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DO MERGERS IMPROVE THE EFFICIENCY OF BANKS IN TAIWAN? EVIDENCE FROM STOCHASTIC FRONTIER APPROACH

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ABSTRACT

Banking consolidation is a global trend, but in Taiwan, after the failure of the Second Financial Reform, it does not have a clear policy for bank mergers. This paper investigates whether mergers influence the cost efficiency of banks in Taiwan, and our results suggest that the government should utilize market mechanism to encourage FHC or large banks' mergers. We use the method of stochastic frontier approach (SFA) to investigate the uncertain relationship between merger and the cost efficiency of Taiwanese banks. Based on Battese and Coelli (1995), we use maximum likelihood estimation method to estimate the stochastic cost efficiency model and the inefficient model simultaneously. We find that, for Taiwanese banks, technology efficiency increases with time by lowering operation cost; cost efficiency decreases right after merger, and has to wait for three years to regain efficiency. The larger banks and FHC banks benefit more from cost savings than smaller banks.

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INTRODUCTION

The Banking system in Taiwan, which was under a strict control by the government, has gradually adopted liberalization of interest rates, and relaxation of control on exchange rates. In 1989, new banking laws liberalized bank interest rates, and permitted establishment of privately owned banks. Since then, financial reform has accelerated and the financial sector has undergone tremendous changes. During 1991 and 1992, 16 new banks were established; parts of the trust and investment companies and credit cooperatives reorganized into commercial banks, and removed the long-term monopoly held by national banks.

However, as the number of banks in Taiwan increases, banking profits decline and asset quality gradually deteriorates. According to Table 1, return on equity (ROE) dropped from 20.79% in 1990 to -6.93% in 2002, and the decline continued to 4.49% in 2009; the return on assets (ROA) dropped from 0.90% in 2002, -0.48% in 2002, and to 0.28% in 2009. Non-performing loan (NPL) ratio increased from 2.88% at the end of 1995 to 7.48% in 2001 though later fell to 1.15% in 2009. The concentration ratio (CR5) for the five largest banks' assets was 37.6% in 2000 and 41.0% in 2009, indicating that

the Taiwanese banking system was a collection of small-scale operations without any leading banks.

In order to solve the difficult operating environment problems faced by financial institutions, the government passed 'The Financial Institutions Merger Act' in 2000 and 'Financial Holding Company Act' in 2001. In 2002, the government implemented financial market reformation policies that required financial institutions to cut NPL ratio to less than 5% within two years, and increased capital adequacy ratio (BIS ratio) to more than 8%. In 2004, the President announced another reformation policy, the so-called "Second Financial Reform", to encourage the formation of three large-scale financial institutions with 10% market share. By 2005, the government should reduce 12 government-sponsored financial institutions into half. By the end of 2006, 14 financial holding companies should also consolidate themselves into half and at least one financial institution should be under foreign control or should go public overseas. The Second Financial Reform eventually failed and the Financial Supervisory Commission promulgated the 'Financial Markets Package Project' in 2007 as a measure to step down the previous quantity-limit goals.

TABLE 1. OVERVIEW OF TAIWANESE BANKS

Unit: Number ,%, 100 Million

Year	Banks	Branches	ROA	ROE	NPL	BIS	CR5	Assets	Average Assets of Each Bank
1990	24	996	0.90	20.97	-	-	46.8	70,172	2,923
1995	34	1,361	0.31	4.58	2.88	10.34	46.7	124,898	3,673
1996	42	1,936	-0.03	-0.41	3.74	10.11	43.1	144,127	3,432
1997	47	2,176	0.14	2.22	3.74	10.57	41.9	155,028	3,298
1998	48	2,404	0.59	7.99	4.37	10.83	39.2	175,479	3,656
1999	52	2,576	0.49	5.87	4.88	11.17	38.2	192,601	3,704
2000	53	2,693	0.38	4.90	5.34	10.75	37.6	207,751	3,920
2001	53	3,005	0.27	3.60	7.48	10.40	37.6	217,408	4,102
2002	52	3,068	-0.48	-6.93	6.12	10.63	37.9	220,971	4,249
2003	50	3,173	0.22	3.52	4.33	10.07	37.5	237,408	4,748
2004	49	3,189	0.63	10.30	2.78	10.67	48.9	255,053	5,205
2005	45	3,239	0.30	4.81	2.24	10.34	47.7	268,753	5,972
2006	42	3,285	-0.03	-0.43	2.13	10.11	37.7	275,419	6,558
2007	39	3,313	0.14	2.21	1.84	10.81	40.0	278,231	7,134
2008	37	3,264	0.16	2.47	1.54	11.08	41.8	288,692	7,802
2009	37	3,279	0.28	4.49	1.15	11.86	41.0	307,249	8,304

Source: Bank Statement, Banking Bureau, Financial Supervisory Commission.

Banking in Taiwan, however, faces the problem of providing uniform service with little differentiation in available products. There is a lack of innovation in new service development and in creating novel business strategies. Furthermore, a low concentration ratio for banking industry makes price cutting to be the major tool for competition. As a result, banks in Taiwan compete for business in a vicious circle and result in large falls in profit. Bank mergers may be one possible solution to ameliorate

these problems. The key question then, is whether re-organization can effectively increase bank's operational efficiency.

Whether the re-organization of banking structure can actually improve operational efficiency is a major public issue for Taiwan's financial development. There are few studies focusing on banking efficiency. In this paper, we provide a more detailed study on the cost effects in Taiwanese bank mergers and its results are valuable for policy implications. Driven by a trend of increasing globalization, deregulation and technological advances, banks around the world are under competitive pressure to become larger and more diversified. As a result, bank merger can be a viable way to meet such a trend. This paper provides a comprehensive study on the effects of Taiwanese bank mergers and evaluates the merits of such consolidation. The main contribution lies in discovering the time spell it would take for a bank merger to show tangible benefits, showing differences in operational efficiency between merger and non-merger banks, how environment variables affecting merger efficiency, and whether merger bringing economies of scale and scope. Based upon these results, we recommend favorably a financial policy that Taiwanese government should utilize market mechanism to encourage FHC or large banks' merger activities to enhance the banking industry's competiveness. A competitive banking industry helps an economy to be more service-oriented and Taiwan needs such banking conversion to break its bottleneck in growth, which has been bothered this island economy for quite a long time.

The remainder of this paper follows the layout; Section 2, review of the relevant literature, Section 3, discussion of the methodology and data used in the study, Section 4, results and discussion. The paper concludes with Section 5, summary analysis of findings.

REVIEW OF THE LITERATURE

Over the past 20 years, increased competition and regulatory changes have fostered a wave of consolidations through mergers and acquisitions in the banking industry. These changes are a concerned issue among the banking sector, government sector and academic sector, yet there is no firm conclusion on whether bank mergers and acquisitions can increase operational efficiency. Rhoades (1994), Houston and Rynagaert (1994), Peristiani (1997), Berger et al. (1999) and Sanjeev (2006) pointed out that mergers and acquisitions did not necessarily increase the efficiency. Berger et al. (1999), Amel et al. (2004), DeLong and DeYoung (2007) mentioned that mergers and acquisitions operations within the US banking industry had not had a positive effect on performance. Rezitis (2008) also found that the effects of mergers and acquisitions on technical efficiency and total factor productivity growth for Greek banks are rather negative. In particular, the technical efficiency of merger banks decreased in the period after merging, while that of non-merger banks increased over the same period. However, Ashton and Pham (2007) found efficiency improvements on average, but little evidence that reductions in retail deposit rates generated cost savings. DeYoung, Evanoff and Molyneux (2009) in an extensive review of the literature on mergers and acquisitions of financial institutions, concluded that North American bank mergers were efficiency improving, although stockholder wealth effects remained inconclusive. In contrast, a

clear consensus emerged from studies of European bank deals, which appeared to have resulted in both efficiency gains and enhanced stockholder value.

Considering whether relatively large banks have higher operational efficiencies, Miller and Noulas (1996) pointed out that larger banks with larger scale, or higher profit could bring advantages in operational efficiency. Larger banks are more likely to operate under decreasing returns to scale. In addition, market power does not significantly affect efficiency. Bos and Kolari (2005) suggested that both large European and U.S. banks similarly exhibited increasing returns to scale and decreasing (increasing) scope economies for the cost (profit) model. The empirical results of Altunbas, Goddard, and Molyneux (1999) found that the rate of reductions in costs due to technical changes increased, and that large banks benefited more than small banks.

However, Koetter (2005) found that only about half of German bank mergers during the 1990's were successful in improving cost efficiency, and that these cost efficiency gains took up to seven years to materialize fully. Cornett et al. (2006) agreed that the merged bank could increase operational performance mainly due to increases in revenue and scaled decrease in costs.

An empirical analysis of merging German banks from 1995 to 2000, conducted by Behr and Heid (2008), showed that the cost efficiency increased. According to a study of American community banks in the period 1990 to 2006 by Jagtiani (2008), banks conducting acquisitions were more efficient than the acquired banks and mergers might strengthen both profit and efficiency. Behr and Heid (2008) found evidence of cost (but not profit) efficiency improvements in German bank mergers between 1995 and 2000. Beccalli and Frantz (2009) found there were cost efficiency gains but there was no improvement in ROE or profit efficiency.

Berger et al. (1997) analyzed bank efficiency from a profit point of view, Akhavein et al. (1997); Berger (1998); Avkiran (1999) who conducted similar studies, believed that the profit perspective reflected the underlying X efficiency. Avkiran (1999) used a profit function to analyze Australian commercial banks mergers in the period 1986-1995; empirical results showed that the X efficiency of banks conducting the merger was higher than those merged or acquired.

Focarelli et al. (2002) found that banks sought mergers for improving income from services, though higher staff costs could offset increases in income, their returns on equity improved because of a decrease use in capital. Acquisitions aimed to restructure the loan portfolio of the acquired bank and improved lending policies resulted in higher profits. Park and Weber (2006) pointed out that bank mergers and acquisitions did not provide adequate criteria for increasing profit, which meant that it was not necessarily possible to increase profits if the merged group had an unstable foundation and was financially unhealthy. In the long term, however, the economy of scale from bank mergers and acquisitions would generally increase profit.

Knapp et al. (2006) found that bank holding company (BHC) mergers generated substantial profit gains up to five years post-merger, after adjusting annual BHC profits to the average industry trend (otherwise known as profits mean reversion). Else, Berger and Dick (2007) found that large BHCs that entered new local markets were better able to maintain the target banks' market share if they were an early entrant into that market and/or had a recognized brand image.

Studies on the M&A of Taiwanese banking are very limited, in comparison with similar studies of the same issue in Europe and America. Lin (2002a) found that banks engaging in mergers tended to improve cost efficiency. In another study, Lin (2002b) found that bank mergers improved significantly in technical and allocative efficiency, but not in cost efficiency. Lin (2005) also used a two-stage method to evaluate the efficiency effects of bank mergers. The acquiring bank generally improved its cost efficiency, if it merged a bank with a different cultural background. On the other hand, if the acquiring bank merged a homogeneous bank, its cost efficiency would not substantially improve due to lack of financial innovation.

Our study is different from Lin (2002b, 2005) in methodology. Based on Battese and Coelli (1995), we use maximum likelihood estimation method to estimate the stochastic cost efficiency model and the inefficient model simultaneously. Our study period spans from 1997 to 2008, during which Taiwan experienced the first and second financial reformations after the Asian financial crisis. We investigate the changes in cost efficiency of acquiring and acquired banks before and after M&A, and show that bank costs decrease as time passes by after M&A. Merger increases the total cost of the acquiring bank. However, some acquired banks have already entered the phase of cost reduction before the acquisition.

METHODOLOGY

This study evaluates the operational efficiency of banks using the Stochastic Frontier Approach (SFA). In the past, investigations used a deterministic frontier model to evaluate technical inefficiency (Schmidt, 1976). However, Aigner et al. (1977) and Meeusen and Broeck (1977), suggested using an SFA approach, considering not just the Decision Making Unit (DMU) but also unpredictable and non-technical factors, which affected production processes that the DMU could not totally control. Such factors affect output level directly or indirectly, for example, such as conditions of climate, operation of machines, and availability of factors of production. Therefore, the evaluation of an error term is composed of two elements. One represents cost inefficiency, which is usually assumed to be distributed as a truncated, or half-normal distribution, and the other follows a symmetric normal distribution. The former error term is non-negative by construction and reflects cost inefficiency.

Other researchers later estimated stochastic frontier production functions and other external factors affecting technical inefficiencies of banks. Pitt and Lee (1981) and Kalirajan (1990) used a two-stage estimation method to conduct analyses. A two-stage procedure first estimates a stochastic frontier model assuming that inefficiency is independently and identically distributed (iid), then estimates the association of the inefficiency term with firm characteristics and other factors. Therefore, the assumptions of the variables of technical inefficiency in a two-stage estimation method are inconsistent. As a result, the two-step procedure may suffer from estimation biases; Monte Carlo experiments show such biases are substantial (Wang and Schmidt, 2002).

To ameliorate the errors in two-stage approach, researchers make an adjustment by using a one-step method and estimating the stochastic frontier and technical inefficiency models simultaneously (Huang and Liu, 1994; Battese and Coelli, 1995). Such a method has numerous applications in studying the determinants of technical

efficiency at the aggregate level. Consequently, this study adopts the one-stage approach put forward by Battese and Coelli (1995), in which the stochastic frontier model includes a cost frontier and an equation specifying inefficiencies as a function of selected explanatory variables.

Model Specification

This study follows the Battese and Coelli (1995) model to estimate all factors that affect efficiency and cost boundary function of DMU simultaneously. Such a model allows us to cater for multiple inputs and outputs, recognizing joint costs in multi-product outputs. In particular, we specify the following translog multiproduct cost function, with three input prices and three outputs:

$$\ln TC_{it} = \alpha_0 + \sum_{n=1}^{3}\alpha_n \ln Y_{n,it} + \sum_{m=1}^{3}\beta_m P_{m,it} + \frac{1}{2}\sum_{n=1}^{3}\sum_{j=1}^{3}\delta_{nj} \ln Y_{n,it} \ln Y_{j,it} + \frac{1}{2}\sum_{m=1}^{3}\sum_{k=1}^{3}\gamma_{mk} \ln P_{m,it} \ln P_{k,it} + \sum_{n=1}^{3}\sum_{m=1}^{3}\rho_{nm} \ln Y_{n,it} \ln P_{m,it} + \psi t + \eta D1_{it} + \lambda D2_{it} + v_{it} + u_{it} \quad (1)$$

TC_{it} represents total cost of DMU Y_n is the n^{th} output (loans, investment and non-interest income respectively); P_m is the m^{th} input price (price of funding, labor and capital respectively). By adding merging variables, equation (1) shows the difference between the cost of an acquiring bank and of an acquired bank: $D1_{it}$ is the cost of an acquiring bank and $D2_{it}$ is the cost of an acquired bank;[1] t is time, i is banking firm ; $\alpha, \beta, \delta, \gamma, \rho, \psi, \eta, \lambda$ are the coefficients to be estimated ; v_{it} and u_{it} are random error terms, assumed individually and mutually independent. u_{it} is a function of firm-specific factors, which affect technical inefficiency. Specifically, u_{it} belongs to a truncated normal distribution, given by $u_{it} \sim N^{+}(\eta_{it}, \sigma_u^2)$, and $v_{it} \sim N(0, \sigma_v^2)$.

We also specify the following regression model to capture the main determinants of X-inefficiency in mergers for banks in Taiwan:

$$m_{it} = b_0 + b_1 B_{1it} + b_2 B_{2it} + b_3 B_{3it} + b_4 B_{4it} \quad (2)$$

Where, B_{1it} is the dummy variable corresponding to bank i before or after merger at time t, B_{2it} is the BIS ratio of bank i at t, B_{3it} is the NPL ratio of bank i at t, B_{4it} is the ROA of bank i at t, b is a vector of parameters to be estimated.

In estimation, the translog cost function should satisfy the regularity condition[2] that an input share is equal to the derivative of the log cost function with respect to the corresponding log input price (Varian, 1992; Allen and Rai, 1996). This study imposes the homogeneity restrictions by normalizing total costs and input prices by one of the input prices. In particular, we select labor price as the normalizing factor.

After normalizing process, we estimate equations (1) and (2) simultaneously by Frontier 4.1. We calculate the cost inefficiency of each bank by defining the cost inefficiency function as $CE_{it} = e^{u_{it}}$, and $1 < CE_{it} < \infty$, meaning that as *CE* increases, cost efficiency decreases.

Economies of Scale and Scope

We investigate whether banks possess economy of scale and economy of scope. We define the measure for economy of scale (SE) as:

$$SE = \frac{C^*(P,Y)}{\sum_{i=1}^{3} Y_i C_i^*(P,Y)} \tag{3}$$

If $SE > 1$ then a bank is facing decreasing returns to scale, implying it is at the stage of diseconomies of scale. If $SE = 1$ then a bank is operating at constant returns to scale. If $SE < 1$ then an opposition situation occurs for increasing returns to scale, implying the larger the size, the lower the cost for a bank to operate.

Economies of scope exist when the total cost of a firm producing more than one output jointly is lower than the sum of the costs for producing each output separately. In the case of a bank producing three outputs (Y_1, Y_2 and Y_3), as suggested by Mester (1996), the estimate for the degree of economy of scope (SC) is:

$$SC = \frac{C^*(Y_1,0,0,P) + C^*(0,Y_2,0,P) + C^*(0,0,Y_3,P) - C^*(Y_1,Y_2,Y_3,P)}{C^*(Y_1,Y_2,Y_3,P)} \tag{4}$$

An estimate of SC greater than, or less than zero indicates, respectively, scope economies or scope diseconomies.

Data and Definitions[3]

We collect our research data from the Taiwan Economic Journal and the Central Bank of R.O.C. (Taiwan) data banks; they form an unbalanced panel data with 49 banks in total covered the period from 1994 to 2008.[4] As there are many ways to define and categorize input and output variables, in this study we adopt an intermediation approach (Berger and Humphrey, 1991; Ellinger and Neff, 1993; Altunbas et al., 2000) to define the factor input and output of financial institutions.

For our research purpose, the input factors are labor, capital and funding, which are number of employees, net fixed assets and deposits plus borrowing respectively. Outputs, based on Lin (2005), Lang and Welzel (1999), Huang et al. (2009), are the common output items for banks: loans, total investment (including short- and long-term investment), and non-interest income (including transaction fee and other commercial income). Table 2 lists the definitions and summary statistics for these variables. They are in nominal terms and we use consumer price index[5] to convert them into real values.

To study the impact of bank's merger on cost efficiency, we assign dummy variables to each bank, depending on it being an acquiring bank or an acquired bank:

D1=1 for an acquiring bank, and D1=0 for others;

D2=1 for an acquired bank, and D2=0 for others.

TABLE 2. INPUT AND OUTPUT VARIABLES: DEFINITIONS AND DESCRIPTIONS

Unit: Thousand dollars, People, %

	Variable	Description	Mean	Std. Dev.
	Total Cost (TC)	Labor Cost + Capital Cost + Funding Cost	19,310,135	20,832,708
Input	Labor(X_1)	Total Employees	2,603	2,117
	Capital(X_2)	Net Fixed Assets	9,588,734	12,629,681
	Fund(X_3)	Deposits+ Borrowing	392,000,000	456,000,000
	Price of Labor(P_1)	Employee Salary÷Total Employees	1,006	293
	Price of Capital(P_2)	Operating Expense ÷ Net fixed Assets	0.389	0.321
	Price of Funds(P_3)	Interest Payments ÷ Deposits+ Borrowing	0.040	0.036
Output	Output(Y_1)	Loans	324,000,000	358,000,000
	Output (Y_2)	Investment	66,545,820	97,627,673
	Output (Y_3)	Non-Interest Income	1,836,949	2,552,965

To examine the effectiveness of a merger event, we add a merger dummy variable D3 which is set pre-merger = 0 and post-merger = 1. Merger influences the environment variables including BIS, NPL ratio (asset quality), and ROA (profitability) factors, which indicate the soundness of a bank's operation.

Some studies conclude that bank merger does not necessarily improve operational efficiency (Houston and Rynagaert, 1994; Berger et al., 1999; Sanjeev, 2006), and cast doubts whether merger lowers cost efficiency.

A lower BIS ratio implies a higher financial leverage for banks. It can improve bank funding efficiency, and increase profitability. However, according to Mester (1996) from a 'moral crisis' perspective, the lower the BIS ratio for banks, the higher the tendency for high-risk activities. An increase in BIS ratio, on the other hand, can reduce the number of 'moral crisis' cases, and encourage a more ethical system.

Responding to a higher NPL ratio, a bank in general will allocate undistributed earnings to make provisions for loan losses. This also implies that a bank with lower asset-quality will have a higher operational risk, as well as lower overall banking operation efficiency. Several studies indeed found that banks with higher NPL ratio would have lower operational efficiency (Berger and DeYoung, 1997; Berger and Mester, 1997; Drake and Hall, 2003).

We define ROA as bank's pre-tax profit divided by average total assets. It is clear that the better banks utilize their assets, the higher profits the banks earn. Altunbas

et al. (2000) showed that ROA and inefficiency value had inverse relationship. We also expect to find such a relation in our study.

EMPIRICAL RESULTS

We use the MLE method to estimate equations (1) and (2) simultaneously and apply equations (3) and (4) to study the issues of economies of scale and scope.

Cost function estimation

Table 3 shows the results of the estimated stochastic cost frontier function. We use the likelihood ratio test (LR test) to determine if the proposed inefficiency model is acceptable or not[6]. Our LR test statistic is 113.600 (greater $\chi^2_{0.01}$ (5)=15.086), which soundly rejects H_0 at the significance level of 1% and implies the suitability of the proposed inefficiency model.

As our study covers a period of 15 years and is possibly subject to changes in production technologies, it is necessary to take time (*t*) into consideration. The empirical results in Table 3 show that costs decrease as time increases. Acquiring bank (D1) is significantly positive with a significance level of 1% and implies that the costs of the acquiring bank increase with merger. The acquired bank (D2) is significantly negative at a significance level of 1%. This is probably because the troubled bank starts cutting off labor, and lowering cost before the occurrence of acquisition due to its financial problems in operation.

TABLE 3. PARAMETER ESTIMATES OF STOCHASTIC COST FRONTIER

Variable	Coefficient		SE	t-Value
Constant	-6.358	***	0.227	-27.963
lnY1	0.583	***	0.235	2.482
lnY2	-0.411	*	0.293	-1.400
lnY3	0.152		0.178	0.854
ln(P1/P2)	-2.361	***	0.231	-10.245
ln(P3/P2)	0.885	***	0.254	3.487
1/2QlnY1	0.082	***	0.016	5.183
1/2QlnY2	0.230	***	0.040	5.726
1/2QlnY3	0.047	***	0.012	4.071
1/2Qln(P1/P2)	-0.186	***	0.025	-7.479
1/2Qln(P3/P2)	-0.012		0.017	-0.676
lnY1*lnY2	-0.108	***	0.021	-5.246
lnY1*lnY3	0.004		0.009	0.422
lnY2*lnY3	-0.041	**	0.019	-2.122
ln(P1/P2)ln(P3/P2)	0.068	***	0.020	3.488
lnY1*ln(P1/P2)	-0.016		0.016	-1.029
lnY1*ln(P3/P2)	0.009		0.014	0.608
lnY2*ln(P1/P2)	0.136	***	0.022	6.147
lnY2*ln(P3/P2)	-0.074	***	0.025	-2.987
lnY3*ln(P1/P2)	-0.059	***	0.013	-4.705
lnY3*ln(P3/P2)	0.081	***	0.014	5.822
Time(t)	-0.011	***	0.003	-3.769
Acquiring Bank(D1)	0.036	**	0.019	1.835
Acquired Bank(D2)	-0.110	***	0.044	-2.499
Log Likelihood Function		282.707		

*Note:*** Denotes the statistical significance at 1% level, ** at 5% and * at 10 %.*

The Wald Test is applied[7] for testing the marginal effect of the bank's stochastic frontier cost function with respect to different output and input price factor. As expected, the first order coefficient for loan variable (Y1) , investment (Y2) and non-interest income (Y3) is significantly positive at the significance level of 1%. This fits monotonicity and expectation theory. As for funding price (P1), labor price (P2) and capital price (P3), the test results also show a significant positive effect at a 1% level. This is consistent with the cost function features as a non-decreasing function with factor prices.

Inefficiency model

Table 4 demonstrates our empirical results of the inefficiency model. As bank inefficiency increases after merger, its business performance decreases. Previous studies, however, show that post-merger efficiency improvements are not immediately evident (Diaz et al., 2004; Campa and Hernando, 2006).

TABLE 4. PARAMETER ESTIMATES OF THE INEFFICIENCY MODEL

Variable	Coefficients	SE	t-Value
Constant	0.070 ***	9.03E-03	7.743
M&A Factor	0.086 ***	2.32E-02	3.706
BIS	-0.004 ***	3.97E-04	-11.042
NPL	0.004 ***	1.11E-03	3.343
ROA	-0.015 ***	3.91E-03	-3.766

*Note:*** Denotes statistical significance at 1%.*

The significant effect of BIS ratio implies that under merger, an increase in capital adequacy ratio will decrease cost-inefficiency for Taiwanese banks. This result is consistent with the hypothesis raised by the moral hazard approach (Mester, 1996). Although the growth of large scale banks after merger can be fast but such growth may not necessarily be stable, and the management, therefore, should pay special attention to bank risks, and should strengthen its capital and reserves.

Resti(1997) indicated that bank efficiency and asset quality had a direct relationship. Our study indicates that the NPL ratio and cost-inefficiency have a positive relation; a deteriorated asset quality increases bank's total cost. The bank must bear large disposable costs due to bad loans. As for Taiwanese case, many mergers involve small-scale banks with poor business performance. Following government guidelines, government owned banks take over those poorly managed smaller banks, and result in more bad loans and higher cost-inefficiency.

ROA and cost-inefficiency are negatively related. This implies that when banks fully utilize their assets, the profitability of assets increases, and so is an improvement in banks' operational efficiency. If a bank can increase its profitability after merger, it also enhances operational efficiency.

Bank merger efficiency

Acquiring banks

We analyze changes in pre-merger and post-merger efficiency for acquiring banks (Table 5 and Figure 1). Our results show that the cost-inefficiency for most acquiring banks (out of 24 acquiring banks) increases compared to the year before merger. For the first year after merger comparing to merger year, the cost-inefficiency of 15 banks increases, while the cost-inefficiency of 9 other banks decreases. For the second year after merger, the cost-inefficiency of 12 banks increases. For the third year after merger, the cost-inefficiency of 9 banks increases.

These results not only demonstrate that merger cannot immediately increase the operational efficiency of acquiring banks, but also show that the decrease in operational efficiency due to the cost burden for integration. However, at the fourth and fifth year, the inefficiency value clearly decreases, and only two banks slightly increase their inefficiency.

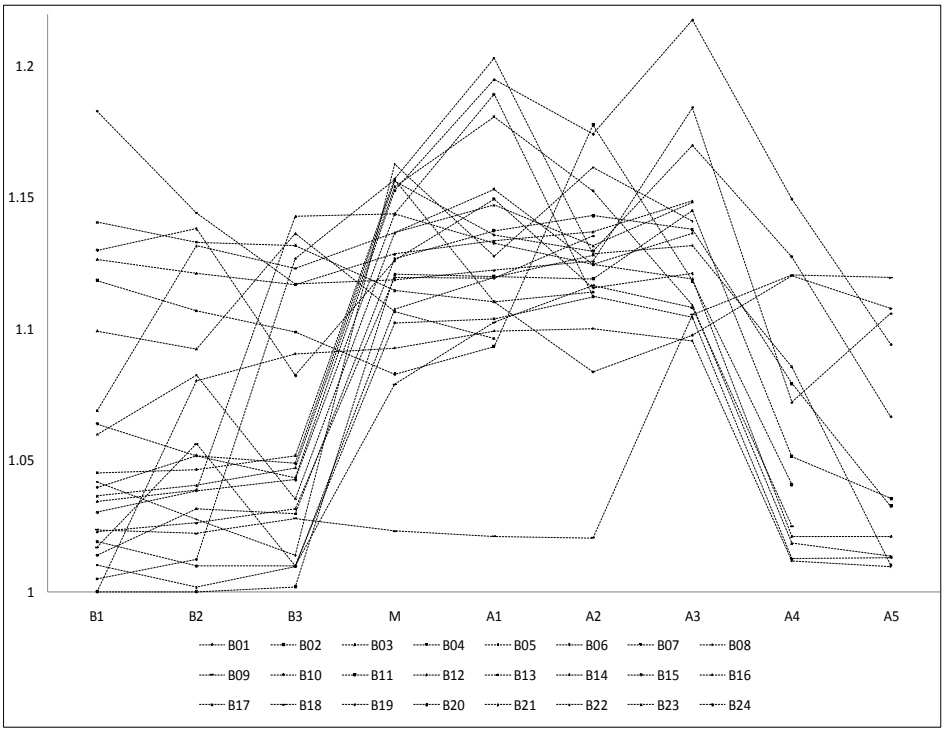
Figure 2 arranges the acquiring banks by asset sizes in descending order. Results show that at the fourth and fifth year, the inefficiency values for larger banks are smaller. Clearly, larger banks have advantages in increasing operational efficiency through merging smaller banks after a longer period.

TABLE 5. CHANGES IN PRE-MERGER AND POST-MERGER EFFICIENCY FOR ACQUIRING BANKS

Bank	The 3th Year Before Merger	The 2rd Year Before Merger	The 1st Year Before Merger	Merger Year	The 1st Year After Merger	The 2rd Year After Merger	The 3th Year After Merger	The 4th Year After Merger	The 5th Year After Merger
B01	1.023	1.026	1.032	1.120	1.119	1.135			
B02	1.014	1.032	1.030	1.127	1.137	1.143	1.138	1.079	1.033
B03	1.099	1.092	1.136	1.107	1.096				
B04	1.019	1.010	1.010	1.102	1.104	1.112			
B05	1.069	1.132	1.123	1.137	1.153	1.125	1.137		
B06	1.064	1.052	1.049	1.156	1.136	1.130	1.170	1.128	1.067
B07	1.084	1.098	1.120	1.108	1.109				
B08	1.042	1.028	1.014	1.163	1.128	1.161	1.141		
B09	1.023	1.021	1.020	1.105	1.121	1.120	1.106		
B10	1.040	1.052	1.043	1.153	1.195	1.174	1.218	1.150	1.094
B11	1.116	1.107	1.099	1.083	1.093	1.178	1.118	1.041	
B12	1.034	1.039	1.143	1.144	1.133	1.125	1.119	1.021	1.021
B13	1.141	1.133	1.132	1.115	1.110	1.114			
B14	1.045	1.047	1.052	1.157	1.203	1.129	1.132	1.086	1.010
B15	1.130	1.138	1.082	1.126	1.150	1.116	1.121		
B16	1.000	1.080	1.091	1.093	1.099	1.100	1.095	1.012	1.009
B17	1.010	1.002	1.010	1.107	1.120	1.128			
B18	1.017	1.056	1.010	1.079	1.103	1.117	1.108	1.025	
B19	1.183	1.144	1.117	1.119	1.122	1.126	1.184	1.072	1.106
B20	1.000	1.000	1.002	1.121	1.120	1.119	1.145	1.052	1.035
B21	1.127	1.121	1.117	1.129	1.134	1.137	1.149		
B22	1.060	1.082	1.035	1.137	1.147	1.132	1.148		
B23	1.036	1.040	1.047	1.154	1.181	1.153	1.109	1.018	1.013
B24	1.030	1.038	1.043	1.144	1.189	1.113	1.104	1.013	1.013

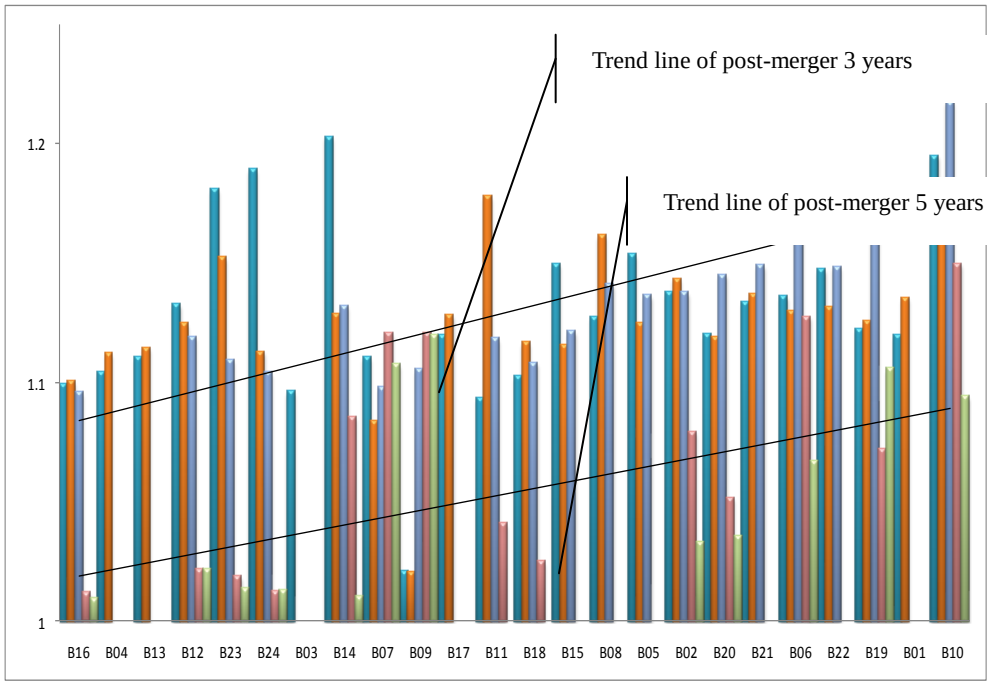
Note: The gray part shows the year of merger.

FIGURE 1. CHANGES IN EFFICIENCY FOR ACQUIRING BANKS



Note:B3:the 3th year before merger, B2:the 2rd year before merger, B1:the 1st year before merger, M:merger year, A1:the 1st year after merger, A2:the 2rd year after merger, A3:the 3th year after merger, A4:the 4th year after merger, A5:the 5th year after merger.

FIGURE 2. CHANGES IN EFFICIENCY FOR ACQUIRING BANKS, BY ASSET SIZE IN DESCENDING ORDER



Note: X axis represents assets from large to small bank, Y axis represents efficiency value

Acquired banks

Table 6 and Figure 3 show the changes of inefficiency values for 18 acquired banks. Most acquired banks exhibit an increasing trend in cost-inefficiency before acquisition. Some banks, however, exhibit a decreasing in cost-inefficiency, i.e., become more efficient before merger. For example, the efficiency values of C02, C05, C15, C16, and C18 reach one before mergers. Therefore, we can separate acquired banks into two groups. The banks in one group are performing poorly, while banks in the other are sound, but agree to be acquired to keep competitive.

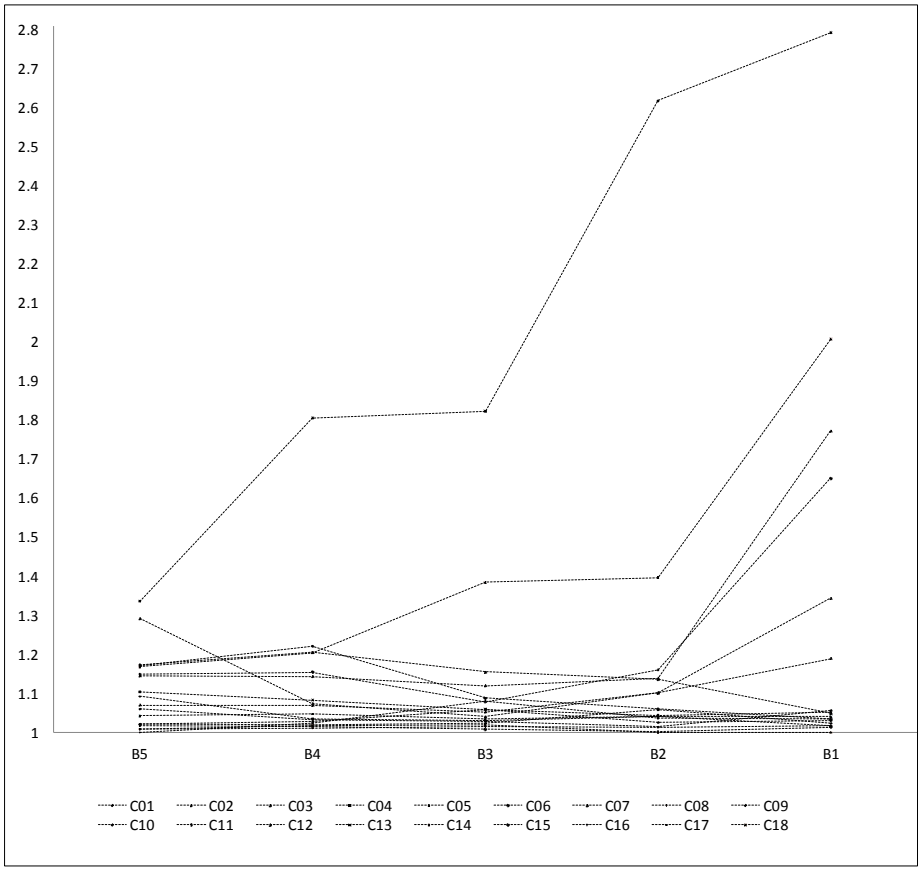
Table 6 shows the acquired banks that had previously acquired other banks. The operational efficiency for all banks has decreased, and especially C04 performs the worst. The only two exceptions are C02, operational efficiency increases after the first year, and C11, operational efficiency increases after the second year.

TABLE 6. CHANGES IN PRE-MERGER EFFICIENCY FOR ACQUIRED BANKS

Bank	The 5th Year Before Merger	The 4th Year Before Merger	The 3th Year Before Merger	The 2rd Year Before Merger	The 1st Year Before Merger
C01	1.021	1.027	1.059	1.026	1.030
C02	1.173	1.205	1.155	1.136	1.049
C03	1.069	1.069	1.052	1.101	1.189
C04	1.336	1.806	1.823	2.619	2.794
C05	1.043	1.047	1.034	1.041	1.040
C06	1.018	1.016	1.007	1.002	1.013
C07	1.292	1.074	1.040	1.101	1.344
C08	1.008	1.010	1.014	1.013	1.016
C09	1.021	1.020	1.023	1.058	1.023
C10	1.060	1.033	1.029	1.015	1.057
C11	1.149	1.154	1.078	1.160	1.651
C12	1.145	1.143	1.120	1.139	1.773
C13	1.104	1.083	1.059	1.044	1.051
C14	1.168	1.204	1.385	1.397	2.008
C15	1.171	1.221	1.088	1.059	1.034
C16	1.000	1.024	1.081	1.036	1.035
C17	1.093	1.035	1.031	1.040	1.016
C18	1.009	1.016	1.019	1.000	1.000

Note: The gray part shows the year of merger.

FIGURE 3. CHANGES IN EFFICIENCY FOR ACQUIRED BANKS



Note: B5:the 5th year before merger, B4:the 4th d year before merger, B3:the 3th year before merger, B2:the 2rd year before merger, B1:the 1st year before merger.

FHC and non-FHC

Table 7 shows that acquired banks have the highest average inefficiency value. The average efficiency value for non-merger banks is better than that of acquiring banks; although smaller banks do not have merger activities, they are still cost- efficient. The acquiring banks include Financial Holding Companies (FHC) and non-Financial Holding Companies (non-FHC). The merger efficiency value of FHC is better than that of non-FHC and this implies that merger produces more cost savings for financial conglomerates.

We also investigate changes in efficiency value after merger occurs. Table 8 shows that the inefficiency value for FHC decreased after the second year of merger, but the inefficiency value for non-FHC only decrease after the fourth year of merger. The integration speed and efficiency of FHC is better than that of non-FHC. However, non-

merger banks have the lowest inefficiency value. Obviously, the 7 medium- and small-scale banks focus on their own business strategies to keep their competitiveness[8].

TABLE 7. AVERAGE EFFICIENCY FOR MERGER AND NON-MERGER BANKS

Bank's Type		Average Efficiency
Acquiring Banks	FHC	1.059
	Non-FHC	1.084
Non-Merger Bank		1.034
Acquired Banks		1.099

TABLE 8. CHANGES IN PRE-MERGER AND POST-MERGER EFFICIENCY FOR FHC AND NON-FHC

Bank's Type	The 3th Year Before Merger	The 2rd Year Before Merger	The 1st Year Before Merger	Merger Year	The 1st Year After Merger	The 2rd Year After Merger	The 3th Year After Merger	The 4th Year After Merger	The 5th Year After Merger
FHC	1.053	1.065	1.064	1.118	1.133	1.126	1.120	1.046	1.022
Non-FHC	1.066	1.066	1.066	1.132	1.135	1.137	1.155	1.075	1.058

Economies of scale and scope economies

The average value measuring economies of scale for acquiring banks is 1.116, which implies they are at the stage of increasing returns to scale. However, the values of economies of scale for government owned or sponsored banks are close to one, which represents a constant return to scale. The average value of economies of scale for acquired banks is 1.176, which also indicates the increasing returns to scale. We notice that some small banks have very high values of economy of scale and become the target for acquisition. Lastly, the average value of economies of scale for non-merger banks is 1.161. In sum, except for government owned or sponsored banks and one non-merger bank, all banks in Taiwan are at the stage of economy of scale. It is therefore appropriate for Taiwanese banks to expand their sizes, and M&A is a good alternative under such a strategy.

To better understand the relationship between economies of scale and the size of bank assets, we set up equation (7) to depict such a relation with economy of scale as the dependent variable, and assets (x), and asset square as (x^2) as explanatory variables.

$$Y = a + bx + cx^2 + \varepsilon \qquad (7)$$

Table 9 shows the fitting results. Accordingly, we estimate the optimal asset size for constant returns to scale being around 1.69 trillion ($NT dollars). Such a size represents 7% of total bank assets; a bank with this size ranks the 7th out of total 36

banks in Taiwan. This also implies that there are 29 banks short of the optimal size yet. Interestingly, only one private bank, China Trust Bank, ranks in top seven, all other six banks are government owned or sponsored.

TABLE 9. REGRESSION RESULTS BETWEEN ECONOMIES OF SCALES AND ASSETS

	Non Standardized Coefficient		Standardized Coefficient	t-Value	Significant Level
	Coefficient Estimate	SE	Beta Distributions		
Constant	1.200	.005		236.867	.000
Assets	-1.895E-10	.000	-1.171	-12.170	.000
Asset Square	5.619E-20	.000	.765	7.950	.000

Table 10 shows the average value of economies of scope for acquiring banks is 5.166 (Non-FHC 5.045, FHC 5.372), while those for acquired banks and non-merger banks are 4.8695 and 5.0464 respectively. These results demonstrate that regardless the bank being an acquiring bank, acquired bank, or non-merger bank, the diversification of financial products always reduces costs. It is therefore beneficial for banks to expand into different lines of business among loan, investment and others that generate non-interest income.

TABLE 10. MEASURES OF ECONOMIES OF SCOPE

Bank's Type	Economies of Scope
Acquiring Banks	5.166
Non-FHC	5.045
FHC	5.372
Acquired Banks	4.870
Non-merger Banks	5.046

CONCLUSIONS

In this paper, we study the cost efficiency issues of bank mergers in Taiwan and our findings are as follows:

Bank costs decrease as time increases. Merger increases the total cost of the acquiring bank. Some acquired bank has already entered the phase of cost reduction before the acquisition. The estimated inefficiency model indicates that inefficiency increases significantly to lower the bank performance after merger. The inefficiency measures for most banks increase substantially after the first year of merger. Evidently, it takes time for the acquiring bank to integrate and improve performance. If an acquiring bank increases its BIS ratio and ROA, it can improve operational efficiency. On the other hand, if its NPL ratio increases, the bank would be less cost-efficient.

Observing the changes in efficiency value reveals that (1) out of the 24 acquiring banks, the cost-inefficiency for most acquiring banks increases after the first year of merger compared to the year before merger. This means that merger cannot immediately increase the operational efficiency of the acquiring bank. On the contrary, it decreases operational efficiency. (2) The cost-inefficiency for many acquired banks, with some

exceptions, was increasing before acquisition. This demonstrates that most acquired banks are troubled with prolonging problems in performance; however, some have good performance but agree the acquisition to remain competitive. (3)The post-merger efficiency of a FHC engaged in acquisition is better than that of a non-FHC. On average, the inefficiency of a FHC lasts two years after merger, but it takes four years for a non-FHC to regain efficiency.

The average value for all banks is at the stage of the increasing returns to scale. With high fixed factors of production, the long-term average cost decreases as production increases. This demonstrates that the banking cost structure in Taiwan encourages bank merging. This result is consistent with Huang and Wang (2001) and Huang et al. (2007). The economy of scale measure (SE) indicates that acquiring banks have relatively larger scales, and non-merger and acquired banks are smaller. However, the acquiring banks who are government owned or sponsored show constant returns to scale. Furthermore, our results indicate the average bank has economies of scope. Hence, banks in Taiwan should pursue multi-product strategy to lower their production costs.

From bank's perspective, when considering merger, the acquiring bank should carefully evaluate its own cost structure and the asset and equity quality of the target bank. Bank management should have a clear objective for merger, and plan in advance appropriate strategies to increase the profit-making capabilities after merger. These precautions would be necessary for a successful merger.

Our study shows that larger banks and FHC banks benefit more from cost savings than smaller banks. In fact, large banks tend to diversify by a large customer base or by offering a wide array of financial services and products. Large banks also have the most up to date technology and risk management techniques, and they usually provide customer convenience with more branches.

Therefore, from government's policy perspective, via merger over time, the larger banks and FHC banks benefit more from cost savings than smaller banks. This is probably due to their greater flexibility and efficiency in adopting new technologies. Because Taiwanese banking industry is low on CR5, and lack of leading banks, under the trend of globalization and rapidly developing closer economic cooperation relation with China, the government financial policy should consider utilizing market mechanism to encourage FHC or larger scale banks to enlarge their scales through mergers.

Our study provides a solid empirical support for Taiwanese government to pursue a bank merger policy. Such a policy can create lead banks to enhance the overall competitiveness of Taiwanese banking industry. With a competitive and sound banking industry, Taiwan may fully utilize its geographic and cultural advantage to expand its bank operation in mainland China, and gains eagerly needed new growth momentum.

ENDNOTES

[1] Because the financial report of an acquired bank consolidates into the acquiring bank, this dummy variable is defined up to the year before the merger.

[2] Since the duality theorem requires that the cost function must be linearly homogeneous in input prices, we impose the following restrictions on the parameters in equation (1):

homogeneity restrictions, $\sum_{j=1}^{m}\beta_j = 1$, $\sum_{j=1}^{m}\beta_{ij} = 0$, $\sum_{j=1}^{m}\gamma_{ij} = 0$, $i = 1,2,.....,m$.

Furthermore, the second order parameters of the cost function in equation (1) must be symmetric, that is,

$$\delta_{nj} = \delta_{jn}, \quad n, j = 1,2,3, \quad \gamma_{km} = \gamma_{mk}, \quad m,k = 1,2,3$$

According to Shephard's Lemma, an input share is equal to the derivative of the log cost function with respect to the corresponding log input price. Each input share should lie between zero and unity, and input shares sum to 1. Cost shares are defined as follows:

$$S_i = \frac{\partial \ln TC}{\partial \ln P_m} = \beta_i + \sum_{j=1}^{3} \gamma_{ij} \ln P_j + \sum_{n=1}^{3} \rho_{ij} \ln Y_n + \eta_i, \quad m = 1,2,3.$$

[3] We do not distinguish merger and acquisition, because Taiwanese banks mainly involve in merger, and acquisition only has a transition role, which is different from the case discussed by Focarelli et al. (2002).

[4] The data retention period for Standard Chartered Bank, Citibank Taiwan, Taipei Bank is only 2 years, and they are not included in our sample.

[5] The consumer price index is from the DGBAS, Executive Yuan with year 2000 as the base year.

[6] To test whether the inefficiency model should be added to the stochastic frontier cost function, the likelihood ratio (LR) test is used in the following way:

Null hypotheses H_0 : Inefficiency model does not exist;

Alternative hypothesis H_1 : Inefficiency model exists

$$LR = -2\ \ln\left[L\ H_0\right] - \ln\left[L\ H_1\right]$$

where $\ln\left[L\ H_0\right]$ is the translog cost function that does not include the inefficiency model, and $\ln\left[L\ H_1\right]$ is the translog cost function that includes the inefficiency model.

[7] Wald tests whether output is consistent with monotonicity, and examines if the cost function is non-decreasing with respect to input prices :

A. Output consistency with monotonicity

Null hypotheses $H_0 : \frac{\partial TC}{\partial Y_n} = 0$, Alternative hypothesis $H_1 : \frac{\partial TC}{\partial Y_n} > 0$, $n = 1, 2$

B. Non-decreasing in input prices:

Null hypotheses $H_0 : \frac{\partial TC}{\partial P_m} = 0$, Alternative hypothesis $H_1 : \frac{\partial TC}{\partial P_m} > 0$, $m = 1, 2, 3$

[8] Without surprise, the acquired bank has the lowest operation efficiency.

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