frac{1}{2} \sum_{j=1}^{3} \sum_{k=1}^{3} \phi_{Pjk} D_F \ln P_{jit} \ln P_{kit} + \frac{1}{2} \sum_{j=1}^{2} \sum_{k=1}^{3} \phi_{YPjk} D_F \ln Y_{jit} \ln P_{kit} \\
& + \eta_{POLICY} POLICY + \phi_{POLICY} D_F POLICY + \varsigma_{POLICY} D_H POLICY \\
& + \varsigma_{RESTRA} D_H RESTRA + \sum_{t=1} \eta_T T_t + \nu_{it} \\
& \qquad (i = 1,2, \ldots,27; t = 1,2, \ldots,13)
\end{aligned}
$$

In order for this cost function to be meaningful in an economic sense, the following four constraints should be met: symmetry between cross partial derivatives (2a), monotony of products and factor prices (2b), homogeneity of degree one in factor prices (2c), and weak concavity in factor prices, satisfied by (2d). Furthermore, to ensure a sufficient degree of freedom in estimation as well as to simplify the estimation work as in Rezvanian (2002). it is also assumed that the cost function (1) is separable between factor prices and products (2e).

$$\alpha_{jk} = \alpha_{kj},\ \beta_{jk} = \beta_{kj},\ \varsigma_{jk} = \varsigma_{kj}\ \phi_{jk} = \phi_{kj} \quad (j,k = 1,2) \qquad (2a)$$

$$\alpha_j > 0, \alpha_{jk} > 0 \ \ (j,k = 1,2) \qquad \beta_j > 0, \beta_{jk} > 0 \ \ (j,k = 1,2,3) \qquad (2b)$$

$$\sum_{j=1}^{3} \beta_j = 1,\ \sum_{j=1}^{3} \varsigma_{Pj} = 1, \sum_{j=1}^{3} \phi_{YPj} = 1, \sum_{j=1}^{3} \beta_{jk} = 0, \sum_{j=1}^{3} \varsigma_{jk} = 0, \sum_{j=1}^{3} \phi_{FPjk} = 0 (j,k = 1,2,3), \qquad (2c)$$

$$Hp\left[\frac{\partial^2 C}{\partial P_j \partial P_k}\right] \le 0 \quad (j,k = 1,2,3) \qquad (2d)$$

$\gamma_{jk}=0,\ \varsigma_{Yjk}=0,\ \phi_{Yjk}=0 \quad (j,k=1,2,3)$ (2e)

For statistical estimation, we consider the asset gap among commercial banks, and use the estimator of White (1980) by which we can obtain a robust estimator even in a case where heteroscedasticity exists and its form is unknown. Equation (1) is estimated with constraints using Seemingly Unrelated Regression (SUR) with cost share functions[13]. In the actual estimation process, equation (1) is first estimated given constraints (2a), (2c), (2d), and (2e), then the consistency of the estimated parameters with constraint (2b) is checked.

4.3 Economies of Scale and Scope, Technological Difference

The trans-log cost function (1) has a general form in that the restrictions of economies of scale and economies of scope[14]. These restrictions will be statistically tested in the process of estimation of the cost function. The following hypotheses concerned with production technology will be tested.

First, economies of scale will be tested. The total elasticity of scale on overall production at time t is represented by equation (3) for cost function $C = C\left(z\ln Y_1, z\ln Y_2, \ln P_1, \ln P_2, \ln P_3\right)$. Economies of scale which do not depend on time passing exist if the value of $\frac{\partial \ln C_{it}}{\partial \ln Y_{1it}} + \frac{\partial \ln C_{it}}{\partial \ln Y_{2it}}$ is strictly less than unity, and vice versa. Economies of scale will be tested using the maximum likelihood test for the hypothesis that cost function (1) has a constant return to scale, satisfying $\frac{\partial \ln C_{it}}{\partial \ln Y_{1it}} + \frac{\partial \ln C_{it}}{\partial \ln Y_{2it}} = 1$.

$$\begin{aligned}\frac{\partial \ln C_{it}}{\partial \ln Y_{1it}} + \frac{\partial \ln C_{it}}{\partial \ln Y_{2it}} &= \alpha_1 + \alpha_2 + \alpha_{11}\ln Y_{1it} + \alpha_{22}\ln Y_{2it} + \alpha_{12}(\ln Y_{1it} + \ln Y_{2it}) \\ &+ \{(\varsigma_{Y1} + \varsigma_{Y2}) + \varsigma_{Y11}\ln Y_{1it} + \varsigma_{Y22}\ln Y_{2it} + \varsigma_{Y12}(\ln Y_{1it} + \ln Y_{2it})\}D_H \\ &+ \{(\phi_{Y1} + \phi_{Y2}) + \phi_{Y11}\ln Y_{1it} + \phi_{Y22}\ln Y_{2it} + \phi_{Y12}(\ln Y_{1it} + \ln Y_{2it})\}D_F\end{aligned} \quad (3)$$

Second, economies of scope will be tested. Economies of scope exist if the following scope equivalency holds. In other words, if the value of equation (4) is strictly less than zero, then economies of scope exist. The actual estimation is conducted in the proximity of the mean values. Economies of scope will be tested using the maximum likelihood test

[13] Cost share functions are derived by Shepherd's Lemma under perfect competition. It is represented as follows in the case of our augmented trans-log cost functions.
$\frac{P_{jt}Q_{jt}}{C_{it}} = \frac{\partial \ln C_{it}}{\partial \ln P_{kt}} = \beta_j + \beta_{kt}\ln P_{kt} + \gamma_{jk}\ln Y_{kt} \quad (j,k=1,\ 2,\ 3)$

[14] "Economies of scale" and "economies of scope" are presumed to exist inherently in the banking industry characterized by large fixed costs and common factors of production. See Leyland and Pyle (1977). Promotion of these economies and technical progress was generally recognized to be an important policy objective in the Philippine financial reforms.

for the hypothesis that cost function (1) satisfies $\frac{\partial^2 C}{\partial Y_{1it}\partial Y_{2it}} = 0$.

$$\frac{\partial^2 C}{\partial Y_{1it}\partial Y_{2it}} = \frac{C}{Y_{1it}Y_{2it}}\{\alpha_{12} + (\alpha_1 + \alpha_{11}\ln Y_{1it} + \alpha_{12}\ln Y_{1it})(\alpha_2 + \alpha_{21}\ln Y_{2it} + \alpha_{12}\ln Y_{2it})$$
$$+ \varsigma_{Y12}D_H + (\varsigma_{Y1} + \varsigma_{Y11}\ln Y_{1it} + \varsigma_{Y12}\ln Y_{1it})(\varsigma_{Y2} + \varsigma_{Y21}\ln Y_{2it} + \varsigma_{Y12}\ln Y_{2it})D_H{}^2 \qquad (4)$$
$$+ \phi_{Y12}D_F + (\phi_{Y1} + \phi_{Y11}\ln Y_{1it} + \phi_{Y12}\ln Y_{1it})(\phi_{Y2} + \phi_{Y21}\ln Y_{2it} + \phi_{Y12}\ln Y_{2it})D_F{}^2\}$$

In examining the estimation results, the technological differences between foreign bank branches and domestic banks are assessed using the coefficient values of the foreign bank branch dummy variable D_F. The effects of foreign majority ownership on cost performance of domestic banks are assessed by using the coefficient values of foreign-acquired bank dummy variable D_H.

4.4 Data Used and Variables

The sample data include unbalanced panel data of 27 banks in Thailand. Out of 28 banks, 17 banks are the Thai domestic and hybrid banks and the remaining 11 banks are purely foreign owned banks (i.e., foreign bank branches). The data set covers the 13-year period from 1990 through 2002. Our sample period covers the 1990s' financial liberalization as well as the 1997 Asian financial crisis, which are believed to be a significant drive of the changes in the Thai banking system. Balance sheet and income statement information are obtained from the I-SIMS database of the Stock Exchange of Thailand. We acquired data for the number of employees from "The Commercial Banks in Thailand", the report annually issued by Bangkok Bank. The values of individual variables used in the estimation are calculated as follows. All variables are normalized by the GDP deflator.

Y_1 = (Interest income)
Y_2 = (Noninterest income)
P_1 = (Interest expense) / (Total liabilities)
P_2 = (Personnel cost) / (Number of staff)
P_3 = {(Rental of premises) + (Rental of leasehold) + (Equipment hire)} / (Fixed assets)
C = (Total interest expenses) + (Payroll expenses) + (Rental of premises) + (Rental of leasehold) + (Equipment hire)

In order for our analysis to be credible, it is more appropriate to select a data set that covers only large and medium sized banks and is available continuously over the sample period. The operational patterns of these banks are more stable and established. In estimating the cost function using the SUR method, the annual panel data from 1990 to 2002 for 27 banks are used. The other banks are excluded from the estimation, since no data were available spanning the entire observation period.

Foreign ownership is measured as the percentage of total foreign shareholders holding more than 5% of the total bank stock. In 2002, four out of 15 commercial banks were majority (more than 50% of total share) held by foreign investors. Even though the common stock of the rest of the domestic banks is not completely owned by foreign banks, the proportion of foreign ownership considerably increased especially in the aftermath of the 1997 financial crisis. The rise in foreign ownership is expected to impact on domestic bank performance[15].

5. Estimation Results

Production Technology of the Thai Domestic Banks

The results of the estimation using the cost function and two cost share functions for the sample of domestic and foreign banks during the period 1991–2002 are summarized in **Table 3**. The estimation method is the SUR (seemingly unrelated regression) method. Most of the coefficient estimators are statistically significant and follow their expected signs. The adjusted *R*-square is high. Overall, we obtain satisfactory results for the cost function estimation.

Table 3 Results of Estimation

The estimation results indicate the existence of economies of scale for Thai domestic banks, but economies of scope were not observed. Regarding economies of scale in the large-sized bank group, the value of conditioning formula (3) was 0.861, which meets the condition of economies of scale. The result of the Wald test, which examines whether conditioning formula (3) is equal to unity, had a high statistical significance of 34.349 (*P*-value = 0.00), indicating clear economies of scale for these banks. On the other hand, regarding economies of scope, the value of conditioning formula (4) was 0.144, which contradicts the condition of economies of scope. The result of the Wald test was 24.055 (*P*-value = 0.00), which examines if conditioning formula (4) is equal to zero, a high statistical significance, indicating diseconomies of scope.

Production technology of foreign bank branches

The foreign bank branch dummy D_F is included in the regression equation to examine whether there is a difference in cost efficiency between domestic banks and foreign banks. Regarding the parameters of dummy variable D_F, which indicate the characteristics of banks, the *t* values of them were large and had a high statistical significance. This indicates that there is a clear difference in the production technology between foreign banks and the other banks.

While we found a negative coefficient for the foreign bank branch dummy, which indicates the lower fixed cost for foreign banks relative to domestic banks, its statistical significance is low. Foreign banks focus on specialized customers and their operational size is smaller than domestic banks. This implies that the fixed cost of foreign bank

[15] To have a controlling power over a company, the Thai corporate charter requires at least 25% of a company's outstanding shares (Stock Exchange of Thailand, 1997). However, a shareholder with at least 20% of a company's shares has an effective control shareholding.

branches is smaller than that of their rivals. However, foreign banks need advanced technologies and equipment to provide new services to their customers while domestic banks mainly focus on their traditional banking business, thereby there is less requirement for them to have a high level of technology and equipment. This second factor tends to increase the fixed cost of foreign bank branches over that of their domestic rivals. The first and second factors have contrary effects on the fixed cost.

If we examine the components of cost structures in detail, the coefficient of $D_F \ln Y_{1t}$ and $D_F \ln Y_{2t}$ are not statistically significant. This suggests that there is no significant difference either in the lending businesses or the fee-based business between domestic banks and foreign banks.

In the foreign bank branches, similarly to domestic banks, economies of scale were observed, while economies of scope were not observed. Regarding economies of scale in foreign bank branches, the value of conditioning formula (3) was 0.864, which meets the condition of economies of scale. The result of the Wald test had a high statistical significance of 3.543 (P-value = 0.069), indicating economies of scale for foreign bank branches. Regarding economies of scope, the value of conditioning formula (4) was 0.169 and the Wald statistics was 38.960 (P-value = 0.000). This result indicates that there were diseconomies of scope with a high statistical significance in foreign bank branches.

We found positive signs for the coefficients of the interaction term between foreign bank branch dummy D_F and prices of labor and physical capital P_2 and P_3, which indicates that the production cost of foreign bank branches is more elastic to the change in wages and rental rates than the production cost of Thai domestic banks. Our findings also suggest that the operational cost of foreign banks is less elastic to the change in borrowing interest rate P_1 compared to that of local banks. These differences in elasticity between foreign bank branches and Thai domestic banks reflect the differences in the details of services provided between the two groups[16]. Highly skilled labor and capital equipment are used more intensively in the production process of foreign bank branches, while funds are more intensively used in the production process of domestic and hybrid banks. Therefore, when wages or rental rates go up, the production cost will rise higher for foreign bank branches than for Thai domestic banks.

The effects of changes in market environments after the crisis

The financial reform policy dummy *POLICY* is included to grasp the effects of the changes in market environment in the postcrisis period. We obtained a significantly positive coefficient for the financial reform policy dummy for domestic banks. Thai domestic banks have tried to restructure their business operations and reduced unnecessary expenses, such as laying off employees and closing a number of branches. However, they, at the same time, were forced to expand their spending by investing in advanced technologies and equipment to compete in the more competitive market as well as to improve the operating efficiency in the long run. Moreover, banks faced an excess amount of liquidity due to the influx of deposits from the closure of finance companies. Simultaneously, banks found it difficult to extend loans due to the remaining large

[16] This is an analogy of the Stolper–Samuelson effect in international economics. The rise in relative price of a commodity corresponds to the rise in the price of the factor that is used intensively in the production process of that commodity.

amount of nonperforming loans and the unrecovered loan demand from firms. An increase in deposits could cause a large interest burden for banks. An increase in costs is likely to outperform a decrease in costs. Thus, we find a rise in costs for domestic banks following the financial reforms taken after crisis.

Contrary to that of Thai domestic banks, the estimated parameter of the financial reform policy dummy for foreign bank branches was negative and statistically significant. This suggests that operational costs of foreign bank branches were reduced under the new market circumstances that emerged after the Asian financial crisis. The strengthening of information disclosure of the corporate sector, improvement of accounting system, and upgrading of the legal system contributed to reducing their operational costs.[17] These reforms improved the transparency of information and lessened the disadvantage in information production that foreign bank branches suffered. These reforms created circumstances in which foreign bank branches could make effective use of their advanced financial skills and enhance their cost efficiency substantially.

Production technology of the foreign-acquired banks

Next, we consider the effect of foreign majority ownership, i.e. the foreign-acquired bank dummy, D_H on cost performance. The estimated results show a difference in terms of production technology between domestic banks and hybrid banks with more than 50% of foreign participation. The results indicate that the acquisition of domestic banks by foreign banks gives rise to significant change in their operation in only a few years.

First, similar to foreign bank branches, we found positive signs for the coefficients of the interaction term between foreign-acquired bank dummy variable D_H and the prices of labor and physical capital P_2 and P_3. That indicates that the production cost of joint venture banks is more elastic to the change in wages and rental rates than the production cost of Thai domestic banks. Our finding also suggests that the operational cost of foreign-acquired banks is less elastic to the change in borrowing interest rate P_1 compared with that of Thai domestic banks. These differences in elasticity between foreign-acquired banks and Thai domestic banks reflect the differences in the details of services provided between the two groups. Highly skilled labor and capital equipment are used more intensively in the production process of foreign-acquired banks, while funds are more intensively used in the production process of domestic banks. Therefore, when wages or rental rates go up, the production cost becomes higher for foreign-acquired banks than for other domestic rivals.

Second, whereas the interaction term between the foreign-acquired bank dummy D_H and interest income Y_{1it} is not statistically significant[18], the coefficient of the interaction term between the foreign-acquired bank dummy D_H and noninterest income $Y_{2\ it}$ is statistically significant and negative. Banks with a majority percentage of foreign

[17] Firms are required to prepare their financial statements in conformance with accounting standards issued by the Ministry of Commerce under the new Accounting Act of B.E. 2543 (2000). Importantly, the Act imposes penalties on companies that do not comply with the prescribed standards. For companies listed on the Stock Exchange of Thailand, an additional penalty may be imposed by the Securities and Exchange Act.

[18] The interaction term between DH and Y1is positive. The hybrid banks with majority foreign ownership seem to face a higher cost in lending than Thai domestic banks. In order to expand lending to new customers, banks with large foreign participation have higher cost in collecting information and monitoring. In addition, they tend to be stricter in managing the lending process. Thus, lending expenses are likely to be greater for banks with high foreign partner participation.

ownership have lower costs in fee-based businesses. Compared to Thai domestic banks whose main income derives from traditional loan businesses, banks with foreign majority participation are more specialized and apply more effort into fee-based business such as investment banking. As a result, they can provide customers with services more efficiently.

Thirdly, compared to either Thai domestic banks or foreign bank branches, foreign-acquired banks possessed greater economies of scale. Regarding economies of scale in foreign-acquired banks, the value of conditioning formula (3) was 0.676, which meets the condition of economies of scale. The result of the Wald test had a high statistical significance of 7.219 (*P*-value = 0.007), indicating economies of scale for foreign-acquired banks. Regarding economies of scope, the value of conditioning formula (4) was –0.335 and the Wald statistics was 2.884 (*P*-value = 0.089). Statistically significant economies of scope were observed in foreign-acquired banks, whereas such economies were not observed in either Thai domestic banks or foreign bank branches.

Our findings imply that foreign-acquired banks drastically changed their business strategy and conducted a wide range of business restructuring activities. They introduced advanced technology and the financial skilled possessed by foreign investors and provided their well-focused customers with financial services that were produced complimentarily. These efforts contributed successfully to reducing the cost of their business operations and realizing the merit of business diversification.

Fourthly, the coefficient on the foreign-acquired banks' dummy is relatively large but not statistically significant. The results suggest that foreign majority ownership is not clearly associated with change in total costs. Foreign-acquired banks have brought about efficient banking techniques and practices, which resulted in greater cost efficiency.

The growth in advanced technologies such as internet-banking, phone-banking services will gradually decrease the need of bank staffs as well as costly full-services branch network. This would result in the reduction in operating costs for those foreign-acquired banks. On the other hand, similar to Thai domestic banks, foreign-acquired banks modernized their management style and adopted a more stringent credit examination system, both of which expanded their operational cost, at least in the short-run. The result of estimation reflects the contrary effects of these two factors.

As some may argue, a higher cost associated with an increase of foreign ownership from our results may not reflect the cost efficiency of foreign banks' entry. Instead, it reflects debt burden and restructuring expenses foreign banks have to be responsible for after buying troubled domestic banks.

However, Thai authorities have issued several measures to solve with the bad debt problems in order to attract the new foreign shareholders. Nonperforming loans (NPLs) from those banks are transferred to AMCs (Asset Management Companies) established by the government to manage bad debt. In addition, those banks are required to write down their capital to reduce its accumulated losses and then increase capital to sell to new investors. In the case of Nakornthon Bank, the state-owned Financial Institutions Development Fund (FIDF) agrees to compensate for lost revenue and potential losses due to increase in NPL to NTB for five years (Montreevat, 1999). Accordingly, balance sheets' conditions of domestic banks at the time of being bought by foreign banks are supposed to be not very problematic. New foreign shareholders do not appear to face a

high burden of restructuring costs. Thus, higher costs after the entry of foreign shareholders should be able to reflect the real operating efficiency for each bank.

Finally, we include an interaction term of restructuring activities dummy (*RESTRA*) and joint-venture bank dummy variable to capture the effect of restructuring for banks with high foreign ownership. We observed that the estimated parameter of the restructuring activities dummy was negative and statistically significant. The results imply that the increased foreign ownership spurred the managers of banks to apply greater effort into achieving operating efficiency, such as integrating duplicate branches and laying off redundant labor in the aftermath of the crisis. On the other hand, we do not find any statistically significant effects of financial restructuring for other domestic banks[19]. Compared to those banks mainly acquired by foreign banks, domestic banks appear to place little importance on their restructuring processes.

The regression estimates of the cost function including interest income as a single output are shown in the second column of Table 3. Basically, the results are similar to those obtained from the first column of Table 3. They are generally satisfactory in the sense that the value of adjusted *R*-squared is high and the signs of major explanatory variables are as theoretically expected. The major explanatory variables are statistically significant.

6. Robustness of Estimation

There are different methods of measuring the output of banking activities. In many previous studies in this field, physical terms such as the outstanding amounts of loans or the number of loans extended have been used as proxy to the outputs of banks. In this section, in order to check the robustness of our findings in the previous section and examine the cost performance of banks from a different perspective, we estimate the cost function using different proxy variables to the outputs of banks[20].

Data on the detailed compositions of assets held by individual banks are available for Thai domestic banks and hybrid banks, but not for foreign bank branches. Therefore, by using the total amount of loans as the output of banks, we estimate the cost functions in the following two ways. First, focusing on the loan business, we estimate the banks' cost function with a single output that is measured in terms of the total amount of loans. Then, paying attention to both the loan business and the fee-based business, we estimate the cost function with two outputs that are measured in terms of the total amount of loans and non-interest income respectively. In both estimations, similar to the previous section, following the intermediation approach, we use raised funds, labor, and physical capital as the inputs of banks.

Table 4 presents the regression estimates of cost function with the total amount of loans and non-interest income as two outputs of banks. Most of the coefficient estimators are statistically significant and satisfy the theoretically expected signs. The adjusted *R*-squared of the estimated equation is reasonably high, indicating that the estimated

[19] The results are not shown in the table.

[20] This approach is somewhat problematic. First, they implicitly neglect the difference in the quality of loans. Second, according to this approach, the amount of fee-based business operations that have increasing importance in today's banking industry cannot be measured.

equation fitted the data reasonably well. Although the estimated coefficient of non-interest income, i.e., the proxy variable representing the outputs of fee-based business, is not statistically significant, the estimation results presented in **Table 4** share similarities with those presented in **Table 3**.

Table 4 Alternative Estimations

First, similar to the estimates presented in **Table 3**, we found that the coefficients of the interaction term between the foreign bank branch dummy D_F and the prices of inputs were negative for labor and physical capital, but positive for funds. This indicates that the production cost of foreign banks' branches is more elastic to the change in wages P_2 and rental rates P_3, but less elastic to the change in borrowing interest rate P_1 than the production cost of Thai domestic banks. These findings confirm that skilled labor and capital equipment are used more intensively in the production process of foreign bank branches, while funds are more intensively used in the production process of domestic and hybrid banks.

Similar to the estimates presented in **Table 3**, the coefficient of D_F is not statistically significant and, in addition, $D_F \ln Y_{1t}$ and $D_F \ln Y_{2t}$ are not statistically significant. These indicate that there is no significant difference in cost performance regarding either the fixed costs of operations or the fee-based business between domestic banks and foreign banks. Both in foreign bank branches and in Thai domestic banks, economies of scale were observed, but no economies of scope were observed.

Second, regarding the effects of financial reform policies on the cost performance of Thai domestic banks and foreign bank branches, the estimation yields similar results to those presented in **Table 3**. The coefficient of the financial reform policy dummy was significantly positive in Thai domestic banks. On the other hand, the estimated parameter of the financial reform policy dummy for foreign bank branches was negative but not statistically significant. These observations confirm that the effects of financial reforms on Thai domestic banks differed from those on foreign bank branches.

Third, the observations regarding the foreign-acquired banks are basically similar to those presented in **Table 3**. We found positive signs for the coefficients of the interaction term between the foreign-acquired bank dummy D_H and the prices of labor and physical capital P_2 and P_3. These findings indicate the resemblance in the cost performance between hybrid banks to foreign bank branches, which suggests that the business operations of foreign-acquired banks were drastically restructured after their foreign acquisition.

The regression estimates of the cost function including the amount of total loans as a single output are presented in the second column of **Table 4**. The estimation results do not considerably change from the results in the first column of **Table 4**. The value of adjusted *R*-squared is high. The major explanatory variables are statistically significant and follow the expected signs.

The estimated results in **Table 4** are basically similar to those presented in **Table 3.** Therefore, the characteristics of different types of banks and the effects of the financial reform policy that were observed in the previous section are sufficiently robust to derive the following conclusions.

7. Conclusions: Summary and Policy Implications

Following the 1997 financial crisis, foreign bank penetration increased substantially in Thailand. This is expected to be a significant catalyst for change in the domestic banking industry and to improve the productivity of the Thai banking sector. To understand the impact of foreign penetration and formulate the most appropriate policies to ensure that foreign banks operate in line with the long-term goals of Thai banking, it is essential to investigate the differences in production technology between foreign and Thai domestic banks and the extent to which these have changed given increasing foreign penetration in recent years.

This paper is the first formal attempt to investigate precisely the comparative cost structure of foreign and Thai domestic banks in relation to the overall process of foreign bank penetration, which began in the early 1990s. This paper estimates the cost functions of foreign and Thai domestic banks by using panel data from 27 commercial banks in Thailand from 1990 to 2002. The production technologies and cost characteristics of the foreign and Thai domestic banks are compared, the impact of increased foreign participation on their cost performance is evaluated, and the sources of operational advantages of foreign and domestic banks are identified. Then, based on the technological characteristics of the banks identified, we discuss the appropriateness of foreign bank entry policy in Thailand as well as the implications for future banking policies.

The results of our empirical analysis provide the following evidence that the recent Thai financial reform policies, particularly allowing greater foreign bank penetration, are on the right track to building a desirable banking industry structure.

First, according to our empirical analysis, the production technologies for foreign bank branches are distinct from those of Thai domestic banks. Foreign bank branches provide services that are human capital intensive and physical capital intensive, while domestic banks provide services that are fund intensive. These performance characteristics of foreign bank branches reflect that they maintain highly skilled workers and invest in advanced technology, limit their credit exposure, and mostly focus on advanced services in investment banking and private banking. On the other hand, Thai domestic banks focus on fund-based business, i.e., traditional retail banking services centering on taking deposits and extending loans.

This suggests that foreign bank branches and their Thai rivals can share their specialized market roles for the highest cost efficiency. Foreign bank branches have the advantage in the wholesale market centering on multinational corporations and large Thai corporations that need highly sophisticated financial services based on international platforms, while Thai domestic banks have the advantage in the retail market where basic banking services are provided to ordinary Thai corporations and households. Appropriate role sharing between foreign bank branches and other banks should be determined by their respective competitive advantages.

Second, the estimated results show that the financial reform policies adopted after the Asian crisis pushed up the operational costs of Thai domestic banks whereas they pushed down the operational costs of foreign bank branches. This suggests that strengthening prudential regulations and upgrading monitoring systems significantly increases the cost

of the credit risk management that is inevitable for modernization of the Thai domestic banks. A rise in operational cost of Thai domestic banks reflects their stricter monitoring and supervision processes, which results in better-quality loans. This is a good sign for improvement in lending practices in the Thai banking market.

On the other hand, the modernization of business practices and improvement of financial regulations and corporate laws after the Asian financial crisis substantially lessened the disadvantage of foreign bank branches in information correction and credit risk examination in Thai banking market. This enabled foreign bank branches to make full use of their advanced skills and technology in providing financial services. As a result, the operational costs of foreign bank branches were reduced after the financial reform policies were adopted.

Third, our empirical study shows that the joint venture banks changed their cost performance drastically in the few years after they were acquired by foreign investors. These joint venture banks had operational characteristics similar to those of foreign bank branches, reflecting their intensive efforts in business restructuring and modernization investment. Foreign investors have brought efficient banking techniques, such as the introduction of advanced techniques in loan portfolio management, ALM (Asset Liability Management), and management information services. Foreign investors have also adopted a rational system for recruitment, promotion, and training. These factors contribute to avoid a rise in the operational cost of foreign-acquired banks. In addition, as foreign partners apply effort into fee-based services, we expect improvement in operating efficiencies in these areas of business. In general, we found that foreign majority acquisition of Thai domestic banks is likely to improve the functioning of the domestic banking market, which ultimately results in positive welfare implications for their customers. Accordingly, the impact of increased foreign participation has evidently been positive.

Finally, according to the estimation results, there are economies of scale in Thai domestic banks, foreign-acquired banks, and foreign bank branches, meaning that enlarging the operational size of banks helps improve cost efficiency. Following the crisis, there has been an increase in fixed costs for domestic banks and foreign-acquired banks owing to large investments in advanced technology. This implies that the banks, particularly small foreign-acquired banks, should increase their scale to reduce the average cost of new investments. These observations support the current financial reform policy that scale expansion from the merger and acquisition process is important for the improvement in operational efficiency and should be encouraged further[21]. Foreign bank entry should be encouraged under the condition that domestic banks are able to prepare themselves for the new competitive market environment.

---

[21] On July 2004, United Oversea Bank (UOB) bought the majority shares of Bank of Asia from ABN AMRO. UOB is to merge UOB Radanasin with Bank of Asia under the Financial Sector Master Plan issued by the Bank of Thailand. It has said that financial institutions operating in Thailand should have "one presence" which would mean that UOB would merge its two entities into one.

On the other hand, economies of scope were evident only in hybrid banks, whereas they were not observed in either Thai domestic banks or foreign bank branches. Foreign-acquired banks succeeded in providing the complimentary financial services demanded by their relatively small but well focused customer base. Following the example of the business practices of foreign-acquired banks, both Thai domestic banks and foreign bank branches should make additional efforts to improve cost efficiency and realize the economies of scope that are to emerge through efficient banking operations.

Appendix

Table A1. List of Commercial Banks

Domestic Banks (including hybrid banks)

1. BOA = Bank of Asia (ABN AMRO)
2. BAY = Bank of Ayudhya
3. BBL = Bangkok Bank
4. BBC = The Bangkok Bank of Commerce
5. BMB = Bangkok Metropolitan Bank
6. BT = BankThai
7. DTDB = The DBS Thai Danu Bank
8. FBCB = First Bangkok City Bank
9. KTB = Krung Thai Bank
10. LTB = The Laem Thong Bank
11. SCB = The Siam Commercial Bank
12. SCIB = The Siam City Bank
13. SCNB = Standard Chartered Nakornthon Bank
14. TFB = Thai Farmers Bank (Kasikornbank)
15. TMB = The Thai Military Bank
16. UB = The Union Bank of Bangkok
17. UOBR = UOB Radanasin Bank

Pure Foreign Banks (i.e. foreign bank branches)

1. STANDARD = Standard Chartered Bank
2. HSBC = The Hong Kong and Shanghai Banking Corporation
3. OVERSEA = Oversea-Chinese Banking Corporation
4. BOA = Bank of America
5. BANQUE INDOSUEZ = Credit Agricole Indosuez
6. CHASE = JP Morgan Chase Bank
7. CITI = Citibank
8. DEUTSCHE = Deutsche Bank
9. BHARAT = Bharat Overseas Bank
10. CHINA = The Bank of China
11. ABN = ABN AMRO Bank

Table A2. Results of EstimationAdministrator

Parameter	Estimated value	t-value	p-value
α_0	3.958	2.994	[.003]
α_1	0.643	4.779	[.000]
α_2	0.221	1.863	[.062]
β_1	0.837	93.309	[.000]
β_2	0.113	15.656	[.000]
β_3	0.050	22.059	[.000]
ζ	6.861	1.574	[.116]
ζ_{Y1}	0.001	0.002	[998]
ζ_{Y2}	–0.357	1.743	[.081]
ζ_{P1}	–0.138	–5.577	[.000]
ζ_{P2}	0.083	4.151	[.000]
ζ_{P3}	1.056	119.774	[.000]
ϕ	–1.299	–0.767	[.443]
ϕ_{Y1}	–0.086	–0.549	[.583]
ϕ_{Y2}	0.084	0.638	[.523]
ϕ_{P1}	–0.092	–6.992	[.000]
ϕ_{P2}	0.086	8.199	[.000]
ϕ_{P3}	1.005	248.767	[.000]
η_{POLICY}	1.506	6.186	[.000]
ϕ_{POLICY}	–0.592	–3.657	[.000]
Adjusted R-square	0.893		
Number of observations	256		

	Estimated value	Wald statistics	p-value
Domestic banks			
Economies of scale	0.864	35.014	[.000]
Economies of scope	0.142	22.162	[.000]
Foreign bank branches			
Economies of scale	0.862	3.561	[.059]
Economies of scope	0.170	39.748	[.000]
Foreign-acquired banks			
Economies of scale	0.508	24.279	[.007]
Economies of scope	–0.3087	1.385	[.239]

References

Barajas, A., Steiner, R., Salazar, N., 2000. The impact of liberalization and foreign

investment in Colombia's financial sector. Journal of Development Economics 63, 157--196.
Bhattacharaya, A., Lovell, C.A.K., Sahay, P., 1997. The impact of liberalization on the productive efficiency of Indian commercial banks. European Journal of Operational Research 98, 332--345.
Chantapong, S., 2001. What Happened to the Banking Sector in the Aftermath of Financial Crisis: the Case of Thailand. Paper presented at the International West–East Conference November 2003, London Kiel Institute of World Economics, Working Paper No. 378.
Chantapong, S., 2003. Comparative Study of Domestic and Foreign Bank Performance in Thailand: The Regression Analysis. Mimeo presented at the International West–East Conference 2003 in London.
Claessens, S., Dermirguc-Kunt, A., Huizinga, H., 2001. How does Foreign Entry Affect the Domestic Banking Market?. Journal of Banking and Finance 25, 891--911.
Claessens, S., Jansen, M., 2000. The Internationalization of Financial Services Issues and Lessons for Developing Countries. Kluwer Academic Press, Boston.
Clarke, G., Cull, R., Peria, M.S.M, Sanchez, S.M., 2001. Foreign Bank Entry: Experience, Implications for Developing Countries, and Agenda for Further Research, Policy Research Working Paper Series 2698, The World Bank.
Crispin, S., Tasker, R., Goad, G.P., Dolven, B., 2000. Banking on Change. Far Eastern Economic Review.
Denizer, C., 2000. Foreign Entry in Turkey's Banking Sector, 1980–1997, in: Claessens, S., Jansen, M. (Eds.), The Internationalization of Financial Services: Issues and Lessons for Developing Countries. Kluwer Academic Press, Boston.
DeYoung, R., Nolle, D.E., 1996. Foreign-Owned Banks in the U.S.: Earning Market Share or Buying it?. Journal of Money, Credit and Banking 28, 622--636.
Elyasiani, E., Mehdian, S.M., 1995. The Comparative Efficiency Performance of Small and Large U.S. Commercial Banks in the Pre- and Post- Deregulation Eras. Applied Economics 27, 1069--1079.
Elyasiani, E., Rezvanian, R., 2002. A Comparative Multiproduct Cost Study of Foreign-owned and Domestic-owned US Banks. Applied Financial Economics 12, 271--284.
Goldberg, L.G., 1992. The competitive Impact of Foreign Commercial Banks in the United States, in : Gilbert, R.A. (Eds.), The Changing Market in Financial Services. Kluwer Academic Press, New York.
Greenwald, B., Levinson, A., Stiglitz, J.E., 1993. Capital Market Imperfections and Regional Economic Development, in: Giovannini, A. (Eds.), Finance and Development: Issues and Experience. Cambridge University Press, Cambridge, pp.65--98.
Intarachote, T., Brown, Z.M., 2000. The Impact of Financial liberalization on the efficiency and Productivity of Commercial Banks in Thailand. Paper presented to the Annual Conference of the European Association of University Teachers in Banking and Finance, Göteborg University, 30 August-2 September 2000.
Jagtiani, J., Khanthavit, A., 1996. Scale and Scope Economies at Large Banks: Including Off-Balance Sheet Products and Regulatory Effects. Journal of Banking and Finance 20,1271--1287.
Jayaratne, J., Wolken, J., 1999. Banking Consolidation and Small Firm Finance:

Discussion of How important are small banks to small business lending? New Evidence from a Survey of Small Firms. Journal of Banking and Finance 23, 427--458.
Jayapani, P., 1997. Impacts of financial development on economic growth: a case study of Thailand. PhD Thesis, Thammasat University, Thailand.
Kwan, S.H., 2003. Operating performance of banks among Asian economies: An international and time series comparison. Journal of Banking and Finance 27, 471--489.
Leightner, J.E., Lovell, C.A.K., 1998. The Impact of Financial Liberalization on the Performance of Thai Banks. Journal of Economics and Business 50, 115--131.
Levine, R., 1996. Foreign banks, financial development, and economic growth, in: Claude, E., Barfield. (Eds.), International Financial Markets. AEI Press, Washington, DC. , pp.224--255.
Leyland, H. E., Pyle, D. H., 1977. Information Asymmetries, Financial Structure, and Financial Intermediation. Journal of Finance 32, 371--387.
Lindgren, C.J., Garcia, G., Saal, M., 1996. Bank Soundness and Macroeconomic Policy. International Monetary Fund, Washington DC.
Litan, R.E., Masson, P., Pomerleano, M., 2001. Open Doors: Foreign Participation in Financial Systems in Developing Countries. Brookings Institution Press, Washington DC.
Maddala, G.S.,1998. Introduction to Econometrics, Macmillian, U.S.A.
Meinster, D., Elyasiani, E., 1988. The Performance of Foreign-owned, Minority-owned, and Holding-company-owned Banks in the U.S.. Journal of Banking and Finance 12, 293--314.
Montreevat, S., 1999. Impact of foreign entry on the Thai banking sector: Initial stage of bank restructuring. Thammasat Economic Journal 17, 29--59.
Montgomery, H., 2003. The Role of Foreign Banks in Post-Crisis Asia: The Importance of Method of Entry. Research Paper Series 51, ADB Institute.
Mahajan, A., Rangan, N., Zardkoohi, A., 1996. Cost Structures in Multinational and Domestic Banking. Journal of Banking and Finance 20, 238--306.
Okuda, H., Hashimoto, H., 2004. Estimating Cost Functions of Malaysian Commercial Banks: The Differential Effects of Size, Location, and Ownership. Asian Economic Journal 18, 233--259.
Okuda, H., Mieno, F., 1999. What Happened to Thai Commercial Banks in the Pre-Asian Crisis Periods: Microeconomic Analysis of Thai Banking Industry. Hitotsubashi Journal of Economics 40, 97--121.
Okuda, H., Rungsomboon, S., 2004. The Effects of Foreign Bank Entry on the Thai Banking Market: Estimation Analysis over the Period of 1990-2002. Paper presented at Japan Society of Monetary Economics at Aichi University on September 12, 2004.
Petersen, M.A., Rajan, R.G., 1995. The Effect of Credit Market Competition on Lending Relationships. The Quarterly Journal of Economics 110, 407--443.
Pomerleano, M., Vojta G.J., 2001. Foreign Banks in Emerging Markets: An Institutional Study, in: Litan, R.E., Masson P., Pomerleano, M. (Eds.), Open Doors: Foreign Participation in Financial Systems in Developing Countries. Brookings Institution Press, Washington DC., pp.59--104.
Sabi, M., 1996. Comparative Analysis of Foreign and Domestic Bank Operation in

Hungary. Journal of Comparative Economics 22, 179--188.
Schargrodsky, E., Sturzenegger, F., 2000. Banking Regulation and Competition with Product Differentiation. Journal of Development Economics 63, 85--111.
Stiglitz, J.E., Weiss, A.M., 1981. Credit Rationing in Markets with Imperfect Information. American Economic Review 71, 393--410.
Suwanaporn, C., 2003. Determinants of Bank Lending in Thailand: An Empirical Examination for the Years 1992 to 1996. Development Economics and Policy Series 33, Frankfurt am Main: Peter Lang Verlag.
Terrel, H., 1986. The Role of Foreign Banks in Domestic Banking Markets, in: Cheng, H. (Eds.), Financial Policy and Reform in Pacific-Rim Countries. Lexington Books, Lexington.
Unite, A., Sullivan, M., 2003. The Impact of Liberalization of Foreign Bank Entry on the Philippine Domestic Banking Market. Journal of Banking and Finance 27, 2323--2345.
Weller, C.E., Scher, M.J., 1999. Multinational Banks and Development Finance, ZEI Working Paper, Center for European Integration Studies.
World Bank, 2001. Finance for Growth, Oxford University Press, U.S.A.

Table 1. Evolution of Foreign Participation for Domestic Banks (as the Percentage of foreign-owned shares to total shares)

	Before the Crisis (1992-1996)	After the Crisis (1999-2002)
BAY	10.50	9.48
BB	13.18	31.78
BBC	11.52	-
BMB	9.75	0.00
BT	-	0.50
FBCB	16.03	-
KTB	7.45	0.60
LTB	1.67	-
SCB	15.02	27.93
SCIB	11.96	-
TFB	15.30	28.75
TMB	16.14	2.45
UB	18.27	-
BOA	5.06	77.90 (Joint-Venture)
DTDB	7.43	56.85 (Joint-Venture)
SCNB	5.56	75.00 (Joint-Venture)
UOBR	1.67	75.00 (Joint-Venture)

(Source) The I-SIMS database of the Stock Exchange of Thailand.
(Notes) 1. BOA = Bank of Asia (ABN-AMRO), BAY = Bank of Ayudhya, BBL = Bangkok Bank, BBC = The Bangkok Bank of Commerce, BMB = Bangkok Metropolitan Bank, BT = BankThai, DTDB = The DBS Thai Danu Bank, FBCB = First Bangkok City Bank, KTB = Krung Thai Bank, LTB = The Laem Thong Bank, SCB = The Siam Commercial Bank, SCIB = The Siam City Bank, SCNB = Standard Chartered Nakornthon Bank, TFB = Thai Farmers Bank (Kasikornbank), TMB = The Thai Military Bank, UB = The Union Bank of Bangkok, UOBR = UOB Radanasin Bank.

2.

–Bangkok Bank of Commerce (BBC) was turned into a nonbank, Asset Management Companies (AMCs), owned by the Financial Institutions development Fund (FIDF)

–Bangkok Metropolitan Bank (BMB) and Siam City Bank (SCIB) were recapitalized according to end-2000 LCP rules by the government.

–BankThai Public Company Limited was established in 1998 as a state-run commercial bank, with the Financial Institutions Development Fund (FIDF) as the largest shareholder (48.98%).

–First Bangkok City Bank (FBCB) was integrated with Krung Thai Bank (KTB) in August 1998.

–During the same period, The Union Bank of Bangkok (UB) and the 12 finance companies were consolidated with Krung Thai Thanakit (KTT).

–Laem Thong Bank (LTB) was merged with Radanasin Bank (RAB), a new bank established in March 1998 with the purpose of purchasing and managing assets of financial institutions. Then, it was sold to the Singapore-based United Oversea Bank (UOB) and changed its name to UOB Radanasin (UOBR), a new bank established with the purpose of purchasing and managing assets of financial institutions.

–Four commercial banks are majority-owned by foreign investors. DBS Thai Danu Bank (DTDB) was acquired by Development Bank of Singapore (DBS) in January 1998, Bank of Asia (BOA) was acquired by ABN AMRO Bank in June 1998, Standard Chartered Nakornthon Bank (SCNB) was acquired by Standard Chartered Bank in September 1999, and UOB Radanasin Bank (UOBR) was acquired by United Oversea Bank (UOB) in November 1999.

Table 2. Operational Behavior of Foreign and Domestic Banks

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Average
Borrowing interest rate														
Foreign	0.08	0.08	0.07	0.06	0.05	0.09	0.08	0.08	0.13	0.06	0.07	0.05	0.02	0.07
Domestic	0.09	0.11	0.08	0.07	0.06	0.08	0.08	0.09	0.11	0.05	0.04	0.03	0.03	0.07
Wage rate														
Foreign	0.29	0.31	0.36	0.37	0.40	0.52	0.51	0.62	0.61	0.73	0.76	0.84	0.53	0.53
Domestic	0.14	0.15	0.17	0.18	0.21	0.21	0.23	0.25	0.22	0.26	0.29	0.30	0.31	0.22
Rental rate														
Foreign	0.60	0.50	0.66	0.51	0.48	0.38	0.35	0.38	0.39	0.58	0.59	0.60	0.61	0.51
Domestic	0.21	0.20	0.20	0.17	0.13	0.13	0.14	0.14	0.20	0.28	0.18	0.20	0.19	0.18
Non-interest income / Total income														
Foreign	0.76	0.79	0.77	0.77	0.76	0.83	0.82	0.74	0.84	0.75	0.76	0.77	0.63	0.77
Domestic	0.92	0.92	0.92	0.91	0.90	0.90	0.92	0.93	0.94	0.87	0.85	0.81	0.80	0.89
Total cost / Total income														
Foreign	0.54	0.59	0.55	0.51	0.53	0.57	0.54	0.54	0.51	0.50	0.52	0.44	0.44	0.52
Domestic	0.80	0.84	0.75	0.74	0.69	0.74	0.77	0.82	1.13	1.14	0.93	0.77	0.64	0.83
Interest expense / Total cost														
Foreign	0.75	0.78	0.74	0.71	0.70	0.75	0.75	0.78	0.79	0.67	0.64	0.60	0.52	0.71
Domestic	0.87	0.89	0.85	0.84	0.82	0.86	0.87	0.88	0.90	0.81	0.75	0.71	0.68	0.83
Personnel expenses / Total cost														
Foreign	0.15	0.13	0.16	0.18	0.18	0.16	0.13	0.11	0.10	0.19	0.22	0.25	0.26	0.17
Domestic	0.09	0.08	0.11	0.11	0.13	0.10	0.09	0.08	0.07	0.12	0.16	0.19	0.21	0.12
Rental expenses / Total cost														
Foreign	0.04	0.03	0.05	0.05	0.06	0.09	0.05	0.04	0.04	0.07	0.08	0.09	0.11	0.06
Domestic	0.04	0.03	0.04	0.04	0.05	0.04	0.04	0.04	0.04	0.07	0.09	0.10	0.11	0.06

(Source) The I-SIMS database of the Stock Exchange of Thailand.

Table 3. Results of Estimation

Parameter	Two products			Single product		
	Estimated value	t-value	p-value	Estimated value	t-value	p-value
α_0	4.044	3.045	[.002]	3.404	2.547	[.011]
α_1	0.633	4.665	[.000]	0.873	15.277	[.000]
α_2	0.228	1.902	[.057]	–	–	–
β_1	0.837	96.074	[.000]	0.837	97.120	[.000]
β_2	0.113	15.964	[.000]	0.112	16.103	[.000]
β_3	0.050	22.057	[.000]	0.050	22.088	[.000]
ζ	3.614	0.539	[.590]	7.985	1.303	[.193]
ζ_{Y1}	0.375	0.713	[476]	–0.350	–1.378	[.211]
ζ_{Y2}	–0.560	0713	[.079]	–	–	–
ζ_{P1}	–0.149	–5.022	[.000]	–0.149	–5.042	[.000]
ζ_{P2}	0.087	3.637	[.000]	0.087	3.642	[.000]
ζ_{P3}	1.062	149.725	[.000]	1.062	150.275	[.000]
ϕ	–1.449	–0.852	[.394]	–2.459	–1.426	[.154]
ϕ_{Y1}	–0.069	–0.437	[.662]	0.059	0.578	[.449]
ϕ_{Y2}	0.073	0.547	[.585]	–	–	–
ϕ_{P1}	–0.092	–7.235	[.000]	–0.092	–7.272	[.000]
ϕ_{P2}	0.087	8.391	[.000]	0.086	8.396	[.000]
ϕ_{P3}	1.006	248.809	[.000]	1.006	252.861	[.000]
η_{POLICY}	1.566	6.079	[.000]	1.432	6.069	[.000]
ϕ_{POLICY}	–0.591	–3.636	[.000]	–0.714	–4.408	[.000]
ζ_{RESTR}	–0.472	–1.799	[.072]	–0.295	–1.286	[.199]
Adjusted R-square	0.894			0.889		
Number of observations	249			253		
	Estimated value	Wald statistics	p-value	Estimated value	Wald statistics	p-value
Domestic banks						
Economies of scale	0.861	34.349	[.000]	0.873	26.638	[.000]
Economies of scope	0.144	24.055	[.000]	–	–	–
Foreign bank branches						
Economies of scale	0.864	3.543	[.069]	0.932	0.688	[.406]
Economies of scope	0.169	38.960	[.000]	–	–	–
Foreign-acquired banks						
Economies of scale	0.676	7.219	[.007]	0.522	7.926	[.005]
Economies of scope	–0.335	2.884	[.089]	–	–	–

Table 4. Alternative Results of Estimation

Parameter	Two products			Single product		
	Estimated value	t-value	p-value	Estimated value	t-value	p-value
α_0	0.710	0.159	[.646]	5.741	4.703	[.000]
α_1	0.839	6.194	[.000]	0.775	15.013	[.000]
α_2	0.088	0.766	[.444]	–	–	–
β_1	0.837	93.133	[.000]	0.837	97.068	[.000]
β_2	0.113	15.955	[.000]	0.113	16.148	[.000]
β_3	0.050	22.056	[.000]	0.050	22.108	[.000]
ζ	16.682	4.266	[.000]	5.580	1.396	[.163]
ζ_{Y1}	–0.509	1.547	[.122]	–0.221	–1.378	[.168]
ζ_{Y2}	–0.200	–0.633	[.527]	–	–	–
ζ_{P1}	–0.092	–7.257	[.000]	–0.149	–5.042	[.000]
ζ_{P2}	0.087	3.623	[.000]	0.087	3.642	[.000]
ζ_{P3}	1.062	149.155	[.000]	1.062	150.336	[.000]
ϕ	–2.640	–1.301	[.193]	–8.137	–4.499	[.000]
ϕ_{Y1}	–0.010	–0.060	[.952]	0.293	3.891	[.000]
ϕ_{Y2}	0.059	0.458	[.647]	–	–	–
ϕ_{P1}	–0.092	–7.257	[.000]	–0.090	–7.170	[.000]
ϕ_{P2}	0.087	8.409	[.000]	0.085	8.293	[.000]
ϕ_{P3}	1.006	249.705	[.000]	1.006	252.521	[.000]
η_{POLICY}	0.806	3.731	[.000]	1.442	6.296	[.000]
ϕ_{POLICY}	–0.212	–1.450	[.147]	–0.772	–5.019	[.000]
ζ_{RESTR}	–0.233	–1.049	[.294]	–0.339	–1.502	[.133]
Adjusted R-square	0.906			0.891		
Number of observations	249			253		
	Estimated value	Wald statistics	p-value	Estimated value	Wald statistics	p-value
Domestic banks						
Economies of scale	0.927	18.832	0.000	0.775	19.243	[.000]
Economies of scope	0.074	6.499	0.011	–	–	–
Foreign bank branches						
Economies of scale	0.997	0.002	0.968	1.069	0.873	[.350]
Economies of scope	0.125	6.249	0.012	–	–	–
Foreign-acquired banks						
Economies of scale	0.218	67.953	0.000	0.554	26.426	[.000]
Economies of scope	–0.037	0.211	0.646	–	–	–