Measuring Efficiency of Vietnamese Commercial Banks: An Application of Data Envelopment Analysis (DEA)

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Abstract

In this paper, we focus on the efficiency performance of the Vietnamese commercial banks in terms of their efficiency change, productivity growth, and technological change during the period 2001–2003. We use a data envelopment analysis (DEA) model for this purpose. Productivity is measured using the Malmquist total factor productivity index. The panel data of 13 commercial banks in Vietnam are used for the empirical research. It is found that the average cost efficiency of the sampled banks was about 60.6 percent, and the average annual growth of the Malmquist index was negative 2.2 percent over the study period. Conversely, the total factor productivity (TFP) increased by 5.7 percent in 2003 relative to 2001 (the base year), and the TFP of 2003 was 15.1 percent higher than that of 2002. This TFP improvement was achieved primarily by greater technical efficiency and, to some extent, by technological advancement. These empirical results might benefit Vietnamese policy makers, who are interested in examining the effects of deregulation on productivity of the Vietnamese commercial banks, so as to improve the overall efficiency of the banking industry.

Key words: commercial banks, data envelopment analysis, efficiency, Malmquist index, total factor productivity, Vietnam

JEL Classification: C14, D24, G21

1. Introduction

Economic globalization is a natural development of the global labor division and cooperation, with the support of modern science and technology. This trend is irreversible. It involves every nation, covers most facets of socioeconomic life, promotes competition, and strengthens cooperation while increasing the interdependence between economies. In this competitive environment, banks are forced to examine their performance because their survival will be dependent upon their productive efficiencies.

The main purpose of this paper is, therefore, to investigate the efficiency of banks and to analyze the changes in the productivity and technology of the Vietnamese commercial banks. Two different approaches can be taken to measuring efficiency: the non-parametric (or linear programming) and parametric (or stochastic frontier production function) approaches. This paper uses the first approach, commonly known as data envelopment analysis (DEA). To measure productivity changes and to decompose the productivity changes into technical efficiency and technological changes, we will use the Malmquist total factor productivity index to explore the differences in productivity between these banks.

However, severe data limitations compel us to confine our attention to only 13 Vietnamese commercial banks in the database from the Economic Census for Enterprises, which was

conducted by the General Statistics Office of Vietnam (GSO) in 2001–2003. The results presented in this paper might be helpful to bank managers in identifying their banks' efficiency performance and the underlying reasons for their successes or failures. It might also help banks in strategic planning and help policy makers in their attempts to improve the overall efficiency of the banking industry and identify the need for reforms of the domestic banks.

The paper is organized as follows. Section 2 provides a brief overview of the Vietnamese banking industry. Section 3 presents a literature review on measuring efficiency performance of the commercial banks. Section 4 outlines the data and methodology for the paper. The empirical results from the DEA approach are presented in Section 5. Some concluding remarks are given in Section 6.

2. An Overview of the Banking Industry in Vietnam[1]

Since the implementation of *Doi moi* (renovation), which was initiated by the Vietnamese Communist Party in 1986, the Vietnamese economy has gradually moved to a market economy and has swiftly become integrated into the regional and global economies. Those reforms were of strategic importance in the past. They promoted the formulation and development of new economic relations as well as new socio-economic infrastructure. The banking system has gradually provided more effective intermediation of financial resources. The direct outcomes and impacts of this process are a deep monetization of economic resources and relations. This also means that economic reform has been closely linked with financial liberalization in a mutually supporting relationship, thus bringing more potential and development opportunities for the banking system.

The enactment of the Ordinance on the State Bank and the Ordinance on Banks, Credit Cooperatives, and Financial Companies in May 1990 resulted in the formation of the two-tier banking system, in which commercial banks conduct the monetary transactions and provide banking services while the State Bank of Vietnam (SBV) fulfills the state regulatory function of a central bank. The current legal framework for banking activities was basically completed with the enactment of the Law on the State Bank and the Law on Credit Institutions in December 1997. The previous measures and the current laws on banking not only recognize and protect business operation by the state-owned commercial banks (SOCBs), but also encourage the development of non-state banks and foreign credit institutions in Vietnam on the basis of equal treatment between different credit institutions, regardless of ownership, in order to create a sound competitive environment and transparency in banking operation. In 1991, the banking system in Vietnam consisted of only four SOCBs and one joint venture bank. By 2002, there were already five SOCBs; one policy bank; 36 joint stock commercial banks (JSCBs); 26 branches of foreign banks; five joint venture banks; 41 representative offices of foreign credit institutions, financial companies, and financial leasing companies; and about 900 people's credit funds.

Commercial Banking: In recent years, the autonomy and accountability of the commercial banks for their business have been institutionalized and enhanced in practice. Commercial banks have the rights to decide on deposit and lending interest rates and to select their own method of loan security. Neither institution nor individual can illegally intervene in the operation of the commercial banks. Directed credit or policy-oriented lending is being separated from commercial credit. The international principles and standards for commercial banking (e.g., accounting and auditing, risk management, credit analysis, investment, foreign exchange, and loan classification and provisioning) have been gradually introduced to Vietnam. Banking products and services have become more diverse. Some commercial banks have built e-banking

[1] This section is heavily based on Phung (2002).

and automatic transaction systems, such as Connect 24, ATMs, e-accounts, credit cards, and trusted computing base (TCB) fast access. By putting priority on introducing modern technology, especially information technology (IT), banks are providing more services to their customers. These efforts have made for substantial improvement in the depth and quality of the banking payment system. Money transfers and payment through banks in the country now take only a few seconds; these transactions used to take hours or even days. The remarkable progress in the banking payment system was further marked by participation in the Society for Worldwide Interbank Financial Telecommunication (SWIFT) system in March 1995 and the introduction of the interbank electronic payment system in May 2002, which allowed the development of wholesale and retail banking throughout Vietnam and was connected to the international payment system. The payment system of Vietnam currently reaches the average level of the region.

Strengthening of Commercial Banks: Due to the low starting point of the banking system, the severe legacy of the centrally planned economy, and the negative impacts of the Asian financial crisis in 1997, the commercial banks in Vietnam faced considerable difficulties in addition to their own financial, organizational, and operational weaknesses. Thus, restructuring of the commercial banks was an urgent need for the whole banking system. It has been underway since 1998 for the JSCBs and since 2001 for the SOCBs. The core of the strengthening efforts for commercial banks is recapitalization, including increasing the chartered capital with the goal of reaching the international capital adequacy ratio (8%), and dealing outright with non-performing loans, including efforts to stop the growing non-performing loans. The restructuring of the commercial banks has made some progresses so far: almost 5 trillion VND of chartered capital has been supplemented to the 5 SOCBs; most of the JSCBs have increased their minimum chartered capital to the level of legal capital in order to reach 100 billion VND per JSCB. Some JSCBs have reached a chartered capital of 350 billion VND. In addition, more than 43 percent of all non-performing loans of the banking system have been resolved, bringing the ratio of non-performing loans in total outstanding loans from 12.7 percent (as of 31 December, 2000) to 5 percent (as of 31 December, 2002).

3. Measuring Efficiency of Commercial Banks: Literature Review

The efficiency performance of banks has been discussed for years. Recently, due to rapid growth of financial markets and financial innovations, it has become more important to measure the efficiency of financial institutions. If the financial institutions operate more efficiently, they might expect an improved profitability and a greater amount of intermediated funds.

The evaluation of commercial bank efficiency has been approached from various angles. Parametric programming approaches have generally been concerned with the production or cost function base. A host of studies have focused on estimating characteristics of the cost function and measuring economies of scale and scope by assuming that all banks were operating efficiently; these studies include Bell and Murphy (1967), Longbrake and Johnson (1975), and Kolari and Zardkoohi (1987). Banker and Maindiratla (1988) argued that the estimated cost function represented the average behaviors of banks in the sample, and the regression procedures could be modified to orient the estimates toward frontier. During 1992–1997, efficient cost frontier approaches were used in 116 out of 130 studies related to financial institution frontier efficiency across 21 countries (Berger and Humphrey, 1997).

There is also a method that uses the bank efficiency frontier to construct measures of overall, technical, and scale efficiency. It uses a non-parametric programming approach and investigates inefficiencies among the sampled banks. This approach estimates how much total productivity in the banking sector can be improved and ranks the efficiency scores of individual

banks. Notable among studies using this method include those by Berg *et al.* (1991) for Norwegian banks, Grifell-Tatje and Lovell (1996) for Spanish banks, Lang and Welzel (1996) for German banks, Resti (1997) for Italian banks, Leightner and Lovell (1998) for Thai banks, Gilbert and Wilson (1998) for Korean banks, Altunbus *et al*. (1999) and Drake and Hall (2000) for Japanese banks, Rebelo and Mendes (2000) for Portugese banks, and Sathye (2001) for Australian banks. The study of Berg *et al.* (1993) showed that the mean productivity index was 1.09 between Finland and Norway, 1.52 between Finland and Sweden, and 1.40 between Norway and Sweden. Sathye (2001) studied the productivity changes in the Australian banking over the period 1995–1999 by using the Malmquist index, and found that the mean total factor productivity in Australian banking was 1.013.

To the best of our knowledge, there have been few studies on scale, scope, and x-efficiency for the financial institutions in Vietnam. Measurements of bank efficiency have been based mainly on traditional analysis, which is mainly based on the financial statements of the banks. Therefore, as stated earlier, this paper will focus on measuring the efficiency, productivity growth, and technological changes over the period 2001–2003 for the Vietnamese commercial banks in order to determine whether there was a rise in efficiency and productivity of these banks in the study period.

4. Methodology and Descriptions of Data and Variables

4.1. Methodology: Data Envelopment Analysis (DEA) and the Malmquist Index

The data envelopment analysis (DEA) approach was pioneered by Charnes, Cooper, and Rhodes (or CCR) (1978) and later extended by Banker, Charnes, and Cooper (or BCC) (1984). This approach decomposes cost (input saving) efficiency into technical and allocative efficiencies. It also allows the decomposition of technical efficiency into pure technical efficiency and scale efficiency. The Malmquist index is commonly used to assess banks' productivity changes. In order to identify the possible causes behind productivity changes, the Malmquist index is usually decomposed into technical efficiency and technological progress changes. DEA is a linear programming technique that maps a piecewise linear convex isoquant (a non-parametric surface frontier) over the data points to determine the efficiencies of each decision-making unit (DMU) relative to the isoquant. The objective of DEA is to measure relative efficiency among similar units that share the same technology (or processing procedure) for similar goals (or outputs) through using similar resources (or inputs). The efficiency scores of DMUs are bounded between zero and one; fully efficient banks will have an efficiency score of one. Several alternative models have been introduced in the DEA literature (see, for instance, Charnes *et al.* (1994) for details). Each of these models seeks to determine which DMUs establish the best efficiency frontier. The employed DEA model defines the shape of the efficiency frontier. In this paper, we use the input-oriented models by CCR (1978) as well as BCC (1984), in which the former assumes constant returns to scale, while the latter assumes variable returns to scale.

Cost efficiency (CE) measures the possible reductions in cost that can be achieved if a bank is technically and allocatively efficient (Elyasiani and Mehdian, 1990). A bank is said to have technical efficiency (TE) if it operates on the efficient frontier, and allocative efficiency (AE) if it is properly choosing the correct mix of inputs given the input prices[2]. TE can be decomposed into pure technical efficiency (PTE) and scale efficiency (SE). Pure technical inefficiency results from using more inputs than necessary (input waste), while scale inefficiency occurs if the bank does not operate at constant returns to scale.

[2] Note that $CE = TE*AE$.

Another useful metric within the DEA framework is the Malmquist index, which is the product of two elements: (i) change in technical efficiency or how close a bank can get to the efficient frontier (namely, the catching up index) and (ii) technological change (namely, the changes in best-practice index) or how much the benchmark production frontier shifts at each bank's observed input mix (innovations or shocks). A Malmquist index that is greater than 1 implies that total factor productivity progress occurred, while an index less than 1 means that total factor productivity declined.

The Malmquist total factor productivity (TFP) index measures the TFP change between two data points by calculating the ratio of the distances of each data point relative to a common technology. Following Färe *et al.* (1985), the Malmquist TFP change index between period *s* (the base period) and the period *t* is given by:

$$m_o(y_s, x_s, y_t, x_t) = [d^s_o(y_t, x_t) * d^t_o(y_t, x_t) / d^s_1(y_s, x_s) * d^t_1(y_s, x_s)]^{1/2}, \quad (1)$$

where the notation $d^s_o(y_t, x_t)$ represents the distance from the period *t* observation to the period *s* technology. A value of m_o greater than one indicates a positive TFP growth from period *s* to period *t*, while a value less than one indicates a TFP decline. The decomposition of the above can be done as follows:

$$\text{Efficiency change} = d^t_1(y_t, x_t) / d^s_o(y_s, x_s) \quad (2)$$

$$\text{Technological change} = [d^s_o(y_t, x_t) * d^s_1(y_s, x_s) / d^s_o(y_t, x_t) * d^t_1(y_s, x_s)]^{1/2}. \quad (3)$$

In empirical applications, the four distance measures that appear in (1) are calculated for each firm in each pair of adjacent time periods using a mathematical programming technique described by Coelli *et al.* (1998) and Coelli (1996) for the computer program DEAP Version 2.1.

As previously stated, technical efficiency can be decomposed into pure technical efficiency and scale efficiency. Likewise, the change in technical efficiency can be partitioned into a change in pure technical efficiency (ΔPE) and a change in scale efficiency (ΔSE).

4.2. Descriptions of Data and Variables

We use data of the 13 Vietnamese commercial banks from the Economic Census for Enterprises, which was conducted by the General Statistics Office of Vietnam (GSO) over the period 2001–2003.

We determine the appropriate number of inputs and outputs in light of the available data. Generally speaking, the product of inputs and outputs in a DEA application should optimally be less than the sample size in order to distinguish the banks effectively. Therefore, we will use three inputs (labor, capital, and deposits) and two outputs (interest income and non-interest income). We measure labor (L) by total labor expenses of the bank, capital (K) by the value of physical capital, and deposits (D) by the sum of savings deposits and other deposits. Our analysis also incorporates input prices in order to measure cost efficiency. The unit price of labor is the total cost of all of a bank's employees (i.e., salaries and employee benefits) divided by the total number of the employees. The unit price of capital is measured by physical capital expenses divided by the value of physical capital. The price of deposits is computed by the total interest expenses of deposits divided by the sum of saving deposits and other deposits. Table 1 summarizes relevant variables and their definitions.

Table 1. Definitions of the Relevant Variables

	Output		***Input***			***Input prices***		
Variable Name	y1	y2	x1	x2	x3	w1	w2	w3
	Interest income	Non-interest income	Labor	Capital	Deposits	Price of labor	Price of physical capital	The price of deposits

Definition	Operating income	Total labor expenses	Physical capital	Saving deposits and other deposits	Labor expenses/ number of employees	Physical capital expenses/ x2	Total interest expenses/ x3

5. Empirical Results and Analysis

5.1. Analysis of Efficiency Estimates

Using DEA and the data of the 13 Vietnamese commercial banks, the estimated results indicate that the most cost-efficient banks over the study period were generally urban banks, such as the Bank for Foreign Trade of Vietnam (Vietcombank) and North Asian Commercial Joint Stock Bank. In contrast, rural banks were the smallest banks and were generally the least cost-efficient ones, particularly Dai A Rural Commercial Joint Stock Bank. Table 2 summarizes the estimated efficiency scores over the study period, while Table 3 makes a detailed presentation of the estimates for each bank.

Table 2. Summary of Estimated Efficiency Measures, 2001–2003

	CE	***AE***	***TE***	***PE***	***SE***
Year 2001					
Mean	**0.575**	**0.621**	**0.912**	**0.940**	**0.970**
Maximum	1.000	1.000	1.000	1.000	1.000
Minimum	0.362	0.362	0.704	0.728	0.809
Std. Dev.	0.249	0.223	0.119	0.102	0.061
Year 2002					
Mean	**0.628**	**0.690**	**0.895**	**0.974**	**0.919**
Maximum	1.000	1.000	1.000	1.000	1.000
Minimum	0.359	0.414	0.678	0.862	0.678
Std. Dev.	0.228	0.184	0.127	0.048	0.116
Year 2003					
Mean	**0.614**	**0.643**	**0.948**	**0.977**	**0.970**
Maximum	1.000	1.000	1.000	1.000	1.000
Minimum	0.306	0.329	0.809	0.861	0.809
Std. Dev.	0.212	0.196	0.071	0.049	0.053
Average (2001–03)					
Mean	**0.606**	**0.651**	**0.918**	**0.963**	**0.953**
Maximum	1.000	1.000	1.000	1.000	1.000
Minimum	0.306	0.329	0.678	0.728	0.678
Std. Dev.	0.225	0.198	0.108	0.071	0.083

Note: CE = cost efficiency; AE = allocative efficiency; TE = technical efficiency; PE = pure technical efficiency; and SE = scale efficiency

Source: Author's estimates

Table 3: Estimated Efficiency Scores for Individual Banks, 2001–2003

Banks	***CE***	***AE***	***TE***	***PTE***	***SE***	***Scale Type***
Year 2001 (Mean)	**0.575**	**0.622**	**0.912**	**0.940**	**0.970**	
Technology Commercial Joint Stock Bank	0.704	0.704	1.000	1.000	1.000	cons
Maritime Commercial Joint Stock Bank	0.383	0.461	0.830	0.848	0.979	drs
Ninh Binh Rural Commercial Joint Stock Bank	0.371	0.458	0.809	1.000	0.809	irs
North Asian Commercial Joint Stock Bank	1.000	1.000	1.000	1.000	1.000	cons
Saigon Thuong Tin Commercial Joint Stock Bank	0.389	0.506	0.768	0.889	0.863	drs
Asia Commercial Bank	0.637	0.637	1.000	1.000	1.000	cons
Dai A Rural Commercial Joint Stock Bank	0.362	0.362	1.000	1.000	1.000	cons

Rach Kien Rural Commercial Joint Stock Bank	0.472	0.473	0.997	1.000	0.997	irs
My Xuyen Rural Commercial Joint Stock Bank	0.464	0.621	0.747	0.750	0.997	drs
Tan Hiep Rural Commercial Joint Stock Bank	0.911	0.911	1.000	1.000	1.000	cons
Industrial & Commercial Bank of Vietnam	0.402	0.570	0.704	0.728	0.967	drs
Agriculture and Rural Development Bank	0.376	0.376	1.000	1.000	1.000	cons
Bank for Foreign Trade of Vietnam	1.000	1.000	1.000	1.000	1.000	cons
Year 2002 (Mean)	**0.628**	**0.690**	**0.895**	**0.974**	**0.919**	
Technology Commercial Joint Stock Bank	0.661	0.661	1.000	1.000	1.000	cons
Maritime Commercial Joint Stock Bank	0.627	0.627	1.000	1.000	1.000	cons
Ninh Binh Rural Commercial Joint Stock Bank	0.459	0.677	0.678	1.000	0.678	irs
North Asian Commercial Joint Stock Bank	1.000	1.000	1.000	1.000	1.000	cons
Saigon Thuong Tin Commercial Joint Stock Bank	0.397	0.537	0.739	0.896	0.825	drs
Asia Commercial Bank	0.504	0.588	0.856	0.862	0.993	drs
Dai A Rural Commercial Joint Stock Bank	0.359	0.414	0.868	0.980	0.886	irs
Rach Kien Rural Commercial Joint Stock Bank	0.631	0.631	1.000	1.000	1.000	cons
My Xuyen Rural Commercial Joint Stock Bank	0.649	0.649	1.000	1.000	1.000	cons
Tan Hiep Rural Commercial Joint Stock Bank	1.000	1.000	1.000	1.000	1.000	cons
Industrial & Commercial Bank of Vietnam	0.482	0.642	0.751	0.920	0.816	drs
Agriculture and Rural Development Bank	0.426	0.573	0.744	1.000	0.744	drs
Bank for Foreign Trade of Vietnam	0.967	0.967	1.000	1.000	1.000	cons
Year 2003 (Mean)	**0.614**	**0.643**	**0.948**	**0.977**	**0.970**	
Technology Commercial Joint Stock Bank	0.501	0.501	1.000	1.000	1.000	cons
Maritime Commercial Joint Stock Bank	0.698	0.698	1.000	1.000	1.000	cons
Ninh Binh Rural Commercial Joint Stock Bank	0.492	0.609	0.809	1.000	0.809	irs
North Asian Commercial Joint Stock Bank	1.000	1.000	1.000	1.000	1.000	cons
Saigon Thuong Tin Commercial Joint Stock Bank	0.765	0.765	1.000	1.000	1.000	cons
Asia Commercial Bank	0.528	0.623	0.848	0.861	0.985	drs
Dai A Rural Commercial Joint Stock Bank	0.306	0.329	0.930	0.960	0.968	drs
Rach Kien Rural Commercial Joint Stock Bank	0.495	0.588	0.842	0.879	0.957	irs
My Xuyen Rural Commercial Joint Stock Bank	0.441	0.466	0.947	1.000	0.947	irs
Tan Hiep Rural Commercial Joint Stock Bank	0.824	0.824	1.000	1.000	1.000	cons
Industrial & Commercial Bank of Vietnam	0.624	0.624	1.000	1.000	1.000	cons
Agriculture and Rural Development Bank	0.392	0.416	0.943	1.000	0.943	drs
Bank for Foreign Trade of Vietnam	0.917	0.917	1.000	1.000	1.000	cons

Source: Author's estimates

The mean score of CE for these banks was about 57.5 percent in 2001, 62.8 percent in 2002, and 61.4 percent in 2003. In general, these efficiency scores were on an upward trend in the study period, although there was a slight decrease between 2002 and 2003. In addition, that the mean TE (at 0.918) was higher than the mean allocative efficiency (at 0.615) means the main source of cost inefficiencies in the Vietnamese banks was most likely attributable to regulatory problems and much less to managerial capacity of the studied banks.

The mean score of SE for Vietnamese banks (at 0.953) was slightly lower than PTE (at 0.963) over the period. (Or in terms of average inefficiency[3], scale inefficiency was 0.0493, while pure technical inefficiency was 0.0384.) This result suggests that technical inefficiency might be attributable to scale inefficiency rather than pure technical inefficiency.

5.2. Productivity Improvement

The Malmquist index summary of annual means is presented in the Table 4. All indices are relative to the previous year. The year 2001 is the base year, so the output begins with the year 2002. Table 5 presents the changes in productivity for each bank in the sample.

[3] The relationship between efficiency (*E*) and inefficiency (*IE*) is *E = 1/(1+IE)*.

Table 4. Malmquist Index Summary of Annual Means

Year	*effch*	*techch*	*pech*	*sech*	*tfpch*
2002	0.980	0.924	1.041	0.941	0.906
2003	1.066	0.991	1.003	1.063	1.057
Mean	1.022	0.957	1.022	1.000	0.978

Note: effch = technical efficiency change; techch = technical or technology change; pech = pure technical efficiency change; sech = scale efficiency change; and tfpch = total factor productivity change

Source: Author's estimates

Table 5: Changes in Efficiency and Productivity for Individual Banks, 2001–2003

Banks	*effch*	*techch*	*pech*	*sech*	*tfpch*
Years 2001–2002 (Geometric Mean)	**0.980**	**0.924**	**1.041**	**0.941**	**0.906**
Technology Commercial Joint Stock Bank	1.000	1.103	1.000	1.000	1.103
Maritime Commercial Joint Stock Bank	1.204	0.917	1.179	1.021	1.104
Ninh Binh Rural Commercial Joint Stock Bank	0.839	1.112	1.000	0.839	0.932
North Asian Commercial Joint Stock Bank	1.000	0.539	1.000	1.000	0.539
Saigon Thuong Tin Commercial Joint Stock Bank	0.963	0.932	1.007	0.956	0.897
Asia Commercial Bank	0.856	0.754	0.862	0.993	0.645
Dai A Rural Commercial Joint Stock Bank	0.868	0.947	0.980	0.886	0.823
Rach Kien Rural Commercial Joint Stock Bank	1.003	1.119	1.000	1.003	1.122
My Xuyen Rural Commercial Joint Stock Bank	1.338	1.012	1.334	1.003	1.354
Tan Hiep Rural Commercial Joint Stock Bank	1.000	1.184	1.000	1.000	1.184
Industrial & Commercial Bank of Vietnam	1.066	0.893	1.263	0.844	0.952
Agriculture and Rural Development Bank	0.744	1.106	1.000	0.744	0.823
Bank for Foreign Trade of Vietnam	1.000	0.672	1.000	1.000	0.672
Years 2002–2003 (Geometric Mean)	**1.066**	**0.991**	**1.003**	**1.063**	**1.057**
Technology Commercial Joint Stock Bank	1.000	0.880	1.000	1.000	0.880
Maritime Commercial Joint Stock Bank	1.000	1.010	1.000	1.000	1.010
Ninh Binh Rural Commercial Joint Stock Bank	1.192	0.886	1.000	1.192	1.056
North Asian Commercial Joint Stock Bank	1.000	1.046	1.000	1.000	1.046
Saigon Thuong Tin Commercial Joint Stock Bank	1.354	1.050	1.116	1.213	1.421
Asia Commercial Bank	0.991	1.000	0.998	0.992	0.991
Dai A Rural Commercial Joint Stock Bank	1.071	0.946	0.980	1.093	1.013
Rach Kien Rural Commercial Joint Stock Bank	0.842	1.003	0.879	0.957	0.844
My Xuyen Rural Commercial Joint Stock Bank	0.947	0.894	1.000	0.947	0.847
Tan Hiep Rural Commercial Joint Stock Bank	1.000	1.120	1.000	1.000	1.120
Industrial & Commercial Bank of Vietnam	1.332	1.132	1.087	1.225	1.507
Agriculture and Rural Development Bank	1.268	0.961	1.000	1.268	1.219
Bank for Foreign Trade of Vietnam	1.000	0.999	1.000	1.000	0.999
Average 2001–2003 (Geometric Mean)	**1.022**	**0.957**	**1.022**	**1.000**	**0.978**
Technology Commercial Joint Stock Bank	1.000	0.985	1.000	1.000	0.985
Maritime Commercial Joint Stock Bank	1.097	0.962	1.086	1.011	1.056
Ninh Binh Rural Commercial Joint Stock Bank	1.000	0.993	1.000	1.000	0.993
North Asian Commercial Joint Stock Bank	1.000	0.751	1.000	1.000	0.751
Saigon Thuong Tin Commercial Joint Stock Bank	1.141	0.989	1.060	1.077	1.129
Asia Commercial Bank	0.921	0.868	0.928	0.993	0.800
Dai A Rural Commercial Joint Stock Bank	0.964	0.947	0.980	0.984	0.913
Rach Kien Rural Commercial Joint Stock Bank	0.919	1.059	0.937	0.980	0.973
My Xuyen Rural Commercial Joint Stock Bank	1.126	0.951	1.155	0.975	1.071
Tan Hiep Rural Commercial Joint Stock Bank	1.000	1.151	1.000	1.000	1.151
Industrial & Commercial Bank of Vietnam	1.191	1.005	1.172	1.017	1.198
Agriculture and Rural Development Bank	0.971	1.031	1.000	0.971	1.002
Bank for Foreign Trade of Vietnam	1.000	0.819	1.000	1.000	0.819

Source: Author's estimates

Following Coelli *et al*. (1998), productivity changes reflect the product of changes in technological progress and technical efficiency. The above results thus can be interpreted as follows. The average level of the Malmquist index (*tfpch*) was only 0.978, meaning that there was a decline in TFP by 2.2 percent over the study period despite the mean score of technical efficiency index (*effch*) of 1.022. The main cause of the falling TFP was that the technological change index (*techch*) was only 0.957 (a decline of 4.3%). In addition, technical efficiency change index (*effch*) and technological change index, respectively, increased from 0.980 and 0.924 in 2002 to 1.066 and 0.991 in 2003 (or an improvement of 8.6% and 6.7%). The net result of technical efficiency and technological change increased by 15.1 percent in the TFP index, from 0.906 in 2002 to 1.057 in 2003.

In general, the increase in technological progress was not sufficiently robust to contribute to an increase in TFP because of the decline in the rate of mean technological progress by 4.3 percent over the study period. These results suggest that the total factor productivity change was more attributable to the technical efficiency change (*effch*) than technological change (*techch*). Also, during the study period we found that the total factor productivity in 2003 increased by 5.7 percent. This might suggest that the institutional reforms in banking system were indeed successful. However, the technological change index (*techch*) was also only 0.991 (or a decline of 0.9%), meaning that technological progress in 2003 was satisfactory. For example, by 2003, only 7 out of 13 banks in Vietnam provided various banking services, such as Connect 24, ATMs, e-accounts, and credit cards. This situation indicates that a lack of technological savvy on the part of the banks was preventing many of their customers from learning about e-banking during the study period.

6. Concluding Remarks

We examined several efficiency measures and productivity changes in the Vietnamese commercial banks during the period 2001–2003 using a data envelopment analysis (DEA) approach. Data of 13 banks was used for this purpose. The analysis results indicated that the banks' cost efficiency average was 60.6 percent. The sources of inefficiency of the sampled banks were found to be derived from both allocative (regulatory) and technical (managerial capacity) problems, in which the technical inefficiency score was lower than the allocative inefficiency score over the study period. Significant allocative inefficiency showed that the Vietnamese commercial banks were unable to use the input mix properly.

We also analyzed the changes in total factor productivity (TFP) among these sampled banks. We found that the average annual growth of the Malmquist index was negative 2.2 percent over the study period. The decline in TFP was due to a 4.3 percent reduction in technological efficiency. Moreover, we discovered that the TFP increased by 5.7 percent in 2003 relative to the base year 2001, and the TFP of 2003 was 15.1 percent higher than that of 2002. This total factor productivity improvement was attributable more to technical efficiency change than to technological change (or innovations in banking technology). These findings might help bank managers to understand the underlying reasons for their banks' efficiency performances. Moreover, they could also help policy makers to establish more comprehensive policy settings for promoting further development of the banking industry in Vietnam.

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