

# Measuring the Efficiency of Banks: Successful Mergers in the Korean Banking Sector

Kimie Harada



KOREA INSTITUTE FOR  
INTERNATIONAL ECONOMIC POLICY

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# **Measuring the Efficiency of Banks: Successful Mergers in the Korean Banking Sector**

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## Executive Summary

This paper investigates how the Korean banking sector has published reform, with a focus on mergers and acquisitions of banks. It examines the technical efficiency implications of Korean banks to evaluate their pre- and post-consolidation efficiency. Using a sample from the period 1996 to 2003, we consider two hypotheses: whether banks with high foreign ownership perform better than domestic banks, and whether bigger banks or banks under a holding company improve their efficiencies and become more competitive.

The study has some significant findings. Average bank scale efficiency deteriorated until 1998, then gradually improved to 2003. Banks with high foreign ownership performed better than other banks. Bank holding companies' efficiency level fell temporarily after compulsory or voluntary mergers, but they still enjoyed high efficiency scores even after becoming larger.

JEL Classification: G21; G34; D21

Keywords: Banks; Consolidation; Data Envelope Analysis; Efficiency Analysis

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# Measuring the Efficiency of Banks: Successful Mergers in the Korean Banking Sector<sup>\*)</sup>, #)

Kimie Harada<sup>\*\*)</sup>

## I. Introduction

The banking sector in Korea has shown the most improvement among Asian countries in recent years. Dramatic reductions in nonperforming loans and improvements in corporate governance followed the government's stabilization of the financial sector in the wake of the currency crisis. The

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government played a major role by injecting 55.8 trillion Won (about US\$ 77.29 billion) in public funds in the banking sector alone for financial restructuring by the end of 2003.<sup>1)</sup> The government acquired failed banks' stakes with some portion of the funds. The privatization of those banks that were temporarily controlled by the government was a major concern, so mergers and acquisitions were encouraged and the limit on stake holdings by foreign investors was lifted. Two key ongoing policy issues for Korean banks, therefore, are the effectiveness of mergers and acquisitions and whether or not the increase in foreign participation in the financial sector has some benefits from their advanced management skills. Unfortunately, however, there is little academic literature that analyzes the issues empirically apart from Park and Kim (2002) and Park and Yoon (2002).

Nonperforming loans are no longer a serious problem in Korea. Average nonperforming loans ("substandard and below" credits) for all banks in Korea (commercial and specialized) stood at 2.6 percent of total loans at the end of 2003 compared with 2.3 percent a year earlier. Although the amount of overall nonperforming loans increased slightly in 2003, the overall trend in nonperforming loans has been downward as shown by the decrease of nonperforming loans from 112 trillion Won in March 1998 to 28.7 trillion Won at the end of 2002.<sup>2)</sup> An improvement in nonperforming

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1) The breakdown is as follows: 21.9 billion Won for recapitalization, 12.8 billion Won for deposit payment, and 3.6 billion Won for asset purchases. These public funds used for financial recapitalization were used through the Korea Deposit Insurance Corporation (KDIC) and 17.5 trillion Won was used through the Korea Asset Management Corporation (KAMCO) for disposal of nonperforming loans. The total amount injected by the government through both institutes was 102.1 trillion Won (see Table 5 in Park 2003).

2) Korean banks and Japanese banks are sometimes compared with respect to the speed of their responses to problems like nonperforming loans. Problem loans

loans is attributed to securitization, sales to asset management companies such as the Korea Asset Management Corporation (KAMCO), and write-offs (see FSS 2004a, Bank of Korea 2003, and FSS 2004b for more detail).

Corporate governance in the Korean banking sector improved dramatically and various financial deregulation measures were introduced after the crisis. The ownership and governance structure of commercial banks were most extensively changed by a series of amendments to the Banking Act (the Banking Act and other Korean laws and decrees that are related to the banking industry are available in English at The Korea Federation of Banks' webpage [http://www.kfb.or.kr/Eng/09\\_law/](http://www.kfb.or.kr/Eng/09_law/)). As an example of the new corporate governance system, external directors, known as the "Outside Director System," and audit committees were adopted in December 1999 and January 2000, respectively, to improve oversight of management. In addition, shareholders' rights were also better protected than before the crisis and some other new standards were implemented (see Park 2003, Joh 2003, Nam 2004, Nam and Nam 2004, Park 2005 for information on the corporate governance system in Korea).

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by major Japanese banking groups were 5.7 percent of total loans at the end of fiscal year 2003 (March 2004), which is down from 7.9 percent a year earlier. It seems that Korean banks took strong remedial action and that Japanese banks are taking a longer and less effective approach to their problems, as the amounts of bad loans written-off in recent years are striking. As of March 1993, official outstanding bad loans were 12.8 trillion yen (approximately equivalent to 128 trillion Won) for the top 20 banks but in the subsequent five years, the banks wrote off 37.6 trillion yen and as of March 1998 still had bad loans of 14.5 trillion on their books (Ueda 2003). The amounts of nonperforming loans in Japan both written-off and still existing are a serious issue. In terms of nonperforming loans alone, Korean banks are performing well. See Ito and Harada (2005) for brief chronological review of the banking sector crisis of Japan.

At the heart of the structural reform is the acceptance of bank holding companies and the lifting of the 4 percent corporate ownership ceiling for foreign investors. When the Financial Holding Company Act of 1999 was enacted, Woori Financial Holdings and Shinhan Financial Group were established and those companies acquired smaller regional banks as shown below (subsection 2.1). The bank holding company was a new type of structure in Korea. In November 1998, the Foreign Investment Promotion Act was enacted and the principle of an individual corporate ownership ceiling of 4 percent for foreigners was lifted. The Financial Supervisory Commission approved the takeover of the Korea Exchange Bank by Lone Star, a US private fund, with a 51.0 percent stake. Citigroup's purchase of 90 percent of KorAm Banks' stakes has also been approved.<sup>3)</sup>

The purpose of this paper is to offer empirical evidence on the productive efficiency of Korean banks using a nonparametric frontier framework. Korean banks have experienced dramatic structural reforms and severe changes in the banking sector as well as recovery in some aspects such as profitability, corporate governance, and risk management practices. However, there seem to be few empirical papers that examine the adaptation and performance of Korean banks quantitatively. To model banks' behavior, we use a nonparametric frontier approach because the approach has gained popularity in banking analyses in recent years in related literature, which examined mainly western countries' bank

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3) One of the notable changes in the Korean financial market in recent years is the increasing ownership by foreign investors. The share of total market capitalization of foreigners' shareholdings has steadily risen and totaled more than 40 percent in January 2004. In addition to the above examples, Kookmin Bank is a 74 percent foreign-held bank (see the Korea Federation of Bank's homepage)

consolidations. The approach does not require *a priori* functional form and provides firm-level efficiency scores with a multiple output and input framework without input prices and costs. There are many other advantages as stated in section 3.<sup>4)</sup>

Following the restructuring and privatization of Korean banks, mergers and acquisitions increased and the independence of bank management seems to have improved. Therefore, it is worth examining the effectiveness of bank mergers and acquisitions and whether increased foreign participation in banking brought better management skills.<sup>5)</sup> In particular, this paper analyzes improvements in performance in terms of technical efficiencies of Korean banks. Section II of this paper reviews related literature on bank consolidations as well as having a brief look at the Korean banking system, and examines alternative hypotheses. Section III describes efficiency measurement and data. Section IV shows the empirical results, and section V concludes the paper.

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- 4) In frontier analysis there are some other approaches. The econometric frontier approach and the deterministic frontier approach both require parametric production functions or cost functions such as the Cobb-Douglas function. The nonparametric approach is free from the restrictions of parametric models so is suitable for examining the efficiency improvements of firms.
- 5) It might be considered too early to judge the outcomes of bank mergers in Korea. This paper uses a nonparametric approach to focus on efficiency scores and is not a qualitative analysis, so transitional management improvement in Korean banks can be observed using the methodology in this paper.

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## II. Banking System and Related Literature

### 1. Bank Consolidations

Korean banks, in practice, used to be controlled by the government, and voluntary bank mergers were not observed in the market up until the late 1990s. The government substantially nominated and approved the top management of banks, defined the scope of business, specified the banking products and services that could be sold, regulated the number of employees or branches, set the criteria for the financial adequacy of banks, and directed the extension of credits to specific industries and firms (Park 2003). In this situation, Korean banks were limited and could not set their own business objectives and strategic mergers were not open to them. For these reasons, research papers on bank consolidations in Korea are quite scarce.<sup>6)</sup>

Table 1 shows that the total number of banks has not changed significantly over time. The total number of banks has remained quite stable because the number of nationwide banks increased slightly from 11 in 1990 to 16 in 1997 while the number of other types of banks did not change (see Appendix Table A2 for types of bank and their scope of operations). By the

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6) As far as the author knows, papers that analyze Korean banks in the 1990s are those that qualitatively or macroeconomically examine the sector or those that quantitatively look at the effect of financial deregulations in Korea. To date, no paper has examined efficiency improvements of Korean banks as a result of bank consolidations.



end of 1999, 10 banks out of 33 had been closed down or merged with viable banks. By the end of 2003 there were 19 banks in Korea.

**Table 1. Number of banks**

Korea	1980	1990	1995	1997	1998	1999	2000	2001	2002	2003
Nationwide banks	5	11	15	16	12	11	11	9	8	8
Regional banks	10	10	10	10	8	6	6	6	6	6
Specialized banks	7	7	7	7	6	6	5	5	5	5
Sum	22	28	32	33	26	23	22	20	19	19

Source: The Korea Federation of Banks and Financial Supervisory Service.

Cheil Bank (the First Bank of Korea) and Seoul Bank were regarded as being in the worst trouble, but were recapitalized by the government in January 1998. By the end of 1999, Cheil Bank was sold to New Bridge Capital, but Seoul Bank could not be sold to foreign investors and was merged with Hana Bank in 2002.<sup>7)</sup> Around the same time, the Financial Supervisory Commission (FSC) classified 12 banks into three categories based on accounting firms' evaluations of banks that failed to meet the Bank of International Settlement's (BIS) 8 percent capital adequacy ratios. The business licenses of five banks out of 12 were revoked, namely Chung

<sup>7)</sup> The situation was quite similar in Japan. Ito and Harada (2005) and Harada (2005) state that there were few mergers of financial institutions until the mid-1990s and in Japan banks could not establish financial holding companies until 1998. Both the Korean and the Japanese governments nationalized two banks in the late 1990s and sold them later to the private sector, one to a foreign investment company and the other to a group of domestic firms.

Chong Bank, Kyonggi Bank, Daedong Bank, Dongnam Bank, and Dongwha Bank. These nonviable banks were taken over by five healthier banks whose BIS capital adequacy ratios were more than 8 percent (Korea Housing Bank, Shinhan Bank, Hana Bank, KorAm Bank, and Kookmin Bank) through the P&As (Purchase and Assumptions) formula. Five banks among the seven remaining banks were merged into two banks. Commercial Bank of Korea and Hanil Bank became Hanvit Bank in January 1999, and Chohung Bank took over two regional banks, Chungbuk Bank and Kangwon Bank, in February 1999 and May 1999, respectively. Of the other two banks, Korea Exchange Bank was recapitalized and rehabilitated by Commerzbank from Germany in July 1998, and Peace Bank chose to withdraw from its international businesses and was merged into Hanvit Bank in December 2001. Among the healthier banks, Hana Bank and Boram Bank merged (Boram Bank was dissolved, leaving Hana Bank as the surviving bank), and Kookmin Bank merged with the Korean Long-term Credit Bank (see Appendix Figures A1 and A2 for chronological flow charts. See Ahn 2001, FSS 2004a, and Park 2005 for more details).

Following another financial restructuring after 2000, two of the major changes were the appearance of large-scale banks or financial groups and foreign investors' takeovers of Korean banks. Hanvit Bank, Peace Bank, Kwangju Bank, Kyongnam Bank, and Jeju Bank were considered rather unhealthy, and were asked to submit rehabilitation plans. After review, these banks were ordered to become subsidiaries under bank holding companies. As a result, the Woori Financial Holding Company was established in April 2001. Kookmin Bank was newly established in April 2001 following a merger of Kookmin Bank and Korea Housing Bank. Shinhan Bank established the Shinhan Financial Group and placed Jeju Bank and Chohung Bank as subsidiaries. Seoul Bank was taken over by Hana

Bank in December 2002. These banks or groups were encouraged to seek consolidation to spread universal banking services that were promised early approval in the financial market. Banks with high foreign ownership ratios are Korea Exchange Bank and KorAm Bank while other major banks also receive foreign capital (see FSS 2004a, b).

## **2. Related Literature in the Banking Sector**

In Korea, the number of banks did not change until recently because the banking sector was protected and regulated; therefore, outside entry and exit from the sector were not common. It was not until the crisis in the late 1990s that there was a wave of mergers and acquisition. Academic literature on bank consolidations in the economy is therefore quite limited.

Park and Kim (2002) classified the consolidation formula that Korean banks took into three categories: M&A (merger and acquisition), P&A (purchase and assumption), or consolidation of a nationwide bank and a regional bank, and examined the effects of consolidation on corporate loans to medium and small sized firms. Their panel analysis with three consolidation dummy variables found that P&A had positive effects on corporate lending while takeover of a regional bank by a nationwide bank had negative effects. Park and Yoon (2002) explored the effect of foreign capital into the First Bank of Korea using an event study. They examined stock price movements of firms that borrowed from the bank. They divided news into bad or good and found that bad news had negative effects and good news the contrary.

Joh (2003) examined the monitoring role of banks by looking at the relationship between capital structure and financial distress of firms. Joh (2003) did not assess the consolidation of banks, but clarified banking sector

problems and regarded poor governance as an important feature of Korean banks' poor performance. Niimi (2000) used the nonparametric frontier approach to analyze the relationship between financial deregulation and efficiency in the Korean banking sector focusing on the pre-crisis period in 1997. Niimi (2000) found that financial deregulation led to moral hazard for bank owners, lowers efficiency, and lowered profitability.

### **3. Hypotheses**

Poor lending decisions like those Joh (2003) pointed out and less efficient productivity in the early 1990s as shown in Niimi (2000) would be two characteristics observed in the Korean banking sector. As mentioned in subsection 2.1, Korean banks have changed dramatically in recent years so it is worth examining whether banks improved their efficiency level following the banking sectors' structural reforms and consolidations.

Appearance of consolidated large banks and allowance of foreign ownership are two major changes that have taken place in recent years, and the effects of these two characteristics on banks' performance, especially on their efficiency, are examined. First, there is an empirically examination of the performance of banks with high foreign ownership. Banks with high foreign ownership would plausibly do better as foreign management or bank CEOs employ advanced banking practices and a different credit culture from that previously espoused in the Korean banking sector. If foreign ownership improves bank management and performance by introducing drastic restructuring then it will result in efficient production. Ahn (2001) considered that foreign ownership had very important implications for Korea's traditionally xenophobic business culture.

According to the Group of Ten (2001) report, the primary motives for consolidation were usually cost savings and revenue enhancements, and the most important forces encouraging consolidation were improvement in information technology, financial deregulation, globalization of markets, and increased shareholder pressure for financial performance. As seen in subsection 2.4, there was a high level of consolidation across many industrial countries in the 1980s and 1990s. For example, in the US, the number of independent banking organizations has shrunk by over one-third, from more than 12,000 to fewer than 8,000 in nearly two decades, and more than a quarter of the industry is now owned by holding companies (see Berger 1998 and Berger, Kashyap, and Scalise 1995). If consolidation has important impacts such as the removal of geographic and product market entry restrictions, and if these restrictions impede operating efficiency and bank profitability, then bank consolidation has value and improves efficiency .

In Korea, the number of banks also shrank more than 40 percent, from 33 in 1997 to 19 in 2003 and more than half of the banks were under holding companies. Therefore, it is also examined whether bigger banks or banks under a holding company improve their efficiencies and become more competitive. If banking is becoming more competitive, banks need to grow bigger to improve cost efficiencies and to obtain economies of scale, since expanding scope means that banks can offer customers more diversified financial services at lower costs.

#### **4. Related Literature on Bank Consolidation**

There has been substantial research literature assessing whether consolidations in the banking industry improve the efficiency of banks. The Group of Ten (2001) found that there was a high level of merger and

acquisition activity in the 1990s among financial firms, and a significant number of large financial institutions had been created. Most mergers and acquisitions involved firms competing in the same industry and the same country. Cross-border mergers and acquisitions were less frequent: acquisitions of banking firms accounted for 60 percent of all cases. Therefore, the number of banking firms decreased in almost every country and a high degree of interdependency would suggest the possibility of systemic risks. One striking feature of the Korean banking sector is that the high foreign ownership ratio at Korean banks was attributed to foreign investors' cross-border activities; however, the above findings still hold for Korea.

The main analysis used to examine the consolidation effect is based on econometric studies that include event studies of stock price responses and performance analysis using financial statements. Post-merger performance studies, however, have found small average benefits from consolidations. Calomiris and Karceski (1998) explained why econometric analyses such as event studies failed in assessing large efficiency gains from bank consolidation. They also argued that detailed case studies of some consolidations help understanding of the effect of consolidation more precisely. Houston, James, and Ryngaert (2001) also pointed out that empirical studies examining stock market reactions to consolidation announcements found little evidence of wealth creation. One interpretation given in Houston, James, and Ryngaert (2001) was that bank acquisition results in value destruction for acquiring firm shareholders due to managerial hubris or corporate control problems. Similarly, Berger (1998) also expressed negative ideas about estimating the effects of consolidation through event studies and similar methods.

Another type of study concerning the examination of consolidation or consolidation announcements is an analysis based on individual bank

performance, for example by examining the motives behind consolidation activity. This used case studies that had the flexibility to make a case-by-case basis analysis or comparison. Calomiris and Karceski (1998) recommended applying case studies to the causes of consolidation. However, James (1998) pointed out that case studies of bank consolidations are questionable because it is not clearly explained why they tend to show more favorable results from consolidation.

Therefore, academic literature on the gains from bank consolidation results in an unsolved paradox; neither is there any consensus between academics and the media. The Group of Ten (2001) stated that research results and views of the media regarding the potential for efficiency gains from consolidation may differ because of differences in perspective. The media may not focus on cost reductions or revenue enhancement, which usually interest researchers, and tend to look at cost savings rather than at measures of efficiency.

It seems that there is no perfect measure for examining bank consolidation. However, research into the efficiency analysis of financial institutions is becoming popular. Berger and Humphrey (1997) documented 130 papers that measured x-efficiency or frontier efficiency of financial institutions, and mentioned that 116 of the papers are dated 1992 or later. X-efficiency estimation mainly considers cost efficiency (whether consolidations reduce costs per unit of output) using before and after profit efficiency, comprising both cost efficiency and revenue effects. It is suggested that analysis of profit is more appropriate for evaluating consolidation because outputs tend to change or increase substantially following a consolidation, and changes in output scale cannot be a problem in estimating the efficiency.

The merits of frontier analysis are twofold. It gives numerical efficiency values, and automatically selects the best performance firm within the analyzed firms or industry. Even without sufficient knowledge or experience in the field, it is easier to relate results to policy implications or research interests. This paper analyzes efficiency implications of mergers in the Korean banking sector using a methodology of frontier analysis, data envelope analysis, or the nonparametric frontier approach.<sup>8)</sup>

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8) Harada (2005) analyzes the same implications of mergers in the Japanese banking sector using the same methodology.



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### III. The Non-parametric Methodology<sup>9)</sup>

#### 1. Efficiency Measurement Concept

Data Envelope Analysis (DEA) is the optimization method of mathematical programming based on Farrell (1957) which deals with single-input and single-output technical efficiency measure to the multiple-input and multiple-output case.<sup>10)</sup> The nonparametric approach applied to measure the degree of efficiency of banks, DEA, is widely used in empirical estimates examining financial institution efficiency. There are two types of approach for estimating frontier function (either cost frontier function or production frontier function): a parametric approach and a nonparametric approach.<sup>11)</sup> DEA, initially an idea from Farrell (1957), is a nonparametric approach that solves linear programming problems to find a set of best-practice frontier observations. The objective of DEA is to determine which firms operate on their efficiency frontier and which do not. Therefore, the nonparametric approach provides a piecewise linear frontier by enveloping the data used in

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9) This subsection is similar with Harada (2005) in that data envelope analysis was used to measure changes in technical efficiency of Japanese banks.

10) Mathematical programming generalized by Farrell (1957) is single-input / single-output technical efficiency measure. DEA is multiple-input / multiple-output version which constructs a relative efficiency score as the ratio of a single virtual output to a single virtual input.

11) There are many approaches to measuring frontier efficiency and no consensus has been reached. Greene (1997) provided a survey of frontier production function.

the analysis without requiring explicit specification of functional form for either cost or production function.

There are now enough frontier efficiency studies of financial institutions to make comparisons of average efficiency levels across both measurement techniques and countries, as well as outline the primary results of the many applications of efficiency analysis to policy and research issues (Berger and Humphrey 1997). However, one weakness of DEA is that it does not assume a random error term but assumes that there is no measurement error in constructing the frontier. Deviation from the efficient frontier is regarded as inefficiency for some units and, because of this tendency, DEA is likely to overstate the true levels of inefficiency.

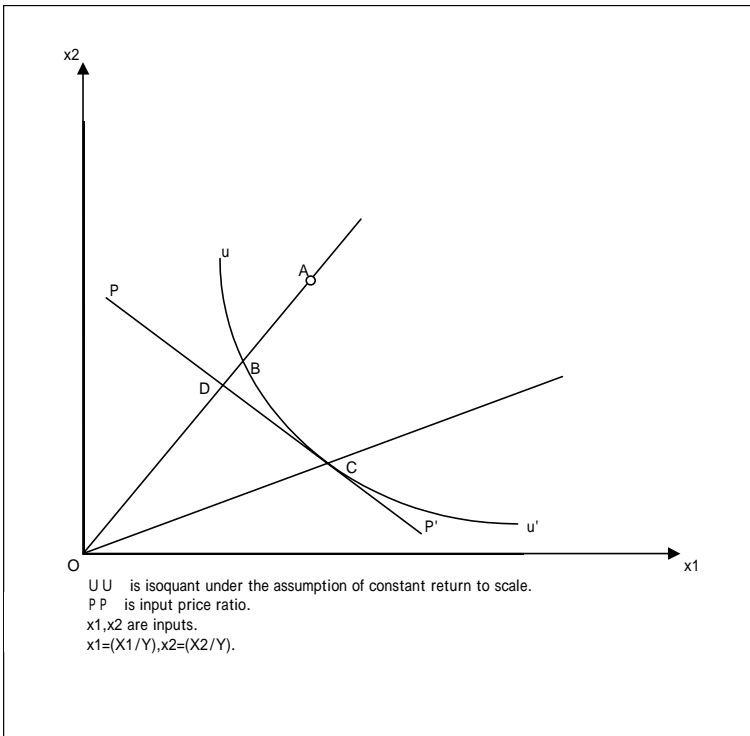
Despite this weakness, this paper employs the nonparametric approach because it has two theoretical properties that are especially useful for interpretations. One is that the DEA model is mathematically related to a multi-objective optimization problem in which all inputs and outputs are defined as multiple objectives. The other property is that DEA efficiency scores are independent of the units in which inputs and outputs are measured (Yue 1992). As Drake and Hall (2003) pointed out, given the wide diversity across banking institutions in Japan in size and business, these features of DEA are important.

A firm's efficiency consists of two components: technical efficiency, which reflects the ability of a firm to obtain maximal output from a given set of inputs, and allocative efficiency, which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices (Coelli 1997). These two measures of efficiency are combined and described as overall efficiency.

Because the measure of efficiency in DEA analysis varies from model to model, we employ the input-oriented measure. The treatment below mainly

followed Farrell (1957) and Coelli (1997). For a simple case, two inputs ( $x_1$  and  $x_2$ ) are used to produce an output ( $y$ ) under the assumption of constant return to scale. In Figure 1, the unit isoquant of the fully efficient firm is represented by  $UU'$  and the input price ratio is represented by the line  $PP'$ . As the fully efficient firm is not known in reality, this isoquant is estimated from observations. Firms on the isoquant have overall efficiency, and the efficiency level is 1 under the assumption of constant returns to scale.

**Figure 1. Technical and Allocative Efficiencies**



If a firm uses quantities of inputs defined by point A, this point is not only technically efficient but also allocatively efficient. Any firm on the line OA produces output with the same inappropriate input mix, but the firm

located on A is able to choose B where it requires fewer inputs without changing the input mix. The distance BA could represent the technical inefficiency of that firm, which is the amount by which two inputs could be proportionately reduced without reduction in output. The distance BA is the additional cost attributing to the inappropriate technology. Producing output at point B, that firm can reduce cost by the ratio BA/OA and is fully technically efficient because technical efficiency is measured by the ratio OB/OA, which will take a value between 0 and 1. If a firm takes 1, which lies on the isoquant, that indicates that the firm is fully technically efficient.

Producing output at B, however, is allocatively inefficient in choosing an inappropriate input mix. The firm at C is both technically and allocatively efficient in choosing the cost minimizing production process given the relative input price. Therefore, a technically efficient firm located at B can attain point C by changing the input mix. Producing output at C is equivalent to producing the same level of output as the input required at D. The allocative efficiency of the firm operating at A is defined as the ratio OD/OB because the distance DB represents the reduction in production costs that would occur if production point C were chosen. Therefore, by producing output at point C, the firm can attain an allocatively and technically efficient point.

As technical efficiency is OB/OA and allocative efficiency is OD/OB, the overall efficiency is defined, by adding both efficiencies, as the ratio OD/OA (=OB/OA+OD/OB). The distance DA is interpreted in terms of a cost reduction.

## 2. Data Envelope Analysis

DEA constructs a nonparametric envelopment frontier over the data points that all the observed points lie on, or below the production frontier when input-oriented measures are adopted. Assuming constant return to scale, the following duality in the linear programming problem needs to be solved:

$$\begin{aligned}
 & \min_{\lambda, \theta} \theta \\
 \text{s.t.} \quad & -y_i + Y\lambda \geq 0, \\
 & \theta x_i - X\lambda \geq 0, \\
 & \lambda \geq 0.
 \end{aligned} \tag{1}$$

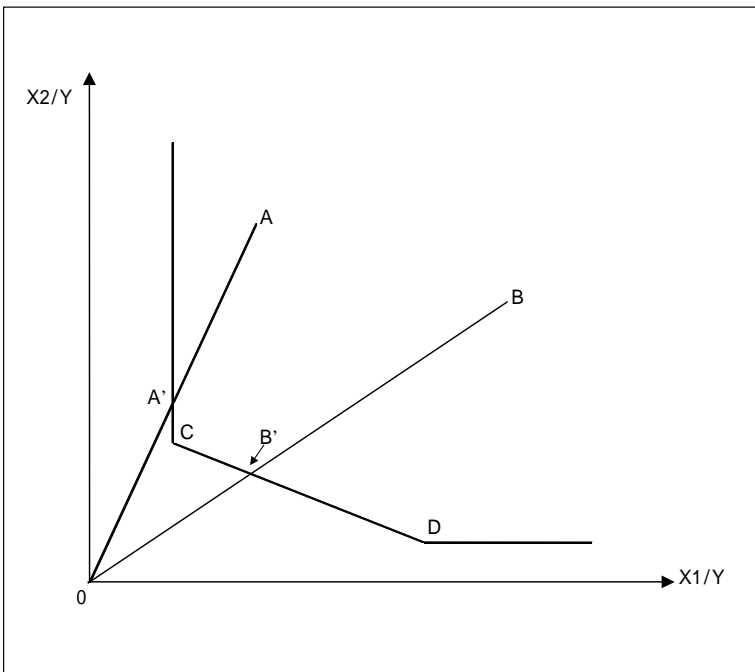
Where  $\theta$  is a scalar and will satisfy  $\theta \leq 1$ . A value of  $\theta = 1$  indicates that it is a point on the frontier and a technically efficient point.  $\lambda$  is a  $N \times 1$  column vector. In this problem,  $K$  inputs and  $M$  outputs of  $N$  firms are assumed so that the  $K \times N$  input matrix,  $X$ , and the  $M \times N$  output matrix are used as the data. That is,  $y_i = (y_1, y_2, \dots, y_m)$  is a vector of outputs produced by a particular firm and  $x_i = (x_1, x_2, \dots, x_k)$  is a vector of inputs utilized by the firm. The obtained value of  $\theta$  will be the efficiency score for firm  $i$ . This linear programming must be solved  $N$  times for each firm and  $\theta$  will then be obtained.<sup>12)</sup>

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12) Following Coelli (1997), the best way to introduce DEA is via the ratio form. For each firm, the ratio of all outputs over all inputs needs to be obtained. They are, for example,  $u' y_i / v' x_i$  where  $u$  is an  $M \times 1$  output weights vector and  $v$  is  $K \times 1$  vector of input weights. The first programming problem is to select optimal weights. By finding values for  $u$  and  $v$ , efficiency measures are maximized. See Coelli (1997) for a detailed explanation.

As pointed out in earlier literature such as Coelli (1997) or Greene (1997), these efficiency measures assume that there is a production function of the fully efficient firm. In empirical estimation, the efficient isoquant must be estimated from the sample data; a piecewise-linear convex isoquant might occasionally be observed as shown in Figure 2. This piecewise-linear convex isoquant leads to a problem known as “slacks.”

**Figure 2. Piecewise-linear convex isoquant**



Based on the analysis in the previous subsection, points A and B are not technically nor allocatively efficient points, and points A' and B' are not always efficient although they are points on the isoquant. This is because producing on the line between C and D is efficient, and using input

combinations C and D defines the frontier. At point A', a firm could reduce the amount of input x2 used by the amount CA', so it is doubtful whether a point on the isoquant is an efficient point. The amount CA' is known as "slack." DEA tends to treat inefficiency caused by slack as allocative inefficiency. However, the firm would not be able to improve its efficiency level without changing technology, even where there are output slacks. A suggestion for finding stricter efficient points is to use multistage DEA where a sequence of linear programming is conducted to identify the efficient point.<sup>13)</sup> Multistage DEA conducts a sequence of radial linear programming and removes inefficiency caused by slacks.

A DEA model to account for variable returns to scale (VRS, i.e. increasing return to scale and decreasing return to scale) is also provided as an extension of the constant returns to scale (CRS) DEA. The CRS assumption is valid only when all firms are operating at an optimal scale. Following Coelli (1997), the CRS linear programming problem may be easily modified by adding a constraint:  $N1' \lambda = 1$  into equation (1).

$$\begin{aligned}
 & \min_{\lambda, \theta} \theta \\
 \text{s.t.} \quad & -y_i + Y\lambda \geq 0, \\
 & \theta x_i - X\lambda \geq 0, \\
 & N1' \lambda = 1 \\
 & \lambda \geq 0.
 \end{aligned} \tag{2}$$

where  $N1$  is an  $N \times 1$  vector of ones. The addition of this constraint provides more accurate technical efficiency scores, which are greater or

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13) Koopman(1951) defined strict technical efficiency. See Ferrier and Lovell (1990) for more detail regarding multistage DEA. Of course, if an infinite sample size were available, the slack issue would be ignored.

equal to those obtained using the CRS DEA. This is because CRS DEA results in measuring technical efficiency are confused by scale efficiency when not all firms are operating at an optimal scale (which is understood in the context of microeconomics, that is it corresponds to the flat portion of the long-run average cost curve).

### 3. The Data and Specification of Bank Production

This study uses financial statement data of banks from the Korea Information Service's (KIS) database and employee data from FSS (2004b).<sup>14)</sup> Data was collected on all unconsolidated statements because consolidated statements were not available at the beginning of the sample period and some regional banks that are under a financial holding company are not yet fully integrated.<sup>15)</sup> Nationwide and regional banks that disclose financial statements are analyzed from 1996 to 2003.<sup>16)</sup> This means that delisted but existing banks are in the sample. In Korea, although some banks delisted themselves from the Korea Stock Exchange (which became the Korea Exchange from January 2005 as a result of the integration of the Korea Stock

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14) Financial statements data and various kinds of micro and macro data are also available on the FSS homepage. One shortcoming of the website is that information on delisted banks is no longer available.

15) A large bank usually absorbs small banks; otherwise a holding company reorganizes whole institutions under its umbrella. Korean banks under holding companies are not yet renamed nor reorganized.

16) Specialized banks (the Korea Development Bank, the Export-Import Bank of Korea, the Industrial Bank of Korea, the credit and banking sector of the National Agricultural Cooperative Federation, and the credit and banking sector of the National Federation of Fisheries Cooperatives) are government-controlled banks and not included in the sample banks.



Exchange, the Futures Exchange, the Kosdaq Market, and the Kosdaq Committee) due to foreign owners' or holding companies' intentions, they were not bankrupted.

To measure relative efficiency, the most important step is the selection of appropriate inputs and outputs. There are two main approaches, "intermediation" and "production" (see Berger and Humphrey 1997 and Yue 1992). The first approach views banks as financial intermediaries whose primary business is borrowing funds from depositors and lending money to others. Under the alternative approach, banks are perceived as institutions that use capital and labor to produce loans and other services; banks' inputs are labor, capital, and operating costs while their outputs are their accounts and transactions. This study employs the production approach and banks are regarded as institutions that produce returns. Three types of outputs and five types of inputs are as follows:

- Y1: Interest income
- Y2: Commission income
- Y3: Other operating income
- X1: Total shareholders' equity
- X2: Number of employees
- X3: Premises and equipment for operation
- X4: General and administrative expenses
- X5: Other expenses

All units are million Won except for the number of employees.

As suggested in Drake and Hall (2003), other business income is included as an output to capture diversified banking business such as fee-income generating business (see Table 2 for a detailed description of subitems, and

**Table 2. The Data**

(Unit: million won except number of employees)

Output	
Financial Statements Items	Subitems
Interest Income	Interest income in won
	Interest on Loans
	Interest on Advances for Customers
	Interest on Call Loans
	Interest on Deposits with Banks
	Interest on Local L/C Bills Bought
	Other Interest Income
	Interest income in Foreign currency
	Interest on Loans
	Interest on Domestic Import Usance
	Interest on Call Loans
	Interest on Call Loans
	Interest on Deposits with Banks
	Other Interest Income in Foreign Currency
	Interest Income on Securities
Interest on Securities	
Dividend Income	
Commission Income	Commission Received in won
	Guarantee Fees in won
	Commission Received
	Credit Card Commission
	Commission Received in Foreign Currency
	Guarantee Fees in Foreign Currency

Table 2. Continued

Commission Income	Commission Received in Foreign Currency
	Discount Earned on Bills Bought
	Credit Card Commission in Foreign Currency
Other Operating Income	Gain on Working of Securities
	Gain on Sale of Securities
	Gain on Redemption of Securities
	Gain on Securities Valuation
	Other Gains
Inputs	
Total shareholders' equity	
Number of Employees	
Premises and Equipment for Operation	Lands for Operation
	Buildings for Operation
	Movables for Operation
	Construction in Process
	Guarantee Money for Bank Premises
	Intangible Fixed Assets
General and Administrative Expenses	Salaries
	Administrative Expenses Except for Salaries
Other Expenses	Loss on FX Transactions
	Contbn. To Credit Guaranty Fund
	Taxes and Dues
	Depreciation etc
	Provision for Severance Pay
	Provision for Possible Loan Losses
	Others

Appendix Tables A3 to A9 for the data in terms of per employee). Outstanding loans were not used as an output because of the possibility that possible nonperforming loans might be included as seemingly sound loans. Moreover, as Joh (2003) pointed out, if banks' lending decisions were not based on the firms' profitability or ability to pay back their borrowings, loan variables are not an appropriate indicator. As the principal and interest of all deposits were fully guaranteed until the end of 2000 to prevent the banking sector's collapse during the crisis period, deposits also cannot be a good indicator as an input because of moral hazard under a regime of deposit protection.

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## IV. Estimation Results

Tables 3 to 9 report year-by-year results of the DEA efficiency scores and returns to scale measures. Looking at the average efficiency scores of each year at the bottom of each table provides striking evidence of gradual deterioration in scores to 1999 and improvement in scores each year of the post-crisis period. These findings hold true for most years as the mean scale efficiencies are 0.968 in 1996, 0.955 in 1997, and 0.937 and 0.929 in 1998 and 1999, respectively, which then improve to 0.976 in 2000, 0.983 in 2001, 0.99 in 2002, and 0.992 in 2003. "Scale" is pure technical efficiency, and if "scale" for a bank is 1 then the bank operates at the optimal level. On average, Korean banks have improved their performance in terms of efficiency scores since 2000. It is also suggested that the changes that occurred during this period, mainly financial reforms such as lifting of the limit on stake holdings by foreign investors and acceptance of bank holding companies, might have had positive effects on the improvements.

In the tables, "crste" and "vrste" stand for technical efficiency scores given by the constant returns to scale model and variable returns to scale model, respectively. As "scale" is pure technical efficiency, it takes the same level with "vrste" or larger than "vrste" as explained in section 3. "Irs" or "drs" in the rightmost column mean that increasing returns to scale or decreasing returns to scale are observed, respectively. If a bank operates at decreasing returns to scale, then a proportionate increase in all of its inputs results in a less than proportionate increase in its outputs; however, it should be noted that the bank is assumed to operate at a technically efficient level.

Therefore, “crste” means that a bank operates at the level where an increase in inputs results in a proportionate increase in the output levels.

Regional banks’ technical efficiencies (“crste”, “vrste”, and pure technical efficiency of “scale”) are smaller than nationwide banks and deteriorated more from 1996 to 1998, as shown in Tables 3 to 6. For example, some regional banks, including three that had their business licenses revoked by the FSC, show lower than average scores in Table 3; their scores do not improve even in 2000. As an example, “crste” of Jeju Bank and Kyongnam Bank are 0.665 and 0.869 in Table 7, but their scores improved greatly in 2003 after coming under the umbrellas of bank holding companies (Jeju Bank is a subsidiary of the Shinhan Financial Group and Kyongnam Bank is under Woori Financial Holdings). Scores of other banks that entered under holding companies (Kwangju Bank and Chohung Bank) were not poor originally, but they are now satisfactory <sup>17)</sup> Larger banks that are core banks of bank holding companies also show 1 as their efficiency scores. Kookmin Bank, Hana Bank, KorAm Bank, Shinhan Bank, and Woori Bank all improved efficiency after 2002. These results apparently suggest that improvements in scale efficiency of these banks are consistent with the hypothesis that consolidated larger banks perform better. This can happen if a merger improves cost efficiency by allowing the same outputs while employing a smaller value of inputs, or if it improves profit efficiency by increasing the value output produced more than the value of inputs used. Larger banks’ (Hanvit Bank, Shinhan Bank, and Chohung Bank) scale efficiency

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17) Ashcraft (2004) found that bank holding companies are a source of strength to their subsidiaries by analyzing the U.S. banking sector. It is also stated that distressed affiliated banks recovered from distress more quickly than either a stand-alone bank or a bank affiliated with a one-bank holding company (Ashcraft 2004 divided bank holding companies into two kinds).

substantially deteriorated temporarily in 1999; however, this seems to be due to the compulsory mergers of small nonviable banks (see Appendix Figures A1 and A2) as it is shown that these banks operate at decreasing returns to scale (“drs” in Table 6).

Banks with high foreign ownership show high scores.<sup>18)</sup> Korea Exchange Bank, KorAm Bank, and Cheil Bank are those banks with a high ratio, and their scores are all 1 in each category. Figures of banks with high foreign ownership ratio, however, were stable throughout the sample period. Thus, it is not obvious that banks perform better after they accept foreign capital. Otherwise, foreign investors injected their capital only in the relatively sound banks and the government dealt with nonviable banks. However, the profitability per employee data in Appendix Tables A3 to A5 show that banks with high foreign ownership ratio improved profitability dramatically during the sample period while these banks’ costs per employee were not decreased (see also Appendix Tables A6 to A9).<sup>19)</sup>

Most of the results in Tables 3 to 10 are well supported by the evidence in Appendix Tables A3 to A9. There is no way to distinguish improvements in efficiency from increases in the exercise of market power from M&As. This

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18) Some banks with high foreign ownership ratio are of course large banks, so for those banks it is not clearly apparent which factor affected the improvement more.

19) Outputs and inputs are divided by number of employees instead of assets to adjust bank size. It is recognized that corporate governance of Korean banks was not established until recent years and regulatory authorities controlled banks. Therefore maximizing their assets were Korean banks’ main interest and number of employees and branches were also regulated (see Park 2005 and Joh 2002). It is supposed that under the new regulatory system the number of employees was more easily changed to improve profitability rather than changes in fixed assets.

paper employs a nonparametric approach and examines five costs and three output ratios because it is better than examining parametric simple cost or profit models. However, such ratios include both effects, namely, improvements in efficiency and increases in market power.<sup>20)</sup> Therefore, each output and input per employee is supplementally shown in Appendix Tables A3 to A9 to examine how each bank performed year by year. Commission and other operating income of larger banks increases rapidly despite some downturn, as does that of banks with high foreign ownership ratio. Apparently, cost reduction is not very obvious from the appendix tables, although it also shows some improvement. Stable premises and equipment for operation in Appendix Table A7 and stable general and administrative expenses in Appendix Table A8 are indicators of soundness. Because premises and equipment for operation include land and buildings for operation, if a bank reduces both its premises and equipment for operation and its number of employees, then the ratio might not be changed. Much the same is true for general and administrative expenses. Therefore, we find that consolidation in the Korean banking sector did improve its efficiency.

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20) Cost may decrease because the consolidated bank is able to produce the same amount of output with fewer inputs or because the increase in local market concentration allows it to pay lower rates (Berger 1998).



**Table 3. Result 1996 (1996 January-1996 December)**

Name	Note	Crste	Vrste	Scale	
Shinhan Bank		1	1	1	-
Commercial Bank of Korea	Later Hanvit with Hanil in 1999 and Woori in 2001	1	1	1	-
Hana Bank		1	1	1	-
Chohung Bank		1	1	1	-
Korea Exchange Bank		1	1	1	-
KorAm Bank		1	1	1	-
Cheil Bank		1	1	1	-
Seoul Bank		1	1	1	-
Peace Bank		1	1	1	-
Hanil Bank	Hanil up to 1998 and Hanvit untill 2001, then Woori	1	1	1	-
Jeonbuk Bank		0.874	0.931	0.939	irs
Jeju Bank		0.561	1	0.561	irs
Daegu Bank		1	1	1	-
Pusan Bank		1	1	1	-
Kwangju Bank		0.952	0.982	0.969	irs
Kyongnam Bank		0.921	0.925	0.996	irs
Kangwon Bank		0.974	1	0.974	irs
Chungbuk Bank		0.895	1	0.895	irs
Boram Bank		1	1	1	-

Table 3. Continued

Chung Chong Bank		0.896	0.945	0.948	irs
Kyonggi Bank		0.909	0.957	0.951	irs
Daedong Bank		0.993	1	0.993	irs
Dongnam Bank		1	1	1	-
Dongwha Bank		1	1	1	-
mean		0.957	0.989	0.968	

**Table 4. Result 1997 (1997 January-1997 December)**

Name	Note	Crste	Vrste	Scale	
Shinhan Bank		1	1	1	-
Commercial Bank of Korea	Later Hanvit with Hanil in 1999 and Woori in 2001	1	1	1	-
Hana Bank		1	1	1	-
Chohung Bank		0.99	1	0.99	drs
Korea Exchange Bank		1	1	1	-
KorAm Bank		1	1	1	-
Cheil Bank	Fully controlled by the government	1	1	1	-
Seoul Bank	Fully controlled by the government	1	1	1	-
Peace Bank	Fully controlled by the government	1	1	1	-
Korea Housing Bank		1	1	1	-

Table 4. Continued

Hanil (later Hanvit) Bank	Fully controlled by the government	0.964	1	0.964	drs
Jeonbuk Bank	Merged by Hana Bank in 1998	0.775	1	0.775	irs
Jeju Bank	Fully controlled by the government	0.691	1	0.691	irs
Daegu Bank		0.965	0.971	0.995	drs
Pusan Bank		1	1	1	-
Kwangju Bank	Fully controlled by the government	0.84	0.891	0.943	irs
Kyongnam Bank	Fully controlled by the government	1	1	1	-
Kangwon Bank		0.843	1	0.843	irs
Chungbuk Bank		0.782	1	0.782	irs
Boram Bank	Merged by Hana Bank in 1998	1	1	1	-
Chung Chong Bank	Merged by Hana Bank in 1998	0.861	0.951	0.905	irs
Kyonggi Bank	Merged by KorAm Bank in 1998	1	1	1	-
Daedong Bank	Merged by Kookmin in 1998	0.983	1	0.983	irs
Dongnam Bank	Merged by Korea Housing in 1998	1	1	1	-
Dongwha Bank	Merged by Shinhan in 1998	1	1	1	-
mean		0.948	0.992	0.955	

Note: Public funds were injected in several major banks, either full or partial stakes were acquired by the government. The amount was about 34 trillion won.

**Table 5. Result 1998 (1998 January-1998 December)**

Name	Note	Crste	Vrste	Scale	
Shinhan Bank	Urged to purchase failed regional banks compulsorily	1	1	1	-
Hanvit (later Woori) Bank	Urged to purchase failed regional banks compulsorily	0.784	1	0.784	drs
Hana Bank	Urged to purchase failed regional banks compulsorily	1	1	1	-
Chohung Bank	Urged to purchase failed regional banks compulsorily	1	1	1	-
Korea Exchange Bank		1	1	1	-
KorAm Bank	Urged to purchase failed regional banks compulsorily	1	1	1	-
Cheil Bank	Fully controlled by the government	0.98	1	0.98	drs
Seoul Bank	Fully controlled by the government	1	1	1	-
Peace Bank	Fully controlled by the government	1	1	1	-
Korea Housing Bank	Urged to purchase failed regional banks compulsorily	1	1	1	-
Hanil Bank		0.928	1	0.928	drs
Jeonbuk Bank		0.724	1	0.724	irs
Jeju Bank	Fully controlled by the government	0.435	1	0.435	irs
Daegu Bank		0.84	0.841	0.999	drs
Pusan Bank		1	1	1	-
Kwangju Bank	Fully controlled by the government	0.757	0.791	0.957	irs
Kangwon Bank		1	1	1	-
Kyongnam Bank	Fully controlled by the government	0.845	0.879	0.962	irs
Jeonbuk Bank		0.974	1	0.974	irs
Boram Bank		1	1	1	-
mean		0.913	0.976	0.937	

Note: The compulsory intergration process finished by June 1998.

**Table 6. Result 1999 (1999 January-1999 December)**

Name	Note	Crste	Vrste	Scale	
Hanvit (later Woori) Bank	Woori FH established	0.858	1	0.858	drs
Hana Bank		1	1	1	-
Shinhan Bank	Shinhan FG established	0.633	1	0.633	drs
Chohung Bank		0.833	1	0.833	drs
Korea Exchange Bank		1	1	1	-
KorAm Bank		1	1	1	-
Cheil Bank		1	1	1	-
Seoul Bank		1	1	1	-
Peace Bank		1	1	1	-
Korea Housing Bank	Merge with Kookmin and become Kookmin in 2000	1	1	1	-
Jeonbuk Bank		0.631	0.874	0.722	irs
Jeju Bank		0.87	1	0.87	irs
Daegu Bank		0.819	0.856	0.956	irs
Pusan Bank		1	1	1	-
Kwangju Bank		1	1	1	-
Kyongnam Bank		1	1	1	-
mean		0.915	0.983	0.929	

Notes: 1) "Financial Holding Company Act" of 1999 was enacted and holding company was introduced in 1999.

2) "Foreign Investment Promotion Act" was enacted in November 1998.

**Table 7. Result 2000 (2000 January-2000 December)**

Name	Note	Crste	Vrste	Scale	
Hanvit (later Woori) Bank	Rehabilitation plan disapproved (once)	1	1	1	-
Hana Bank		1	1	1	-
Shinhan Bank		1	1	1	-
Chohung Bank		1	1	1	-
Korea Exchange Bank		1	1	1	-
KorAm Bank		1	1	1	-
Cheil Bank		0.992	1	0.992	drs
Seoul Bank		1	1	1	-
Peace Bank	Rehabilitation plan disapproved (once). Become Woori Credit Card Company in 2001.	1	1	1	-
Kookmin Bank		1	1	1	-
Jeonbuk Bank		1	1	1	-
Jeju Bank	Rehabilitation plan disapproved (once). Shinhan Bank's contract for consultation.	0.665	1	0.665	irs
Daegu Bank		0.906	0.933	0.971	irs
Pusan Bank		0.996	1	0.996	drs
Kwangju Bank	Rehabilitation plan disapproved (once)	1	1	1	-
Kyongnam Bank	Rehabilitation plan disapproved (twice). Judged as nonviable	0.869	0.871	0.997	drs
mean		0.964	0.988	0.976	

Note: Six commercial banks were requested to submit rehabilitation plans in September 1999.

**Table 8. Result 2001 (2001 January-2001 December)**

Name	Note	Crste	Vrste	Scale	
Shinhan Bank		0.997	1	0.997	drs
Woori Bank		0.935	1	0.935	drs
Hana Bank		1	1	1	-
Kookmin Bank		0.972	1	0.972	drs
Chohung Bank		1	1	1	-
Korea Exchange Bank		1	1	1	-
KorAm Bank		1	1	1	-
Cheil Bank		1	1	1	-
Seoul Bank	Taken over by Hana Bank in 2002.	1	1	1	-
Jeonbuk Bank		1	1	1	-
Jeju Bank		0.854	1	0.854	irs
Daegu Bank		1	1	1	-
Pusan Bank		1	1	1	-
Kwangju Bank		1	1	1	-
Kyongnam Bank		0.968	0.984	0.984	irs
mean		0.982	0.999	0.983	

**Table 9. Result 2002 (2002 January-2002 December)**

Name	Note	Crste	Vrste	Scale	
Shinhan Bank	Shinhan FG	1	1	1	-
Woori Bank	Woori FH	1	1	1	-
Hana Bank		1	1	1	-
Kookmin Bank	Foreign Ownership	0.909	1	0.909	drs
Chohung Bank	Shinhan FG	1	1	1	-
Korea Exchange Bank	Foreign Ownership	1	1	1	-
KorAm Bank	Foreign Ownership	1	1	1	-
Cheil Bank	Foreign Ownership	1	1	1	-
Jeonbuk Bank		0.947	1	0.947	irs
Jeju Bank	Shinhan FG	1	1	1	-
Daegu Bank		1	1	1	-
Pusan Bank		1	1	1	-
Kwangju Bank	Woori FH	1	1	1	-
Kyongnam Bank	Woori FH	1	1	1	-
mean		0.99	1	0.99	



**Table 10. Result 2003 (2003 January-2003 December)**

Name	Note	Crste	Vrste	Scale	
Shinhan Bank	Shinhan FG (100%)**	1	1	1	-
Woori Bank	Woori FH	1	1	1	-
Hana Bank	Foreign Ownership (26.74%)	1	1	1	-
Kookmin Bank	Foreign Ownership (17.37%)	1	1	1	-
Chohung Bank	Shinhan FG (81.15%)	1	1	1	-
Korea Exchange Bank	Foreign Ownership (64.75%)	1	1	1	-
KorAm Bank	Foreign Ownership (85.82%)	1	1	1	-
Cheil Bank	Foreign Ownership (48.56%)	1	1	1	-
Jeonbuk Bank		1	1	1	-
Jeju Bank	Shinhan FG (62.42%)	0.967	1	0.967	irs
Daegu Bank		0.936	1	0.936	drs
Pusan Bank		0.988	1	0.988	drs
Kwangju Bank	Woori FH (99.99%)	1	1	1	-
Kyongnam Bank	Woori FH (99.99%)	1	1	1	-
mean		0.992	1	0.992	

Notes: 1) Ownership structure of the above banks mostly as of end of 2003.

2) Shinhan FG's foreign ownership is 46.98% as of end of August 2003.

Sources: Foreign ownership are Park (2005) and Korea Federation of Banks' homepage.

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## V. Conclusion

This paper has investigated how the Korean banking sector accomplished reforms by adopting a focus on mergers and acquisitions of banks. The purpose of this paper is to offer empirical evidence on efficiency improvements of Korean banks by using a nonparametric frontier approach, which has gained popularity in banking analyses in recent years. Although Korean banks have experienced dramatic structural reforms, there appear to be few empirical papers that examine whether bank consolidations were effective or how each Korean bank changed and performed quantitatively.

This paper attempted to evaluate bank consolidations based on two hypotheses. First, it considered whether banks with high foreign ownership ratio performed well because foreign management improved bank management and performance that resulted in efficient production. Second, it determined whether large banks and banks under a holding company improved their efficiencies. If a merger improves cost efficiency by allowing the same outputs while employing a smaller value of inputs or it improves profit efficiency by increasing the value of output produced more than the value of inputs used, then becoming larger brings improvements in efficiency.

Our findings supported the hypotheses and suggested that consolidations in the Korean banking sector improved efficiencies. Furthermore, average bank scale efficiency, which had deteriorated until 1998, gradually improved to 2003. Therefore, the government's stabilization of the financial sector has achieved significant improvement in the banking sector in general in recent years. Two key ongoing policy issues, the

effectiveness of consolidation and the increase in foreign participation in the financial sector, have so far shown positive results.

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## Appendix Table

**Table A1. Summary of Appendix Figure 1 Correspondence of banks before and after mergers and reorganization**

Before	After	Comments:
Shinhan Bank Jeju Bank Chohung Bank	Shinhan Financial Group Listed September 2001	Jeju Bank officially incorporated as a subsidiary company in May 2002. BNP Paribas Group, as of the end of 2003, held 4.61% of SFG's common stocks. Shinhan Financial Group (SFG) bought Chohung Bank shares that had been held by the Government, which represented 80.04% of Chohung Bank's total share. Chohung Bank and Jeju Bank are existing but delisted from the Korean Stock Exchange.
Woori Bank Kyongnam Bank Kwangju Bank	Woori Financial Holding Co. Listed April 2001	Woori Financial Holdings (WFH) was set up by the Korean government through the Korea Development Insurance Corporation (KDIC) and was fully privatized. Kyongnam Bank and Kwangju Bank are existing but delisted from the Korean Stock Exchange.

**Table A2. Banking Industry in Korea**

Type of banks	Operations
Nationwide Banks	Regulated by the Banking Act. Include nationwide banks, regional banks and branches of foreign banks. Have branch networks throughout the entire country. Engage in deposit taking, lending and payment and settlement. Handle trusts and securities to a limited extent.
Regional Banks	Operate within the provinces where they are based. Major customers are small and medium sized companies. Engage in many of the same businesses as nationwide banks. Some businesses such as foreign currency deposit taking and loan making, are smaller.
Branches of Foreign Banks	A restriction regarding business area was lifted recently (they used to pursue only wholesale banking). Expanding into retail banking.
Specialized Banks	Established for special industrial needs. Have more channels of financing at their disposal than commercial banks.

Source: Korea Federation of Banks [www.kfb.or.kr/Eng/08\\_industry/industry01.php](http://www.kfb.or.kr/Eng/08_industry/industry01.php).



**Table A3. Interest Income / Number of employees**

(Unit: million won)

Name	1996	1997	1998	1999	2000	2001	2002	2003
Shinhan Bank	25,034	31,276	50,023	21,802	25,798	14,465	4,667	5,009
Woori (Hanvit, Commercial Bank of Korea )	229,314	302,709	279,490	453,316	532,591	424,892	478,066	550,398
Hana Bank	874,639	1,031,847	1,000,425	412,754	450,605	367,553	412,381	594,670
Kookmin (Korea Housing Bank 97-00)	-	245,754	509,926	446,893	534,886	381,209	598,109	594,596
Chohung Bank	221,954	310,110	626,959	439,630	538,756	524,344	498,371	504,055
Korea Exchange Bank	253,371	360,318	674,164	538,713	591,603	569,188	483,024	528,316
KorAm Bank	210,696	329,355	559,610	568,027	598,327	604,373	660,584	709,349
Cheil Bank	238,328	281,303	546,477	353,482	397,996	371,990	368,087	457,343
Seoul Bank	62,371	121,866	370,242	483,055	743,726	741,556	-	-
Peace Bank	140,080	175,726	359,221	437,492	532,543	-	-	-
Hanil Bank	216,244	303,518	621,162	-	-	-	-	-
Jeonbuk Bank	169,750	181,879	342,353	279,073	309,232	342,890	344,950	325,208
Jeju Bank	88,006	119,737	182,167	219,088	284,909	383,568	425,823	402,771
Daegu Bank	192,837	247,551	434,392	368,014	415,910	458,430	478,511	493,339
Pusan Bank	183,798	240,404	476,967	388,666	415,995	480,846	474,888	467,813
Kwangju Bank	195,200	235,054	337,461	335,994	408,743	364,316	436,120	498,316
Kyongnam Bank	176,190	208,450	389,909	322,967	413,511	396,905	424,632	515,470
Kangwon Bank	178,469	218,678	379,870	-	-	-	-	-
Chungbuk Bank	156,887	197,682	347,915	-	-	-	-	-
Boram Bank	258,065	401,422	909,416	-	-	-	-	-
Chung Chong Bank	175,722	190,588	-	-	-	-	-	-
Kyonggi Bank	164,092	195,899	-	-	-	-	-	-
Daedong Bank	157,058	198,815	-	-	-	-	-	-
Dongnam Bank	174,289	241,890	-	-	-	-	-	-
Dongwha Bank	163,919	254,071	-	-	-	-	-	-

**Table A4. Commision Income / Number of employees**

(Unit: million won)

Name	1996	1997	1998	1999	2000	2001	2002	2003
Shinhan Bank	38,967	50,308	71,751	67,808	87,160	104,659	94,070	65,489
Woori (Hanvit Commercial Bank of Korea )	31,192	35,475	25,353	47,077	73,756	92,304	64,480	57,604
Hana Bank	170,921	168,063	112,375	47,295	51,483	64,897	44,730	65,081
Kookmin (Korea Housing Bank 97-00)	-	32,007	53,963	55,293	83,433	32,332	73,242	83,683
Chohung Bank	35,378	40,469	63,421	61,412	106,072	162,312	196,746	172,490
Korea Exchange Bank	25,754	34,865	50,090	42,793	48,372	53,145	58,243	65,488
KorAm Bank	16,721	22,583	30,177	48,434	55,852	101,389	110,801	105,922
Cheil Bank	33,046	37,088	47,302	39,433	45,245	58,198	72,212	78,772
Seoul Bank	6,180	9,366	19,001	22,523	37,203	60,527	-	-
Peace Bank	54,650	113,566	217,079	129,868	74,470	-	-	-
Hanil Bank	28,887	36,772	57,115	-	-	-	-	-
Jeonbuk Bank	9,168	11,895	18,083	17,246	24,378	40,465	28,646	27,108
Jeju Bank	10,241	12,335	13,086	13,169	24,940	58,439	82,266	63,851
Daegu Bank	19,820	24,144	24,725	28,682	38,715	59,231	56,583	58,386
Pusan Bank	16,624	19,915	33,286	30,875	40,111	63,544	61,229	61,703
Kwangju Bank	17,553	22,958	34,013	28,626	41,968	51,406	58,478	38,076
Kyongnam Bank	14,623	15,965	17,762	19,923	32,067	44,866	65,528	63,201
Kangwon Bank	14,382	16,362	27,469	-	-	-	-	-
Chungbuk Bank	17,892	19,254	24,928	-	-	-	-	-
Boram Bank	27,544	37,649	56,789	-	-	-	-	-
Chung Chong Bank	14,003	16,744	-	-	-	-	-	-
Kyonggi Bank	14,306	17,891	-	-	-	-	-	-
Daedong Bank	21,275	24,437	-	-	-	-	-	-
Dongnam Bank	24,144	35,935	-	-	-	-	-	-
Dongwha Bank	41,790	55,546	-	-	-	-	-	-

**Table A5. Other Operating Income / Number of employees**

(Unit: million won)

Name	1996	1997	1998	1999	2000	2001	2002	2003
Shinhan Bank	40,176	343,444	457,112	95,184	133,715	175,289	240,091	221,522
Woori (Hanvit, Commercial Bank of Korea )	14,118	59,856	54,541	121,366	136,032	135,913	105,285	137,431
Hana Bank	154,699	352,201	736,183	322,713	108,868	81,406	66,986	126,080
Kookmin (Korea Housing Bank 97-00)	-	86,467	93,652	62,210	59,333	159,238	176,878	430,366
Chohung Bank	18,642	50,111	258,943	132,485	120,425	102,959	103,480	134,880
Korea Exchange Bank	46,084	104,064	430,317	204,669	263,762	366,060	312,445	317,941
KorAm Bank	28,931	221,364	431,999	200,592	225,156	284,575	413,228	469,603
Cheil Bank	23,755	78,064	143,239	334,574	66,107	43,996	28,406	38,230
Seoul Bank	9,126	26,857	55,484	73,377	127,862	119,490	-	-
Peace Bank	14,931	53,099	86,513	85,131	120,413	-	-	-
Hanil Bank	23,707	137,346	202,523	-	-	-	-	-
Jeonbuk Bank	9,637	142,655	328,685	57,922	43,123	42,550	19,086	61,658
Jeju Bank	11,816	14,035	21,715	105,796	18,617	25,537	13,624	9,507
Daegu Bank	15,772	26,429	50,604	55,432	36,408	20,497	30,036	40,176
Pusan Bank	17,075	22,570	52,145	49,816	28,868	40,142	36,951	29,853
Kwangju Bank	16,478	38,828	37,907	29,931	22,330	25,996	16,749	16,714
Kyongnam Bank	14,160	17,059	35,665	95,756	35,600	67,864	59,981	29,712
Kangwon Bank	14,870	57,697	84,472	-	-	-	-	-
Chungbuk Bank	22,239	27,274	28,961	-	-	-	-	-
Boram Bank	33,533	82,785	168,498	-	-	-	-	-
Chung Chong Bank	9,954	-174	-	-	-	-	-	-
Kyonggi Bank	24,954	163,974	-	-	-	-	-	-
Daedong Bank	14,021	17,245	-	-	-	-	-	-
Dongnam Bank	14,889	30,619	-	-	-	-	-	-
Dongwha Bank	19,212	51,636	-	-	-	-	-	-

**Table A6. Shareholders' Equity / Number of employees**

(Unit: million won)

Name	1996	1997	1998	1999	2000	2001	2002	2003
Shinhan Bank	379,170	392,453	525,015	639,255	691,739	715,462	637,220	769,059
Woori (Hanvit, Commercial Bank of Korea )	190,278	167,480	332,434	250,102	227,786	279,280	406,173	553,281
Hana Bank	745,151	404,983	128,208	313,123	168,129	193,824	396,253	465,054
Kookmin (Korea Housing Bank 97-00)	-	104,295	163,806	244,941	287,226	464,392	546,965	154,398
Chohung Bank	201,111	174,496	23,215	318,695	305,349	385,852	344,292	289,955
Korea Exchange Bank	232,618	228,832	281,493	255,381	268,680	322,094	343,018	550,824
KorAm Bank	215,474	207,383	340,509	335,730	361,681	413,540	540,750	536,810
Cheil Bank	221,189	29,293	9,967	203,652	283,491	340,440	389,607	391,475
Seoul Bank	68,448	92,191	179,227	374,615	442,586	494,781	-	-
Peace Bank	151,360	120,325	-66,415	106,806	211,863	-	-	-
Hanil Bank	208,692	177,567	341,396	-	-	-	-	-
Jeonbuk Bank	225,863	180,460	155,733	202,132	158,007	180,022	217,407	253,506
Jeju Bank	165,108	132,153	84,933	126,660	161,198	240,750	362,262	359,833
Daegu Bank	174,237	220,062	202,295	217,766	230,090	263,607	346,219	408,656
Pusan Bank	123,464	131,517	127,721	195,328	196,058	235,133	427,568	479,234
Kwangju Bank	202,325	181,506	108,920	53,020	119,576	158,701	237,796	331,353
Kyongnam Bank	177,807	175,174	178,942	212,720	169,726	221,306	304,702	394,269
Kangwon Bank	235,989	98,998	-278,929	-	-	-	-	-
Chungbuk Bank	191,930	108,473	-99,249	-	-	-	-	-
Boram Bank	262,740	289,798	59,230	-	-	-	-	-
Chung Chong Bank	190,880	133,096	-	-	-	-	-	-
Kyonggi Bank	158,134	118,431	-	-	-	-	-	-
Daedong Bank	121,777	74,145	-	-	-	-	-	-
Dongnam Bank	133,792	112,572	-	-	-	-	-	-
Dongwha Bank	226,456	168,863	-	-	-	-	-	-

**Table A7. Premises & Equipment for Opt. / Number of employees**

(Unit: million won)

Name	1996	1997	1998	1999	2000	2001	2002	2003
Shinhan Bank	182,224	199,707	235,034	117,614	132,415	136,194	140,274	139,831
Woori (Hanvit, Commercial Bank of Korea )	73,151	85,732	228,354	187,583	188,829	175,434	172,696	168,068
Hana Bank	250,396	489,052	410,813	200,328	199,364	184,057	181,417	190,788
Kookmin (Korea Housing Bank 97-00)	-	87,369	128,783	94,094	98,717	152,244	168,269	138,305
Chohung Bank	76,273	90,611	255,458	252,238	248,807	238,220	212,547	191,517
Korea Exchange Bank	108,257	122,459	184,042	133,539	144,885	141,823	146,306	150,492
KorAm Bank	36,855	112,884	149,485	98,000	114,389	119,707	130,508	128,893
Cheil Bank	65,017	75,691	288,377	230,149	240,102	262,603	286,635	291,729
Seoul Bank	18,077	25,769	44,780	78,880	100,892	107,373	-	-
Peace Bank	26,508	28,848	40,264	16,452	25,649	-	-	-
Hanil Bank	112,725	129,518	293,958	-	-	-	-	-
Jeonbuk Bank	111,534	130,175	263,246	199,065	196,620	214,074	207,255	195,122
Jeju Bank	54,830	62,937	120,121	93,885	131,545	171,438	196,858	181,087
Daegu Bank	73,239	83,686	217,704	146,431	148,548	160,139	168,567	170,506
Pusan Bank	74,310	88,941	225,282	147,696	149,658	169,083	168,615	168,382
Kwangju Bank	100,558	139,650	193,286	186,199	225,207	189,087	198,721	212,815
Kyongnam Bank	106,183	114,227	215,553	141,830	160,070	151,540	154,908	160,347
Kangwon Bank	82,520	104,624	129,846	-	-	-	-	-
Chungbuk Bank	61,393	70,439	188,573	-	-	-	-	-
Boram Bank	88,672	105,979	146,015	-	-	-	-	-
Chung Chong Bank	73,758	99,065	-	-	-	-	-	-
Kyonggi Bank	110,959	124,571	-	-	-	-	-	-
Daedong Bank	68,539	75,133	-	-	-	-	-	-
Dongnam Bank	47,452	53,400	-	-	-	-	-	-
Dongwha Bank	30,387	35,657	-	-	-	-	-	-

**Table A8. General & Administrative Expenses / Number of employees**

(Unit: million won)

Name	1996	1997	1998	1999	2000	2001	2002	2003
Shinhan Bank	67,048	71,088	72,815	93,747	112,053	127,093	139,361	146,276
Woori (Hanvit, Commercial Bank of Korea )	64,231	66,467	53,613	88,609	95,715	94,680	128,363	142,102
Hana Bank	284,649	282,110	332,227	109,154	111,504	100,561	74,126	126,017
Kookmin (Korea Housing Bank 97-00)	-	48,040	86,067	88,934	102,537	75,990	138,868	335,324
Chohung Bank	71,023	76,202	137,654	88,917	102,017	108,451	128,616	135,844
Korea Exchange Bank	72,284	80,086	123,969	92,912	101,346	96,590	112,158	130,911
KorAm Bank	59,363	65,567	56,479	88,903	94,509	119,421	137,471	139,547
Cheil Bank	65,888	63,727	114,282	86,389	93,509	110,831	127,100	144,324
Seoul Bank	12,924	16,098	29,330	63,436	85,737	101,716	-	-
Peace Bank	48,052	55,871	76,603	74,757	101,778	-	-	-
Hanil Bank	72,264	76,547	137,115	-	-	-	-	-
Jeonbuk Bank	53,335	52,949	93,942	79,038	95,521	97,448	100,421	107,684
Jeju Bank	46,701	47,489	60,467	57,894	82,218	94,930	117,246	126,656
Daegu Bank	71,122	74,255	94,564	86,390	86,171	90,499	115,128	127,758
Pusan Bank	61,324	61,938	115,221	84,309	96,904	108,348	126,534	136,122
Kwangju Bank	56,671	63,567	71,007	78,669	88,543	84,331	96,072	118,642
Kyongnam Bank	56,959	58,542	83,649	68,239	96,176	81,906	97,569	117,144
Kangwon Bank	50,862	50,273	91,225	-	-	-	-	-
Chungbuk Bank	48,366	52,267	81,708	-	-	-	-	-
Boram Bank	76,381	63,145	78,268	-	-	-	-	-
Chung Chong Bank	54,364	54,531	-	-	-	-	-	-
Kyonggi Bank	51,965	62,898	-	-	-	-	-	-
Daedong Bank	49,736	55,265	-	-	-	-	-	-
Dongnam Bank	61,190	67,045	-	-	-	-	-	-
Dongwha Bank	61,629	76,577	-	-	-	-	-	-

**Table A9. Other Expenses / Number of employees**

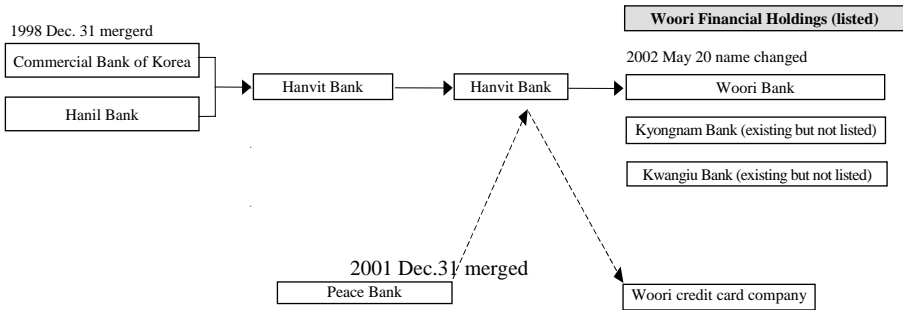
(Unit: million won)

Name	1996	1997	1998	1999	2000	2001	2002	2003
Shinhan Bank	47,543	373,562	474,910	209,557	185,964	246,757	227,183	290,328
Woori (Harvit, Commercial Bank of Korea )	25,551	79,956	99,683	370,763	631,753	210,542	182,316	194,686
Hana Bank	309,532	617,840	1,348,230	285,981	403,235	122,663	78,705	225,440
Kookmin (Korea Housing Bank 97-00)	-	116,546	209,576	72,745	93,332	192,982	235,265	
Chohung Bank	21,917	89,808	438,490	330,616	227,953	191,447	347,998	447,232
Korea Exchange Bank	43,378	112,185	436,386	414,567	427,144	469,722	329,257	425,473
KorAm Bank	28,033	250,334	446,930	307,324	486,426	319,069	489,872	643,921
Cheil Bank	44,546	151,180	453,180	105,825	73,438	55,213	58,827	121,138
Seoul Bank	6,874	27,629	76,662	115,645	247,590	149,373	-	-
Peace Bank	28,766	75,462	272,616	127,091	135,074	-	-	-
Hanil Bank	16,291	170,215	369,412	-	-	-	-	-
Jeonbuk Bank	23,310	207,158	504,035	105,270	34,433	43,872	60,335	80,356
Jeju Bank	11,813	30,601	112,387	60,655	429,883	97,418	102,194	125,785
Daegu Bank	14,738	50,434	177,601	94,059	93,740	67,308	103,236	139,733
Pusan Bank	19,730	38,817	134,679	55,784	75,225	107,413	81,289	119,821
Kwangju Bank	26,289	63,243	145,405	119,227	105,561	33,837	70,055	111,393
Kyongnam Bank	15,583	25,726	133,689	53,148	278,775	84,641	108,989	124,832
Kangwon Bank	17,594	196,693	274,788	-	-	-	-	-
Chungbuk Bank	23,780	90,314	97,755	-	-	-	-	-
Boram Bank	17,029	116,670	523,127	-	-	-	-	-
Chung Chong Bank	20,718	37,826	-	-	-	-	-	-
Kyonggi Bank	36,441	193,556	-	-	-	-	-	-
Daedong Bank	22,216	64,633	-	-	-	-	-	-
Dongnam Bank	17,486	59,247	-	-	-	-	-	-
Dongwha Bank	15,376	76,561	-	-	-	-	-	-

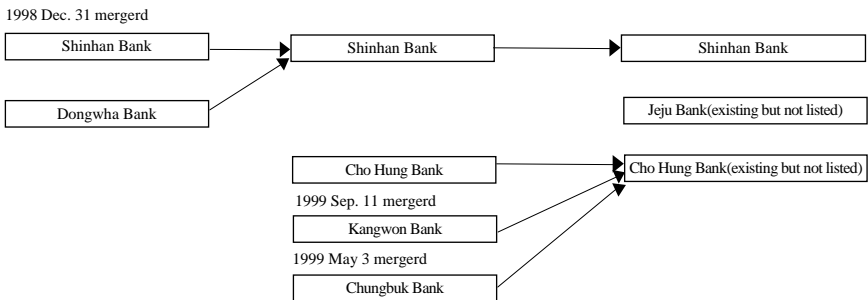
### Appendix Figure

Figure A1. Woori Financial Holdings and Shinhan Financial Group

< Woori Financial Holdings >

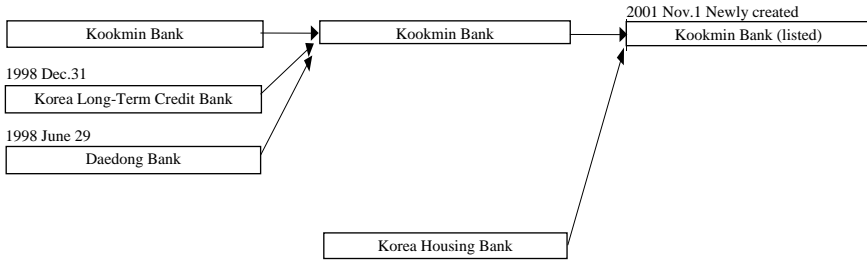


< Shinhan Financial Group >





**Figure A2. Kookmin Bank**



# Measuring the Efficiency of Banks: Successful Mergers in the Korean Banking Sector

Kimie Harada

This paper investigates how the Korean banking sector has plished reform, with a focus on mergers and acquisitions of banks. It examines the technical efficiency implications of Korean banks to evaluate their pre- and post-consolidation efficiency.

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