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ARTICLE INFO	Chang-Sheng Liao (2009). Efficiency and productivity change in the banking industry in Taiwan: domestic versus foreign banks. <i>Banks and Bank Systems</i> , 4(4)
RELEASED ON	Wednesday, 16 December 2009
JOURNAL	"Banks and Bank Systems"
FOUNDER	LLC "Consulting Publishing Company "Business Perspectives"



NUMBER OF REFERENCES

0



NUMBER OF FIGURES

0



NUMBER OF TABLES

0

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Efficiency and productivity change in the banking industry in Taiwan: domestic versus foreign banks

Abstract

This study employs Data Envelopment Analysis to estimate the efficiency of domestic and foreign banks as well as the dynamics of efficiency change in Taiwan. The results indicate that domestic banks' returns to scale are decreasing and that an oversize phenomenon exists in the Taiwanese banking industry. The most important mission of bank managers is to continue to adjust the size of their firms' operating asset bases until they reach efficient levels. The foreign banks are not more efficient than domestic ones, but their productivity growth is better than that of domestic banks. This finding implies that less efficient banks have a higher incentive to use new technology to improve efficiency. The results show that the home field advantage hypothesis is supported in the case of the banking industry in Taiwan.

Keywords: foreign banks, Data Envelopment Analysis, Malmquist index.

JEL Classification: G21, L25.

Introduction

Due to Taiwan's entrance into the World Trade Organization (WTO) in December 2001, its domestic financial market will have to be completely opened up to allow competition with foreign-owned financial institutions. Most scholars believe that the less competitive domestic banks cannot compete with the foreign banks. Additionally, domestic banks have a serious problem with non-performing loans (NPL), which threatens the banks' operations. The government has advanced a series of financial reform policies to improve the quality of banks' assets and capital adequacy ratios, leading the NPL ratio to decline to 8.85 percent in December 2002. Foreign banks have contributed to the Taiwan banking industry in many important areas, such as internationalization, liberalization, operating methods and intangible assets such as technologic know-how and human capital. Many studies have shown that foreign banks' entry into the local market tends to improve banks' efficiency and market discipline. Examples of this are found in Claessens et al. (2001), Unite and Sullivan (2003), Isik and Hassan (2003.)

Hansen and Hunter (1996), Mahajan et al. (1996), Sathye (2001), Williams (1998), Sensrma (2006) have all found that in developed countries, such as the United States and Australia, the efficiency of domestic banks is greater than that of foreign banks. If the foreign banks are less efficient than domestic banks due to more comprehensive financial markets and better technology innovation in developed countries, they also consider that foreign banks from developing countries may be more efficient than domestic banks in their host country. Berger et al. (2000) try to explain this result using the limited global advantage hypothesis; they find some empirical evidence to support this hypothesis for

three of the five host countries studied. Claessens et al. (2001) find that foreign banks have higher profits than domestic banks in developing countries, but that the opposite is the case for developed countries. William (1998) discovers that there is an *International Experience Effect* whereby foreign banks with more international experience earn higher profits globally. In sum, existing studies on the comparative performance and efficiency of domestic and foreign banks show conflicting conclusions.

The purpose of this study is to compare the efficiency of domestic and foreign banks in Taiwan and to understand why customers believe that foreign banks are better than domestic ones. This study employs Data Envelopment Analysis (DEA) to estimate the efficiency of domestic and foreign banks and the dynamics of efficiency change in Taiwan. In fact, domestic banks have an absolute advantage over foreign banks in terms of asset size, market share, language, culture and regulations. The foreign banks have better operating strategies than domestic banks; even in an environment of unfair competition, foreign banks are still more profitable than domestic ones. The foreign banks also have an advantageous position in terms of administration, organization, sale and innovation. Thus, the government and researchers consider the size of Taiwanese banks too small to compete in the international financial market; mergers can increase the banks' competitiveness with foreign banks. In recent year, managers in Taiwan have believed that "large banks are equal to good banks", so we seek to explore the relationship between size and efficiency. In summary, we would like to explore those three questions as follows: first, is the Taiwanese banking industry too large or too small? Second, why do customers often think that foreign banks are better than domestic banks? Finally, what are the determinants of efficiency in the banking industry in Taiwan?

The rest of the study is organized as follows. Section 1 defines the input and output variables and determinants of efficiency regression. Section 2 reports the results of the comparison of the efficiency of foreign and domestic banks using Data Envelopment Analysis. Finally, conclusions from the empirical results are drawn, and practical suggestions are offered.

1. Methodology

1.1. Input-output specifications. In previous studies of commercial banks, there is no agreement on the choice of appropriate inputs and outputs, e.g., Drake (2001), Williams (2003), Isik and Hassan (2003), Li et al. (2004), Ataullah and Le (2006), Chiu and Chen (2009). Following these studies, we used the following input-output variables: the operating revenue of a bank mainly comes from loan and investment businesses, so the input items often include operation expense, interest expense, and the output items include loan and discount, interest income and investment. Following Howcroft and Ataullah (2006), we used loan-based and income-based models. Model A is an

$$EFF_{it} = \beta_0 + \beta_1 SIZE_{it} + \beta_2 MANAGE_{it} + \beta_3 SPEC_{it} + \beta_4 INTIN_{it} + \beta_5 FEEIN_{it} + \beta_6 INVEST_{it} + \beta_7 SHARE_{it} + \beta_8 BRANCH_{it} + \beta_9 EQUIT_{it} + \beta_{10} CONC_{it} + \varepsilon_{it}, \quad (1)$$

where *SIZE* indicates the bank asset, *MANAGE* indicates the managerial ability, *SPEC* indicates the firm product of the specialization level, *INTIN* indicates interest income divided by the total operating income, *FEEIN* indicates the fee income divided by the total operating income, *INVEST* indicates the total investment divided by total assets, *SHARE* indicates the market share of the loan business, *BRANCH* indicates the firm's number of branches, *EQUIT* indicates the equity divided by total assets, and *CONC* indicates the level of concentration in the banking industry. ε_{it} is the error term.

We construct an econometric model with a two input-output specification to estimate overall technical efficiency as dependent variable and to discover the determinants of bank efficiency. *SIZE* measures each bank's total assets by natural logarithm. Following Sinkey (1975), *MANAGE* indicates the managerial ability, measured by operating expenses divided by operating income; a lower ratio implies that the bank applies appropriate control and management in cost-saving. Here, we expect a positive relationship between the *MANAGE* and bank efficiency. The *SPEC* is measured by the Herfindahl index of the outputs.

INTIN represents interest income divided by total operating income, *FEEIN* represents fee income

income-based model; the inputs used are operation expense and interest expense, and the outputs used are interest income and non-interest income. Model B is a loan-based model; the inputs used are operation expense and interest expense, and the outputs used are loan and discount and investment.

1.2. Determinants on efficiency of banking industry. To further investigate the determinants of bank efficiency, we used regression analysis to determine whether the bank efficiency derived from the pooled sample is related to firm-specific factors. Because our data pattern is panel data, the analysis used four estimation methods by pooling OLS, fixed-effect modelling (FM), random-effect modelling (RM) and Tobit censored regression.

Many studies have investigated the determinants of bank efficiency, e.g., Mukherjee et al. (2001), Havrylchyk (2006), Jaffry et al. (2007), using the efficiency estimated derived from the DEA estimations as the dependent variable to construct the determinants of bank efficiency and create a regression model as follows:

divided by total income, and *INVEST* represents total investment as a share of total assets. With these variables relative to income, we expect a positive relationship between the *INTIN*, *FEEIN*, *INVEST* and efficiency. *SHARE* represents the individual bank loan business divided by entire industry value of loans, and *BRANCH* measures the number of branches by natural logarithm. The number of branches may affect the convenience for customers; having more branches, however, also entails higher operating costs (Mukherjee et al., 2001). *EQUIT* is measured by total equity as a share of total asset. Casu and Molyneux (2003) discover there does not appear to be a strong relationship between variation in equity and efficiency levels, but Mester (1996), Pastor et al. (2002), and Carbo et al. (2003) found the positive relationship between equity and efficiency. The concentration is measured by sum of square of the market share (MS); on average, firms with higher market share have higher concentrations.

The primary data source for this study was the Taiwan Economics Journal (TEJ) and some data were obtained from the "Annual report of Bank Business Statistics", published by Republic of China Central Bank. All samples have 48 banks during the period from 2002 to 2004. The data were divided into 28 domestic banks and 20 foreign banks (the foreign bank has a branch in Taiwan). Descriptive statistics of the output and input variables are provided in Table 1.

Table 1. Summary statistics

	Mean	Std.
Input-output model		
Operation expense	4,201	5,477
Interest expense	5,323	7,889
Interest income	9,186	13,214
Non-interest income	3,956	5,018
Loan and discount	219,849	311,929
Investment	62,132	116,956
Regression of determinants on efficiency		
SIZE	18.654	1.6962
MANAGE	0.3325	0.1562
SPEC(A)	0.6536	0.1122
SPEC(B)	0.7506	0.1448
INTIN	0.7106	0.1801
FEEIN	0.1118	0.1155
INVEST	0.1298	0.1109
SHARE	0.0156	0.0222
BRANCH	2.6537	1.8578
EQUIT	0.0714	0.0913
CONC	0.0353	0.0003

2. Empirical results

2.1. Results of bank efficiency estimate. This section reports the results of DEA efficiency analysis. The efficiency index includes overall technical efficiency (OTE), pure technical efficiency (PTE), and scale efficiency (SE). We have also divided the sample into pooled samples representing domestic banks and foreign banks. As can be seen in Table 2, we find similar results between the two models over the period of 2002-2004, but the efficiency score of the loan-based model is lower than the income-based model. This finding implies that the input-output model with loans and discount variables would show a decline in the efficiency score. The gap in this case would be 6.34 percent due to the loans and the discount factor; banks with larger loan businesses cannot increase their efficiency, which suggests that managers should improve loan quality and enhance their management of credit risk.

We find that the two models' mean overall technical efficiency scores are 0.7905 and 0.7449, respectively. The results are significantly lower than previous studies, which have yielded efficiency scores of 0.929 (Chen and Yeh, 2000) and 0.95 (Chang and Chiu, 2006). This implies that the gap of efficiency scores among banks has significantly expanded and that managers engage in many activities and strategies to improve their efficiency that allow the difference between bank and bank efficiency to grow. Compared with the previous studies in the same study period, the OTE score is not similar to that found by Lin et al. (2007), who produced a mean efficiency score of 0.504. This difference comes from whether the measure of efficiency involved foreign banks or used unlike

input-output specification¹. However, our results are closer to those of prior studies, e.g., Chen and Yeh (2000), Chen (2004) and Chang and Chiu (2006).

As for the OTE for each year, the OTE scores are 0.8462 and 0.7828 in 2002. However, the two models show a significant gap between 2002 and 2003; i.e., Model B shows a decline to 0.7178 in 2003. When we only observe domestic banks, we find a steep decline from 0.8498 in 2002 to 0.7244 in 2003 with Model B. Nonetheless, these provide similar conclusions for Models A and B. In this study period, the government, seeking to improve the asset quality of domestic banks, enacted policies to improve domestic bank efficiency and strictly required banks to reduce their amount of non-performing loans (NPL). The NPL ratio declined from 11.27% pre-financial reform to 3.8% in 2004 after the financial reform, forcing the domestic banks to sacrifice something to achieve improved bank quality targets. Thus, the OTE shows a significant decline in 2003 relative to 2002. Similar results can be found when PTE and SE scores are analyzed².

Compared with previous studies, Chen and Yeh (2000) show that the SE is slightly higher than the PTE, indicating that the PTE factor has less importance than the SE factor as a source of inefficiency among all banks. Chen (2004) finds that the mean of pure technical efficiency (0.761) is lower than the mean of scale of efficiency (0.929), suggesting that the PTE plays a more important role than the factor of scale in explaining the source of technical inefficiency within the inefficiency of banks. We find the same result: the mean PTE (0.8778, 0.804) is slightly lower than SE (0.9029, 0.9062). The banks' inefficiency is mainly attributed to the under-utilization of input or the incorrect selection of input combinations and is not due to inadequate operating scale or returns to scale. In a competitive environment, one major strategy is to seek mergers or acquisitions to gain an economy of scale (Lin et al., 2007). Most managers use mergers, e-business or the establishment of financial holding companies to improve banks' efficiency, which enlarges the gap in banks' efficiency. In particular, we observe that the large gap in efficiency among the domestic banks implies that, with the domestic banks, there exists a phenomenon of uneven efficiency, showing some bank managers' inability to improve bank efficiency in the age of post-financial reform.

¹ Lin et al. (2007) define output items as interest revenue, non-interest revenue and pre-tax revenue, and the input items as interest expenditures and non-interest expenditures.

² Liao (2008) finds that financial reform has no real positive effect on the bank's X-Efficiency, indicating that banks' efficiency has not increased by the 2001-2003 financial reforms because as the government requires banks to reduce the amount of NPL by a certain deadline, bank managers sacrifice something to achieve the governments' target.

Many government officers and researchers believe that the size of Taiwanese banks is too small to compete in the international financial market, so they believe that merger activity can increase banks' competitiveness with foreign banks. However, our results show the source of inefficiency to be the under-utilization of input and not an inadequate operating scale. On the other hand, the government is "encouraging" merger activity to address the underperformance of farmers' credit unions. Peng and Wang (2004) have shown that merger activity significantly affects cost efficiency in the Taiwanese banking industry, finding that mergers can increase bank efficiency. This finding implies that the large banks would have a higher efficiency and probability. However, Lin (2005) has found that, if the mergers happened between homogeneous banks, there would be little financial innovation, and cost efficiency would be insubstantially improved. Consequently, the notion that merger activity improves banks' efficiency is not confirmed.

Are there scale issues in Taiwan's banking industry? Following Hauner (2005), we employ the individual type of returns to scale. From Table 3, we observe that the domestic banks almost all fall into the DRS group with two models in all years, indicating that domestic banks' returns to scale are decreasing and that the Taiwanese banking industry is oversized. This is consistent with the result of the comparison of the PTE and SE scores. Although Peng and Wang (2004) find that bank merger activity is positively related to cost efficiency, they also find that increasing returns to scale exist for small and medium banks, while decreasing returns to scale exist for large banks. Thus, the result suggests that every country has a minimum efficient operating scale in their banking system and that bank sizes are indeed too small relative to international banks in Taiwan, but that size is not a key factor behind lower efficiency. We first should determine whether banks' operating asset bases are at the minimum efficient size, mergers may lead banks to deviate from their best practice frontier¹. Gilligan et al. (1984) have found that negligible cost savings could be gained by increasing the bank size; most studies have the same results, e.g., Pi and Timme (1993), Mester (1996), and Avkiran (1999). Therefore, bank managers should not blindly merge to expand their asset base, as it is uncertain whether this would improve efficiency and profitability. In sum, we suggest that banks can use other means to improve efficiency, e.g., fully employ their resources, project appropriate strategies for banking operations, and invest more in innovation.

¹ Drake (2001) has suggested that the minimum efficient scale of operation in UK is at an asset size in the range of GBP 18 to 23bn.

Table 2. Results of DEA efficiency estimates

	Overall technical efficiency		Pure technical efficiency		Scale efficiency	
	Model A	Model B	Model A	Model B	Model A	Model B
All						
2002	0.8462	0.7828	0.8928	0.8319	0.9494	0.9382
2003	0.7585	0.7178	0.8829	0.796	0.8607	0.8875
2004	0.7668	0.734	0.8576	0.8113	0.8986	0.8928
Mean	0.7905	0.7449	0.8778	0.804	0.9029	0.9062
Domestic						
2002	0.8747	0.8498	0.9022	0.8875	0.9707	0.9561
2003	0.7571	0.7244	0.8796	0.793	0.8651	0.9056
2004	0.7986	0.7086	0.8795	0.8594	0.9165	0.9077
Foreign						
2002	0.8064	0.6891	0.8795	0.7543	0.9197	0.9134
2003	0.7604	0.7086	0.8875	0.8004	0.8547	0.862
2004	0.7223	0.6669	0.827	0.7439	0.8736	0.8719

Note: Model A is income-based model, Model B is loan-based model.

Table 3. Results of return scale of domestic and foreign banks

	Model A			Model B		
	CRS	IRS	DRS	CRS	IRS	DRS
2002						
All banks	8	11	29	6	9	33
Foreign	7	9	4	4	9	7
Domestic	1	2	25	2	0	26
2003						
All	6	11	31	10	11	27
Foreign	6	10	4	6	11	3
Domestic	0	1	27	4	0	24
2004						
All	7	18	23	10	11	27
Foreign	5	11	4)	6	9	5
Domestic	2	7	19	4	2	22

Note: CRS = Constant to return scale, IRS = Increasing to return scale, DRS = Decreasing to return scale.

2.2. Efficiency of domestic vis-à-vis foreign banks. In this section, we want to explore why people generally think that foreign banks are better. Most customers generally consider foreign banks to be better than domestic banks in Taiwan. The foreign banks compete with domestic banks in an unfair condition; thus, the domestic banks would be in an advantageous position relative to foreign banks. As can be seen in Table 4, the two models both show domestic banks' efficiency scores to be higher than those of foreign banks. For example, the loan-based model shows that the mean OTE of domestic banks is 0.7854, significantly higher than the foreign banks' mean value of 0.6882. Other efficiency value estimations have similar results. Thus, the results suggest that foreign banks are not always winners in developing countries; this is inconsistent with Claessens et al. (2001), Isik and Hassan (2002), Hasan and Marton (2003) and

Havrychyk (2006), but consistent with Berger et al. (2000), Rao (2005), Sensarma (2006) and Tahir and Haron (2008). The commercial banking revenue is largely generated from loans and investments rather than fee-based income in developing countries (Howcroft and Ataullah, 2006), so the loan-based model showing the domestic banks as better banks is used. However, the number of foreign banks using the covered non-traditional business model is still lower than domestic banks; this implies that foreign banks have a bear significant liabilities and alien responsibility¹, these costs include monitoring from a distance, staff turnover in overseas postings, diseconomies of operation in the retail sector, and barriers to entry such as language, culture, market structure and regulation (Miller and Parkhe, 2002).

Why were our results unlike the customers' perceptions? The results show that foreign banks show lower efficiency by pure technical inefficiency; the mean PTE scores are 0.8647 and 0.7661, respectively. In general, the customers believe that foreign banks can more effectively utilize their resources than can domestic banks. Foreign banks, limited by the liability of foreignness, often need more time to solve these problems, and the operation of foreign banks as branches and not as subsidiary companies decreases their ability to use their banks' resources. The efficiency estimate results show that foreign banks are not better than domestic banks, but we observe the two groups' returns on assets (ROA). Table 4 presents the ROA of domestic and foreign banks over the period from 1997 to 2004, indicating that foreign bank profitability is higher than domestic bank profitability. Based on the loan-based model, the domestic banks' mean OTE is 0.7854, indicating that the gap in efficiency among the sample banks is large; the same result is present in foreign banks. In this study, we use 28 domestic banks, but eliminate partial non-operating banks or regional banks due to our inability to obtain their balance sheet and income statements. Another more important reason is that the government enacted the Financial Institution Act in 2000 in order to increase banks' competitiveness and to help some non-operating banks withdraw from the banking market. This act caused a wave of mergers among domestic banks in this period, with the banks often willing to sacrifice something to achieve merger targets. Managers now consider sacrificing profit and accepting higher purchase premiums a valuable strategy and investment; although this strategy might generate some losses for the bank in the short term, a merger could help improve the bank's efficiency and

profitability in the future. The financial reform policy is another important factor influencing domestic banks' profitability; the government strictly requires banks to reduce the amount of NPL by a certain deadline, causing the average ROA to be -0.447 in 2002 and to decline to 0.2201 in 2003. In addition, foreign banks have a more serious unevenness problem; although foreign banks have a higher profit number, these gains have been lower than 2%. We observe banks' dropout rates; there are no instances of domestic banks' dropping out, but there are several cases where a foreign bank has done so. Thus, foreign banks like a hot-money concept; if they find that there is a low probability of obtaining more profit in a host country, they will withdraw from this market. Thus, foreign banks have higher profit, which might be due to our analysis not including dropout samples, but domestic banks nonetheless have higher efficiency than foreign banks².

Finally, the results shown do not support the global advantage hypothesis proposed by Berger et al. (2000), which argues that multinational banks from a subset of nations are able to operate in the host nation at superior efficiency. This hypothesis implies that, even though the foreign banks are competitive in advanced fee-based business and in terms of financial engineering technology, information technology, and specialization, in developing countries, they are still not at a competitive advantage with domestic banks in the host country. Thus, our results support the home field advantage hypothesis. Why are foreign banks' efficiencies not higher than those of domestic banks? The Taiwan economy is much closer to that of a developed country, such as the US. Hasan and Hunter (1996), Mahajan et al. (1996), and Chang et al. (1998) have found that foreign banks are less cost-efficient than domestic banks. In developed countries, domestic banks market has a complete legal system, financial market discipline, technical progress, high-quality staff and service skills. Thus, foreign banks might have only a few advantages over domestic banks in developed countries.

Although the domestic banks enjoy higher efficiency in Taiwan due to the home field advantage hypothesis, there are some suggestions for managers and policymakers. First, domestic banks are less competitive in terms of information technology, management skills and brand image against foreign banks. They have been strongly focused on traditional loan-extending businesses in the

¹ The domestic institutions' efficiency advantage is sourced in costs borne by the foreign institution. Berger et al. (2000) call these costs a liability of foreignness for foreign banks.

² Return on assets is a single financial index. It is simple reflection of the banks' performance, but this index cannot sum up banks' comprehensive operation conditions, so we use DEA to estimate banks' efficiency indices in a more appropriate way.

past two decades, and they have ignored the need to develop new information technology, innovate new financial business, and improve service skills, often copying the foreign banks' operating experience. Second, foreign banks attach great importance to high-skilled staff, paying higher salaries and bonuses to professional skilled employees when they are more productive, but the domestic banks are restricted by the strictly hierarchical structure, encouraging the most outstanding managers and staff to migrate to foreign banks.

Table 4. Results of comparison of domestic and foreign banks

	Model A			Model B		
	Domestic	Foreign		Domestic		Foreign
OTE	0.8101	0.763		0.7854		0.6882
PTE	0.8871	0.8647		0.8466		0.7661
SE	0.9174	0.8827		0.9232		0.8824
T-value	1.631	0.975	1.483	2.391**	2.141**	1.957*
F-value	3.226*	1.071	2.608	6.602**	5.317**	4.825**
MWW-Z	-0.95	0.00	-0.637	-1.431	-0.752	-0.049
KS-Z	1.62**	1.071	1.564**	1.676***	1.493**	1.493**
Year	1997	1998		1999		2000
Domestic	0.8852	0.7529		0.5654		0.4828
Foreign	1.5228	1.0172		0.7699		1.2924
Year	2001	2002		2003		2004
Domestic	0.2709	-0.477		0.2201		0.6309
Foreign	1.1915	1.1219		1.2909		1.1939

Notes: * significant level at $\alpha = 0.1$, ** at $\alpha = 0.05$ and *** at $\alpha = 0.01$; OTE = Overall technical efficiency; PTE = Pure technical efficiency; SE = Scale Efficiency; Table 4 presents the three efficiency scores for 2002 to 2004; The null hypothesis is that no significant difference exists in the efficiency scores between the domestic and foreign banks; the difference tests employed in the table are Independent sample T-test, one-way ANOVA test with F-statistics, MWW-Z refers to Mann-Whitney-Wilcoxon Test with Z-statistic, the KS-Z refers to Kolmogorov-Smirnov test with Z-statistic.

2.3. Results of total factor productivity change.

The total factor productivity change indices (Malmquist index, TFPCH hereafter) for foreign and domestic banks are presented in Table 5. We decompose them into the constituent components of productivity change, the "catch-up" and "frontier-shift" components. We find great productivity growth over the period from 2002 to 2004 with the loan-based model with the TFPCH at 1.7174; the banks' productivity growth is 71.74%. This implies that banks have to improve efficiency under high pressure from government supervision, the merger bandwagon, and the prosperity and change of the direct financial market. The income-based model also shows 7.12% growth. Compared with the previous studies, Chen and Yen (2000) have shown that the mean TFPCH is 1.013 and that the technical efficiency change index is 0.998; the variations in the change of technical efficiency are not large. The result reflects that the banks showed significant

growth in productivity after the financial reform (after 2001). We find that the bank productivity change increased over the years 2002-2003, 2003-2004, and 2002-2004. Since 2000, the government has required banks to improve the quality of their loan business by a deadline; managers had to change the kind of loan business that transferred to operating the consuming loans and to increase the investment business weight in business collocation. As a result, managers have sought to improve productivity by output diversification and not by expanding their loan business market share. Although the banks' productivities have shown significant growth, the source of bank inefficiency due to not "catching-up" at the efficient frontier (falling behind the best-practice), i.e., by model A's calculation of the mean EFFCH as 0.9132, implies that banks require more to save costs in management or more utilized input resources.

Comparing the change in productivity between domestic and foreign banks, the results show that the foreign banks' productivities are higher than domestic in the two models. We decompose the productivity into the catch-up effect (EFFCH) and the frontier-shift effect (TECCH); the growth in productivity was mostly due to the frontier-shift effect rather than to the catch-up effect, consistent with Chen and Yeh (2000), showing that the Taiwanese banking industry has shown ceaseless innovation in our study period. The foreign banks have advanced much more than domestic banks in terms of technological progress; Levine (1996) indicates that the foreign banks' entry has improved the quality and availability of financial services in the domestic financial market by increasing bank competition and by enabling the greater application of more modern banking skills and technology. There is direct empirical evidence to support this outlook; Unite and Sullivan (2003) empirically show that foreign competition compels domestic banks to be more efficient in the Philippine banking market. Previous studies have had similar results, e.g., Claessens and Jensen, (2000), Claessens et al. (2001).

On the other hand, Cummins et al. (1999) point out that the opportunity for efficiency gains would be lower in a relatively efficient line. As the line is already highly efficient and competitive, firms have a strong incentive to adopt new technologies in order to gain competitive advantage over their rivals. The results indicate that the foreign banks have shown significantly greater progress in technology than domestic banks due to the fact that foreign banks have lower efficiency and have a greater incentive to use new technology to improve on their poor efficiency. Overall, the results indicate great growth in productivity over the period from 2002 to 2004

and that the Taiwan banking industry has shown ceaseless growth over the period of 2002-2004 in terms of THCCH. We find that the foreign banks have shown more significant growth than the domestic ones in terms of technical progress; the foreign banks' technology and service skills often surpass those of the domestic banks. Thus, the customers believe the foreign banks to be better than the domestic banks in Taiwan. However, this superiority rests only in the area of technology; this is not totally reflective of the banks' performance.

Table 5. Results of the total factor productivity change

	Model A			Model B		
	Catch-up	Frontier shift	Malmquist index	Catch-up	Frontier shift	Malmquist index
All banks						
2002-2003	0.9032	1.1556	1.0453	1.0289	1.6263	1.628
2003-2004	1.0222	1.0423	1.0404	1.0223	1.0189	1.0413
2002-2004	0.9132	1.1754	1.0712	1.0426	1.6648	1.7174
Domestic banks						
2002-2003	0.7947	1.6732	1.3164	0.8399	1.6401	1.3631
2003-2004	1.1549	0.9708	1.1069	1.0981	1.0149	1.1109
2002-2004	0.9148	1.1002	1.0074	0.9144	1.6597	1.5112
Foreign banks						
2002-2003	1.284	0.7617	0.9992	1.2937	1.607	1.999
2003-2004	0.7957	3.4591	2.702	0.9162	1.0246	0.9439
2002-2004	0.9133	1.1754	1.0712	1.2222	1.6236	2.0061

Note: The catch-up indicates the bank efficiency change, EFFCH, Frontier-shift indicates the technology change, THCCH, and the Malmquist index indicates the total factor productivity index.

2.4. Regression analysis of determinants on bank efficiency. In this section, we used regression analysis to determine whether the bank efficiency derived from the pooled sample is related to the firm-specific factors. The F test, LM test, and Hausman test indicated that the fixed-effect model is more appropriate for Model A but that the random effect model is more appropriate for Model B. To save space, we chose not to list the OLS results in Table 6. As can be seen in Table 6, the coefficient of SIZE is significantly negative, which is consistent with Kwan (2006) and inconsistent with Hauner (2005). Previous empirical results on the effect of size on bank efficiency are mixed. Thus, we suggest that asset size, a reflection of banks' blind merger activities, causes the firms to diverge from the best-practice frontier and managers to be unable to effectively utilize their resources¹. The coefficient of MANAGE is significantly negative. The result is consistent with general economic sense, as a lower operating expense to operating income ratio implies

that the bank is able to control its operating expense to increase efficiency. The coefficient of SPEC is not significant, indicating that the bank's increased specialisation does not yield more efficiency; the result is in conflict with Mukherjee et al. (2001), Ray and Mukherjee (1996), and Ferrier et al. (1993). The result shows a predicament faced by those operating in the banking industry in Taiwan: they have neither core competitiveness nor advantages in terms of diversification or specialization.

The coefficient of INTIN is significantly positive. This indicates that the loan businesses still play a very important role in the bank activities and that fee income is not an important factor for banks' efficiency, as shown by the coefficient of FEEIN being insignificant. The coefficient of INVEST is significantly positive in Model B, which shows the contrast between the results of Models A and B. This result is consistent with Ataullah and Le (2006); banks dispersed operating funds to investments in lower-risk financial assets during this period, which enabled them to generate more earning assets, which showed a negative impact on the income-based model. Ataullah and Le (2006) suggest that the condition might be due to the fact that an increase in investment shifted banks' resources away from higher-earning, albeit riskier, loans and advances.

The coefficient of BRANCH is not significant; expanding their branch networks cannot raise the efficiency of banks, implying that the government's policy of prohibiting new branches to encourage bank mergers may not be effective in generating greater efficiency. The coefficient of SHARE is significantly positive; empirical evidence again shows that the loan business plays a significant role within the banks' business. The coefficient of EQUIT has conflicting results. The coefficient EQUIT is positively associated with efficiency as expected, but the estimated result shows that the relationship is negative but insignificant. This result might be due to the government requiring that banks improve their capital structure by a deadline, and the banks' need to sacrifice something to achieve the target capital ratio². Mukherjee et al. (2001) provide another explanation: when banks have higher equity and other things constant, there will be lower bank profitability, and they discover a negative relationship between productivity growth and the equity-to-asset ratio. Yao et al. (2007) point out that banks with a high equity-to-asset ratio are less efficient because they are better capitalized, less risk-taking, and hence subject to a softer budget constraint.

¹ Most studies show a positive relationship between size and efficiency, e.g., Mukherjee et al. (2001), Ataullah and Le (2006), some show a negative relationship, e.g., Liao (2008), and still others show no relationship, e.g., Sathye (2001), Peng and Wang (2004), Havrylychuk (2006).

² Based on Basel II, the government required that banks improve the capital structure within two years, that the non-performance loans ratio decline below 5%, and that the capital adequacy ratio rise to 8%, the so-called "258" acts for this financial reform policy.

The coefficient of CONC has a significant negative relationship with efficiency; an increase in the market concentration will reduce bank efficiency; this result is consistent with that found by Sathye (2001) in a study on Australia. Overall, we find that size and concentration have a significant negative relationship with efficiency, that the market share of traditional loan business has a significant positive relationship with efficiency, but that the number of branches has only a slight significant positive relationship with efficiency. This evidence supports the “quiet life” hypothesis as a factor in Taiwan’s banking industry. This hypothesis predicts a reverse causation; that is, when a firm enjoys greater market power and concentration, inefficiency follows, not because of non-competitive pricing, but more so because of a relaxed environment with no incentives to minimize cost (Sathye, 2001). We also recognized that merger activity may raise bank efficiency, but that this is not the only way to do so.

We suggest three ways to enhance bank competitiveness. First, banks are in need of product diversification; most scholars suggest increasing the scale of firms by merger, but in practice, a lack of economics of scope is the main problem in the banking industry in Taiwan. Second, we suggest training employees and enhancing their professional service skills and knowledge; a partial source of the foreign banks’ competitive advantage is their human capital. Third, the government has a responsibility to cultivate an ideal market environment; although the government began to follow the trend for bank deregulation in 1991, this is still an imperfect market, as bureaucratic power still plays an important role (Li et al., 2004). In particular, the government began to aid serial government-orchestrated bank consolidation in 2000; how do merger activities affect bank competitiveness? We do not have direct evidence to reject it or enough long-run data to test it, but our empirical evidence strongly shows that high market concentration reduces bank efficiency¹.

Table 6. Results of determinant on bank efficiency

	Model A			Model B		
	FM	RM	Tobit	FM	RM	Tobit
Constant		2.0092 (4.4844)***	13.444 (3.8235)***		0.3049 (0.4376)	-1.9308 (-0.5615)
SIZE	-0.1215 (-2.279)**	-0.0834 (-3.279)***	-0.5129 (-2.614)***	-0.0409 (-0.5726)	-0.0049 (-0.1287)	0.159 (0.8334)
MANAGE	-0.2384 (-2.2192)**	-0.3528 (-4.2396)***	-3.2184 (-4.6309)***	0.1183 (0.9158)	0.0798 (0.761)	0.491 (0.746)
SPEC	0.1321 (1.4238)	0.1131 (1.3372)	0.2204 (0.2758)	0.0789 (1.0276)	0.0395 (0.5642)	-0.3184 (-0.5382)
INTIN	0.2383 (2.0048)**	1.2557 (2.8702)***	1.8144 (2.5263)**	0.2451 (1.7144)*	0.4747 (3.553)***	3.7007 (4.9724)***
FEEIN	-0.2267 (-0.8492)	0.3874 (2.4694)**	3.8053 (2.8047)***	-0.5385 (-1.704)*	-0.1408 (-0.6054)	-0.3874 (-0.2965)
INVEST	-0.423 (-2.3972)**	-0.1837 (-1.4297)	0.1408 (0.1487)	1.0641 (5.137)***	0.8827 (5.4514)***	4.3928 (4.46)***
SHARE	20.825 (1.7474)*	9.3297 (2.3693)**	49.792 (2.1272)**	28.7381 (2.0223)**	13.063 (2.4478)**	71.945 (3.1312)***
BRANCH	-0.0697 (-0.5921)	0.0715 (2.3247)**	0.3317 (2.3364)***	-0.0892 (-0.652)	-0.401 (-1.3547)	-0.3786 (-2.6542)***
EQUIT	-0.2045 (-1.2107)	-0.1549 (-1.7334)*	0.8988 (0.5073)	-0.5425 (-0.6871)	0.9045 (2.6613)***	7.5035 (4.1714)***
CONC	-153.777 (-1.4617)	-97.4355 (-2.2956)**	-539.51 (-2.1929)**	-155.412 (-1.2332)	-97.8453 (-1.7283)*	-556.17 (-2.3116)**
R^2	0.8063	0.2741		0.8728	0.4192	
Goodness of fits test	F=4.525	LM=24.313	Wald=24.604	F=6.1692	LM=48.2242	Wald=14.29

Notes: * $\alpha = 0.1$ significant at the 10% level, ** $\alpha = 0.05$ significant at the 5 % level, *** $\alpha = 0.01$ significant at the 1% level.

Conclusions

The objective of this study is to explore three interesting problems. First, is the banking industry in Taiwan oversized or undersized? Second, why do customers often think that foreign banks are better than domestic banks? Finally, what are the determinants of efficiency in the banking industry? This study employs DEA method to estimate the efficiency of domestic and foreign banks and the dynamics of efficiency

change in Taiwan. We describe below the results of these three problems in sequence.

First, is the banking industry in Taiwan oversized or undersized? We find the same result, that the mean PTE (0.8778, 0.804) is slightly lower than the mean

¹ The Tobit regression estimated result also presented in Table 6, observed the results almost consistent with Panel data models. This shows our results have “robustness”.

SE (0.9029, 0.9062). The banks' inefficiency may mainly be attributed to the under-utilization of input or the incorrect selection of input combinations, and not to inadequate operating scales or returns to scale. On the other hand, we do find that domestic banks' returns to scale are decreasing, so the Taiwanese banking industry is oversized.

Why do customers often think that foreign banks are better than domestic banks? We find that domestic banks are more efficient than foreign banks, but that foreign banks have some advantage their over domestic counterparts in terms of technical progress due to their need to catch up to domestic banks and improve their poor efficiency. The results do not support the global advantage hypothesis. This finding implies that even though the foreign banks are competitive in advanced fee-based business and superior in financial engineering technology, information technology and specialization in developing countries, they still do not have a competitive advantage over domestic banks in the host country. Thus, our results support the home field advantage hypothesis.

What are the determinants of efficiency in the banking industry? We find that size and concentration have significant negative relationships with efficiency, implying that neither merger activity nor increased size would improve banks' efficiency. Shen (2005) has suggested that the banks' optimal fixed asset size is around NT\$10 billion in the banking industry in

Taiwan. The market share of the traditional loan business has a significant positive relationship with efficiency, but the number of branches only has a slightly significant positive relationship with efficiency; this evidence supports the "quiet life" hypothesis as a factor in Taiwan's banking industry. We have some suggestions for managers and regulators. The domestic banks need to diversify their product offerings; the lack of economic scope in the banking industry is a serious problem. The government has a responsibility to cultivate an ideal market environment, but although the government began to follow the trend for bank deregulation in 1991, the market structure is still that of an imperfect market, as bureaucratic power still plays an important role. This makes some managers not conscientious about the main business; they use their bureaucratic power and networks to pillage public profit and lead to stockholder losses. Li et al. (2004) have found that Taiwan's banking markets are not perfect, in that bureaucratic power still plays an important role in improving efficiency. Thus, the government needs to improve the imperfect competitive market and to avoid inappropriate interventions into market operations.

Acknowledgements

I thank the suggestions made by Dr. Fung-Shyung Shiau, which have helped improve the paper. I am responsible for all remaining errors.

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