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Application of DEA in analyzing a bank's operating performance

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ABSTRACT

This article takes 117 branches of a certain bank in Taiwan in 2006 as the research subject and introduces data envelopment analysis (DEA) to evaluate the operating performances of business units of this bank to provide the reference for a bank's managers in determining operation strategies. The result indicates that, in overall technical efficiency, the case bank has many inefficient branches distinctly; the average overall technical efficiency of branches is 54.8% and the average pure technical efficiency of branches is 67%, which is probably because of lower loan-to-deposit ratio, leading to excessive input waste. The average scale efficiency of the case bank during the sample period is 82%. The ratio of resource waste due to technical inefficiency is 45.2%, of which 55.03% is due to pure technical inefficiency.

1. Introduction

According to the statistics of Financial Supervisory Commission, by the end of June of 2007 after the second governmental financial reform on November of 2004, the number of government-owned banks was reduced from 12 to 8 and total assets slipped from NT$14473 billion to NT$12534.1 billion (market share shrank from 54.05% to 41.52%) although total loans slightly rose from NT$8491.4 billion to NT$8821.5 billion (market share declined from 55.89% to 49.71%), indicating that government-owned bank sector was under weakening. Besides, the number of banks under financial holding companies increased from 9 to 10 and total assets spiked from NT$5495.8 billion to NT$7814.5 billion (market share rocketed from 20.53% to 25.88%) as total loans grew from NT$3132.4 billion to NT$4438.9 billion (market share ramped from 20.62% to 25.01%), indicating the trend of domestic financial sector developed towards large financial holding corporations. As the traditional business comes to the plateau, to maintain growth momentum, besides urging business units to surpass the targets of business operation such as deposit, loan, foreign exchange, it is a greater challenge for bank management to utilize the well-developed cross-selling strategy to provide clients with more diversified financial commodities and more flexible financial planning strategies and instruments to satisfy the clients' need of one purchase, so as to meet the corporate operation objectives of clients, staff, and shareholders. Wu, Yang, and Liang (2006) indicated that in today's economy and society, everyone depends on the efficiency and quality of services that the banking industry provides. With the improvement in technology, the competition in the banking industry has become increasingly intense. Therefore, the performance analysis in the banking industry attracts more and more attention.

Most of current domestic banks adopt branches' bank systems; thus, the quality of a branch's operating performance governs the operating performance of the whole bank. As the banking industry often adopts the multiple inputs and outputs profit organization, a proper and objective weight is very important in determining the efficiency of multiple inputs and outputs. The biggest function of data envelopment analysis (DEA) is to evaluate the operating performance of a group of decision making units (DMUs) and the interaction performance efficiency. The DEA can process multiple inputs and outputs simultaneously; the efficiency frontier so obtained is the combination line of most favorite conditions of evaluated units. Hence, taking this line as the target of other units can not only compare each other but also make units willing to accept the analysis result. Furthermore, the DEA can evaluate the "performance" of each unit under evaluation in various stages and find whether this unit advances or stagnates from the processes of various stages.

Aly, Grabowski, Pasurka, and Rangan (1990) used the Charnes–Cooper–Rhodes (CCR) model to evaluate the technical efficiency, scale efficiency, and allocative efficiency of 322 independent USA banks in 1986. The number of full-time staff, fixed asset, capital and loanable fund were chosen as input variables; real estate loan, commercial and industrial loan, consumer loan, miscellaneous loan, and current deposit were output variables. It is found that 35% of cost inefficiency was attributed to technical inefficiency, that is, input waste or use insufficiency was greater than input combination incorrectness and technical inefficiency was due to

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pure technical efficiency slump but not scale inefficiency; a bank's scale in terms of total deposit or number of branches had a positive impact on pure technical efficiency.

Siems (1992) pointed out that a bank's success depended on management quality. Hence, a bank's efficiency evaluation shall start from evaluating management quality. Input variables included the number of full-time staff, salary expense, fixed asset, interest expense, other non-interest expense and number of loans; output variables included asset, total deposit and interest revenue. The DEA model was used to obtain efficiency value; the samples selected were 611 banks still continuing operation and 319 failed banks from 1986 to 1988. The result indicated that the more approximate to the failure point, the more a bank failed, and the lower efficiency it got, the more it dropped to the lowest point at bankruptcy; surviving banks had higher efficiency values than bankrupt banks; prior to failure, one can distinguish a surviving bank from a failing bank through DEA model efficiency values; management quality would affect the bank's survival. Elyasiani, Mehdian, and Rezvanian (1994) studied the survey of Federal Deposit Insurance Corporation on 203 commercial banks from 1983 to 1987; they chose deposit, the number of staff, and capital amount as input items and real estate loan, miscellaneous loan, and investment amount as output items respectively, utilized the DEA to obtain the technical efficiency, allocative efficiency and total efficiency of each bank, and studied the correlation between production efficiency and financial efficiency. The result showed that production efficiency and financial efficiency had a significant correlation in most cases, indicating that the DEA measurement of a bank's production efficiency can serve as the reference for a bank's operator in doing financial analysis.

Elyasiani and Mehdian (1995) used the DEA to compare the technical efficiency between big and small banks; samples were 150 small banks randomly chosen from 1979 to 1986 (banks with total assets less than NT$500,000 in 1986) and 150 medium and large banks (banks with total assets greater than NT$4 million but less than NT$10 billion in 1986) but the extra large banks with total assets over NT$10 billion were excluded to increase sample homogeneity. The selection of input and output variables adopted the intermediation approach with time saving deposit, current deposit, fixed assets and capital lease, and the number of full-time staff as input items, and output items included investment, real estate loan, commercial and industrial loans, and miscellaneous loan. It is found that in the efficiency analysis using single production frontier, small and large banks had very similar efficiency in 1979, while in 1986, the efficiency of large banks was higher than that of small banks and efficiency variation reached the significant level of 1%; in the efficiency analysis building individual production frontier with scale cluster, the efficiency variation of small banks from 1979 to 1986 was greater than that of larger scale banks, and after releasing control, the efficiency of both large and small banks tended to slip but small banks slipped in greater magnitude. Yeh (1996) studied six old banks in Taiwan from 1981 to 1989 before releasing control; he chose 12 financial ratios, utilized the principal component analysis method to measure single index of operating efficiency with interest revenue, non-interest revenue and loan as output items and interest expense, non-interest expense and deposit as input items respectively, and ran the DEA to assess operating efficiency. The efficiency values obtained from the DEA were divided into three groups, high (efficiency value of 0.99–0.85), medium (efficiency value of 0.84–0.65), and low (efficiency value below 0.64), so as to test whether the financial ratio factor correlates with the DEA efficiency value significantly. The result indicated that the DEA could help the financial ratio analysis method quantify single performance measurement index and provide valuable information for a bank's administrator in decision-making; The DEA index change corresponds with Taiwan's prosperity cycle, the combination of the DEA and financial ratio approach is a worthy method for the government in determining a bank's performance.

Bhattacharyya, Lovell, and Sahay (1997) used the DEA to make a two-stage analysis of totally 70 Indian commercial banks, 419 DMUs, 70 Indian commercial banks from 1986 to 1991. Input items included interest expense and operating expense, output items included loan, deposit, and investment, and six exogenous variables included the numbers of suburban, countryside, urban and metropolitan branches, the ratio of loan on preferential industries to total loan, and capital adequacy ratio (ratio of total capital over risk asset). The finding showed that under various shareholder equities, the average efficiency of public-owned banks was the highest with the minimal average efficiency variance while foreign-owned and private banks had lower average efficiency; nonetheless, the efficiency of foreign-owned banks was the lowest at the initial stage of the research but rose significantly in the last two years of research period (1990 and 1991).

Lin (2002) studied 43 commercial banks in Taiwan, analyzed the cost efficiency between merged banks and non-merged banks, and chose operating cost, total deposit, fixed asset, the number of staff, average salary and interest expenditure as input items and total loan as an output item, respectively. The result indicated that the operating inefficiency of each bank after acquisition was lower than that of each bank without acquisition except in 1999. Wang, Huang, and Lai (2005) studied four state-owned banks and 12 private banks (totally 16 commercial banks) in mainland China in 2004 and chose capital and asset as input items and net income, return on total assets (ROA), return on equity (ROE) as output terms respectively. The result showed that two banks had scale efficiency in the CCR model, two banks were in constant returns to scale, seven banks had increasing returns to scale, and seven banks had decreasing returns to scale; efficiency went down as loan increased and the increase of total loans did not lead to efficiency improvement. Sakar (2006) studied 11 commercial banks listed in Istanbul Stock Exchange in Turkey from December 31, 2002 to March 31, 2005 and chose the number of branches, the average number of staff of each branch, total assets, total loans, and total deposits as input items and the ratio of net interest revenue to asset, ratio of net interest revenue to operating revenue, ratio of non-interest revenue to asset, ROA, and ROE as output items, respectively. The result showed that the banks with fewer than 200 or about 600 branches had better scale effi-

Table 1
Pearson correlation coefficient.

Correlation coefficient	Degree of correlation
>0.8	Very high
0.6–0.8	High
0.4–0.6	Medium
0.2–0.4	Low
<0.2	Very low

Table 2
Correlation coefficients between input and output variables.

Outputs	Inputs			
	Number of staff	Interest expense	Deposit operating amount	Current deposit operating amount
Loan operating amount	0.786**	0.797**	0.831**	0.782**
Earning	0.732**	0.754**	0.770**	0.700**
Operating revenue	0.867**	0.931**	0.925**	0.790**
Interest revenue	0.816**	0.820**	0.856**	0.777

Note: *, **, *** denotes significant at 10%, 5% and 1% level, respectively.