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碩 士 論 文

金控子銀行與一般銀行績效比較

Why bank subsidiaries of Financial Holding Companies outperform independent banks

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中 華 民 國　九十五　年 六 月

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摘　　要

自 2001 年金融控股公司法實施以來，目前台灣已有 14 家金控成立，一般認為金控因具有交叉行銷及一次購足等優勢，故其旗下子銀行的績效也較一般獨立子銀行之績效為優，故本文目的在研究金控子銀行與非金控子銀行間績效是否有所差異，以及金控事業主體不同（如保險、銀行或證券），是否會影響旗下子銀行之績效。本文第一階段使用資料包絡分析法，分析台灣十一家金控子銀行及十三家獨立銀行之績效是否不同。第二階段利用吸引力測度(attractiveness measure)及進步測度(progress measure)來區辨各評估單位(DMUs)間的績效優劣及排名。研究發現，金控子銀行績效顯著優於非金控子銀行，以銀行為金控事業主體之金控子銀行其績效優於事業主體為保險與證券之金控旗下子銀行。本文作者亦依據分層、吸引力測度與進步測度為各評估單位建立標竿，並建議銀行管理當局利用標竿遞進學習。

關鍵詞：金融控股公司、銀行、效率、資料包絡分析、標竿

Why bank subsidiaries of Financial Holding Companies outperform independent banks

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ABSTRACT

The Financial Holding Company Act passed in 2001 and allows banks to combine with insurance firms, security brokerages and to form Financial Holdings. It is thought that the performance of the bank subsidiary of a Financial Holding Company (FHC) is better than the independent bank, because the FHC develops cross-selling strategy and provides a one-stop shopping convenience for its bank subsidiary's customers. The purpose of this research is to determine whether a bank subsidiary in FHC or independent bank has a greater efficiency and ascertain whether different main businesses (banking, insurance, securities) of a FHC affects the performance of its bank subsidiary. Applying a non-parametric frontier approach, data envelopment analysis (DEA), to evaluate the relative efficiencies of 11 bank subsidiaries of Financial Holding Companies (FHCs) and 13 independent commercial banks in Taiwan, this thesis provides evidences that (1) bank subsidiary of a FHC outperforms independent banks; (2) the types of main businesses of a FHC does have influence on the performance of its subsidiary; the ranking of performances from good to bad as follows: banking, insurance and securities. In addition, this thesis measures context-dependent bank performance for different efficiency levels. This context-dependent DEA model allows (1) the benchmarking of our Decision-Making units (DMUs) compared to its competitors; (2) measuring attractiveness and progress and drawing a benchmark-learning roadmap as a tool for ranking all DMUs.

Keywords: Financial Holding Company, DEA, efficiency, benchmark

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CHAPTER ONE
INTRODUCTION

1.1 MOTIVATION AND BACKGROUND

Banking is characterized as a unique and important business to our economy. Moreover we have even heard that the thriving and failing of the banking industry affects economics broadly. Marcia J. Staff et al. (1986) has explained why banks are so special to our economy: "*Banks are unique among financial institutions in that they alone are permitted by law to accept demand deposits.*" As a special business, it was extremely regulated by Taiwanese government before 1981. Most ownership was held by authorities; moreover, interest rates were decided by the Central Bank. A series of financial liberalization and internationalization policies have been executed since 1981. The following are all examples of this trend: the relaxing of the new approved applications for funding commercial banks, rate liberalization, deregulating restrictions on international banking operations and allowing the establishment of Offshore Bank Units (OBUs) for domestic banks. Due to the liberalizations, the number of new banks in Taiwan increased speedily from 26 domestic banks in 1985 to 43 (1,787) domestic banks in 1995, and there were 53(2,576) domestic banks in 1999(number of branches is shown in "( )"). However, poor management by authorities and over competition leaded a series of frauds in banking sector in late 1990s. Consolidating less efficient banks and rural credit co-operatives with greater efficient banks has treated as a great solution to solve the problem of frauds; thus it initiated a lot of activities of Merger and Acquisition (M&A) in banking industry conducted by government from the late 1990s.

To improve the efficiency and global competitiveness of domestic banks, the Legislative Yuan passed the Financial Institutions Merger Act in November 2000. In addition, the Financial Holding Company Act took effect in November 2001. These two laws allow banks, insurance companies, securities brokerage firms and other financial institutions to acquire or merge each other; thus establish Financial Holding Companies (FHCs). To encourage consolidation, the law allows exemption of deed and contract tax, a reduction in income tax and a credit on land-value incremental tax. The laws also provide a legal framework for setting up asset-management companies to help local banks to manage their non-performing loans and assets. It predicts that these laws can enhance the international

competitiveness of domestic banks in Taiwan by grouping up larger Financial Holding Company (FHC).

The performance of the banking sector is always an interesting topic, no matter to academicians or to governments. The main issue in measuring performance of banks includes operating efficiency, marketability, quality issues and others (Xueming Luo (2003), Lawrence M. Seiford and Joe Zhu (1999), Raman et al. (2002)). Based on the abundant literature, policy makers can make better strategic decisions for banks. However, a few issues are less addressed such as the compared efficiency of bank subsidiaries in FHCs and their competitors which we investigate in this paper.

1.2 INTRODUCTION OF THE PRESENT TAIWANESE BANKING MARKET

Before we start to analyze the performance of banks, we should consider the competition and services situation in the Taiwanese banking industry from the point of view of the number of banks, employees and asset structures. According to the financial statistic data prepared by the Banking Bureau in Taiwan, there were 41 domestic banks and 37 local branches of foreign banks in 1993. There are 45 domestic banks and 36 local branches of foreign banks in 2005 as shown in Figure 1[1], We can observe the rapidly increasing number of banks (head office) from 1996. The overall number has reduced since 2000. Second, as shown in Figure 2[2], the number of domestic bank branches has increased since 2002. Since then, the intensifying of competition among Taiwanese banks has become a distinguishing feature among developing countries. Third, there are more than 140 thousand employees served in Taiwanese banks in 2005 and this is an increasing trend from 1990 as shown in Figure 3. Finally, as shown in Appendix 2, the size of the banks has become bigger and the operation is more leveraged.

[1] Original data as shown in Appendix 1
[2] Refer to Appendix 1.

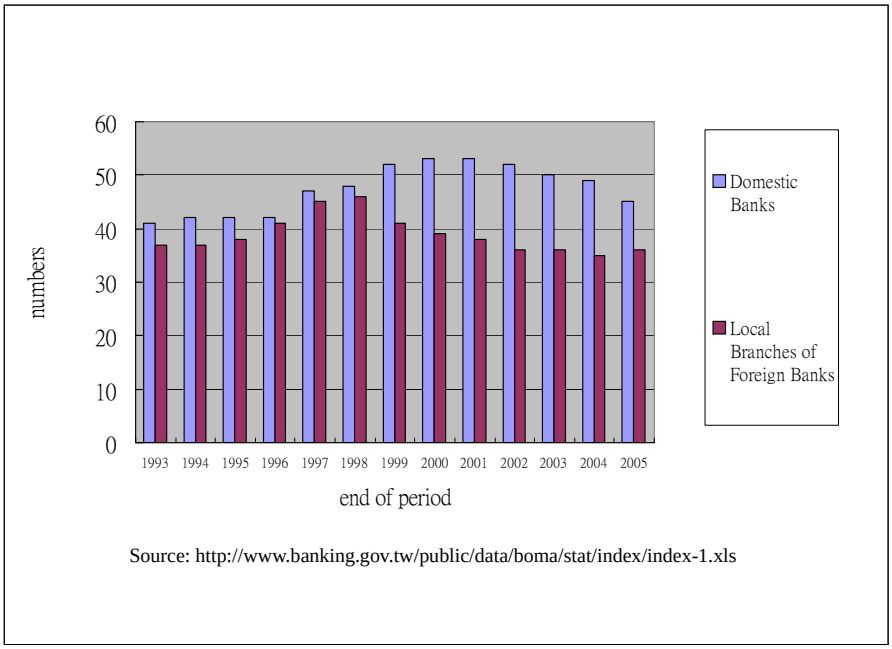


Figure 1. The Number of Taiwanese banks from 1993 to 2005

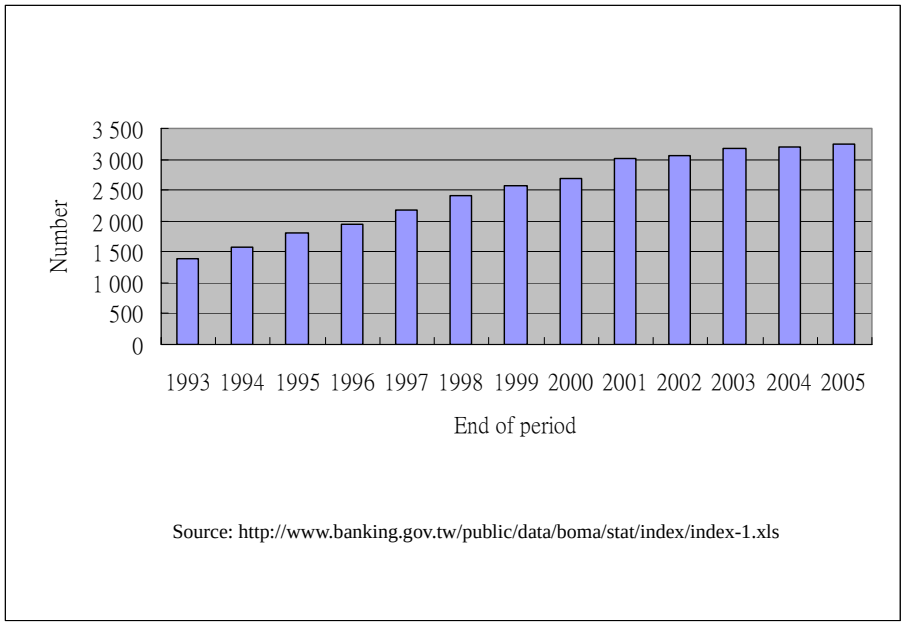


Figure 2. The Number of Taiwanese Domestic Bank Branches from 1993 to 2005

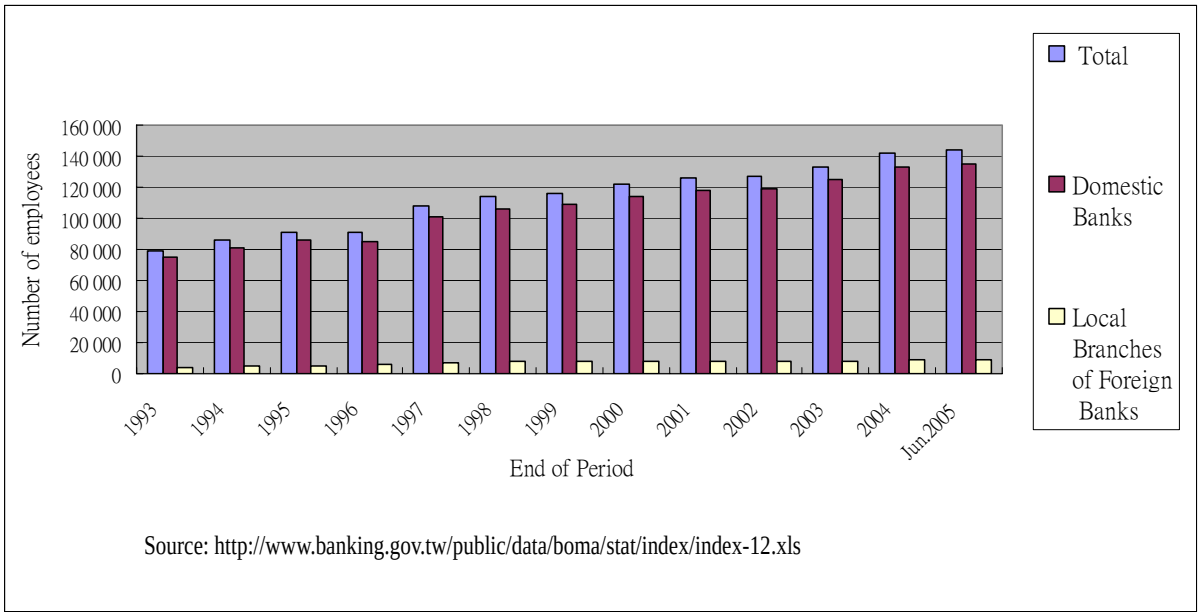


Figure 3. *The* Number of Employees Served in Taiwanese Banks from 1993 to Jun.2005

1.3 RESEARCH QUESTIONS

As mentioned earlier, to go along with the Taiwanese government' opening up of the banking market, the number of financial institutions has increased yearly, once touched the number 48, but the profit margins of banks have become thinner. In order to improve the competitiveness and efficiency of banks, it has allowed the establishment of Financial Holding Companies, which include banks, insurance firms and security brokerages in one company, since the Financial Holding Company Act was passed in 2001. It is thought that the performance of a bank subsidiary in a Financial Holding Company (FHC) is better than the independent bank, because FHC develops cross-selling strategy and provides a one-stop shopping convenience for its bank subsidiary's customers.

In fact, laws similar to the Financial Holding Company Act passed in some developed countries for the purpose of improving efficiency of financial institutions, like in the U.S. In 1999 (Gramm-Leach-Bliley Act of 1999), Canada in 1992 and United Kingdom in 1980s. Meir kohn (2004) have mentioned that as a FHC, it does reap benefits in businesses from economies of scope. For example, having securities subsidiaries to offer full-service brokerage services in an insurance firm helps an insurance company handle products such as variable annuities and mutual funds. Having banks subsidiaries helps an insurance company to save the marketing costs which is a significant part of the cost of insurance. (p.253)

To encourage consolidations among different financial institutions, authorities claimed

that the bank subsidiary of a FHC may outperform an independent bank, because it owns many competitive advantages compared to an independent bank, including cross-selling strategy, marketing cost savings and richer resources. Therefore, the purpose of this research is to determine whether a bank subsidiary in a FHC or independent bank has a greater efficiency and to discover whether different main businesses (banking, insurance, security) of a FHC affect the performance of its bank subsidiary.

1.4 FRAMEWORK OF ANALYSIS

The rest of this thesis is organized as follows:

Chapter Two: Literature Review

We summarize and describe literature and techniques about two performance approaches which were used in our model briefly, including DEA approaches and Ratio Analysis. We also summarize several literature references about financial holding company, financial conglomerates and universal banks.

Chapter Three: Methodologies

In section one, we describe the models used in this thesis including the conventional CCR Output-oriented model (Charnes, Cooper and Rhodes 1978), the model incorporated CCR Output-oriented model with ratio(Lovell, Pastor and Turner (1995), Lovell (1995)) and context-dependent data envelopment analysis with attractiveness and progress(Seiford and J Zhu (2003). Choice of inputs and output, selection of DMUs and adjustment of data also are described in this chapter.

Chapter Four: Empirical Results

We applied the techniques described in Chapter Three to calculate technical efficiency values for the banks assessed. In addition, this thesis measures context-dependent bank performance for different efficiency levels. This context-dependent DEA model allows (1) benchmarking for our Decision-Making units (DMUs) against its competitors; (2) measuring attractiveness and progress and drawing a benchmark-learning roadmap as a tool for ranking all DMUs.

Chapter Five: Concluding Remarks, Limitations and Future Suggestions

Summarize the empirical results and bring up some suggestions for future research.

CHAPTER TWO
LITERATURE REVIEW

2.1 PERFORMANCE MEASUREMENT APPROACHES IN BANKING

Performance measurement is always the main focus beyond managers. According to literature, banks have usually engaged in two kinds of measuring approaches, including Ratio Analysis and Frontier Efficiency Methodologies. We only describe Ratio Analysis and Data Envelopment Analysis (DEA), which is one of the Frontier Efficiency Methodologies, in this section, because we use a technique which incorporated DEA and Ratio Analysis to solve the research questions

2.1.1 Ratio Analysis

Ratio Analysis is a traditional but popular (in practice) performance evaluating method because of its simplicity and ease of understanding. However, it suffers from three main defects. First, this analysis assumes comparable units, which implies constant returns-to-scale (J.C. Paradi 2004). This method fails to examine whether banks operates under increasing returns-to-scale or decreasing returns-to-scale, so the banker can't obtain early-warnings about over-invested problems. Second, each of the indicators yields a one-dimensional measure by examining only a part of the organization's activities, or combining the multiple dimensions into a single, unsatisfactory number. (J.C. Paradi 2004) Third, financial ratios can be extracted from financial data, but they may conclude some conflicting, contradictory or confusing explanations while we consider each indicator simultaneously.

Note that although ratio analysis has many detractors, the overall ease in calculations and understanding makes it maintain its unduplicated position in performance evaluation. This is in contrast to some of the frontier efficiency methodologies like the DEA technique which is treated as a black box in practice. Therefore, we include these financial ratios into our DEA assessment model and try to explain the evaluated results by financial ratios.

2.1.2 Data Envelopment Analysis

Four usual Frontier Efficiency Methodology Approaches can be found in literature, including the Stochastic Frontier Approach (SFA), the Distribution-Free Approach (DFA), the

Thick Frontier Approach (TFA) and the Data Envelopment Analysis (DEA)[1]. The Data Envelopment Analysis (hereafter DEA), one of the non-parametric methods to measure performance, is employed to assess the *comparative efficiency* of homogeneous operating units (this can also be called the units of assessment or Decision-Marking Units).

There are abundant DEA studies about the banking industry, including the Journal of Econometrics, Journal of Banking and Finance, The European Journal of Operations research, the Journal of Economics and Business, INTERFACES, Omega and Management Science. Some of the Journals also have issued special issues about DEA, like the European Journal of Operations research. The DEA method was first described by Charnes, Cooper and Rhodes in 1978 which measures the technical efficiency frontier based the idea of Pareto optimum. Banker, Charnes and Cooper developed a revised model, called the BCC model, to measure the pure technical efficiency and scale efficiency in 1984. DEA is a linear programming formulation that defines a relationship between multiple output and inputs. It distinguishes the most efficient decision-making unit (DMU) from all DMUs. In other words, we examine the performance of each DMUs through comparing itself against Pareto-optimal peer unit (the most efficient decision-making unit).

DEA is first described by Charnes et al. (1978) to evaluate the efficiency/productivity of non-profit organizations. After Sherman and Gold (1985) first adopted DEA to the banking sector, more and more financial articles have used the DEA technique to measure performance of banks and of other financial institutes. In general, researchers have evaluated banks' and their branches' performance from aspects of different time periods, size classes, input-output specifications and frontier techniques. Some of them have incorporated Tobit regression to explain the efficiency value; in other hand, also can use Malmquist and Window analysis to handle multiple years' data. According to the different topics, applications can be divided into several categories as below and we review some articles employed DEA and summarized the input-output choices in Table 1.

1. Deregulation

   Some economists believe that without the government policy's interference, the market mechanism will function well by itself. However, noninterference is hard for government policy makers when considering the crucial status of the banking

[1] We also can classify performance evaluating methods into two groups: parametric and nonparametric approaches. Ratio Analysis and DEA are categorized into nonparametric approaches. SFA, DFA and TFA are categorized into parametric approaches.

industry to macroeconomic and microeconomic concerns for a country. Therefore, regulations usually bind the banking sector in business scope and their operation and many researchers like to investigate the influences of government policies to efficiency/ productivity of banks and what we can predict is the negative relationships between regulations and efficiency. For these reasons, when deregulation is considered, we would like to know that is it exactly good to financial institutions. Consequently, there are many articles which discuss this topic which have been brought out. (Berg et al.(1992), Elyasiani and Mehdian (1995), Eukuyama (1995) Zaim (1995))

2. Merger

Many articles have tried to find out evidence to support the theory if mergers really facilitate good performance of banks or bring up abnormal returns to investors. Theodor Kohers et al. (2000) tried to find out: (1) Is the target banks' efficiency reflected in the bidder banks' abnormal returns? (2) Does the difference in efficiency between the bidder and target banks related to their peers influence the acquirer's anomaly returns? Theodor Kohers et al. (2000) have successfully verified Inefficient Management Hypothesis and Low Efficiency Hypothesis by using both SFA and DEA approaches. Marcia J. Staff, et al. (1986) summarized the evolvement of the American Financial Act and has confirmed that a merger can't bring abnormal returns to the bidder's investors by regression technique.

3. Determining factors of performance: ownership, size….etc.

Tser-Yieth Chen (2000) incorporated efficiency measurement with the ownership topic and found that public-owned banks perform worse in technical efficiency. Muhammet Mercan et al. (2003) have evaluated efficiency/productivity of Turkish banks for the years 1989-1999. There are some conclusions: (1) foreigner owned banks operated more efficiently than government owned; (2) size does matter. Xueming Luo (2003) employed the DEA method to measure 245 American large banks with assets in excess of 1 billion dollars, which come from the Compustat Disk, in the year 2000. There are three conclusions. First, large banks perform better in profitability than in marketability. Second, no evidence supports if the geographical locations of banks affect the performance of banks. Last but not least, overall technical efficiency of the profitability performance can predict the likelihood of

bank failures. Lawrence M. Seiford and Joe Zhu (1999) took 55 U.S commercial banks appearing in the Fortune 1000 (Fortune April 19, 1996) as DMUs to evaluate the efficiency values. The authors found that large banks performed better in profitability. Joe Zhu(2000) calculated the efficiency values by the DEA method of 364 companies appearing in the Fortune 500 in 1995. The author found revenue-top-ranked companies do not necessarily hold the performance-top-rankings in profitability and marketability.

4. Other Applications

Anja Cielen et al. (2004) employed DEA to predict bankruptcy. Chiang Kao et al.(2004) used financial forecast data, imprecise data, to obtain early-warning information needed by financial supervision and managements of banks beforehand, with integrating imprecise data into DEA model. Authors also confirmed the exactitude of performance results by comparing with the real financial data and found out that the real efficiency values are between the low bound and high bound of forecast efficiency values. Raman et al.(2002) combined the Service-profit chain into their research model and had a conclusion that the profitability of a firm will ultimately increase when a firm improves its service quality delivered to customers because good service quality will have good effects on customer satisfaction and then indirectly have positive influence on profitability.

5. Literature Review

There are some literature reviews since 1978 when the first DEA model had been developed. Seiford (1996) “Data Envelopment analysis: The Evolution of the State of the Art (1978-1995)” published in Journal of Productivity Analysis, Tavares (2002) “A Bibliography of Data Envelopment Analysis (1978-2001)”. There are also some literature reviews which summarized financial institutions like Berger et al. (1997), which surveyed 130 studies that applied frontier efficiency analysis to financial institutions in 21 countries. There were 62 applications of the DEA technique.

Table 1. Studies of bank performance

Author(s)	Model	Units	Variables	Concluding Remarks
Necmi Kemal Avkiran (1999)	DEA-CCR Input-oriented	16- 19 Australian trading banks from 1986 to 1995	Model A: Inputs: (1)interest expense, (2)non-interest expense Output: (1)net interest income, (2) non-interest income Model B: Inputs:(1)deposits, (2)staff numbers Output: (1)net loans, (2)non-interest income	1. Efficiencies rose in the post-deregulation period. 2. Acquiring banks are more efficient than target banks. 3. The Acquiring bank does not always maintain its pre-merger efficiency, thus decision-makers should be careful when choosing target banks.
Seiford and J. Zhu (1999)	DEA-CCR DEA-BCC	55 U.S commercial banks who have appeared in Fortune 1000 (Fortune April 19, 1996)	Stage 1: profitability Inputs: (1)employees, (2)assets and equity Output: (1)revenue, (2)profit Stage 2: marketability Inputs: (1)revenue and (2)profit Output: (1) MV, (2)TRI, and (3)EPS	Relatively large banks show better performance on profitability, whereas smaller banks tend to perform better on marketability.
TAI-HSIN HUANG (2000)	Translog Shadow Profit Function (2000)	22 domestic Taiwanese Banks for the year of 1981-1995	Inputs: (1)deposits, (2)labor Output: (1) investments,(2)loans	1. Banks should make more loans and less investment than technically efficient banks with the same input mix. 2. Publicly-owned banks are technically much more efficient than private banks. 3. Private banks are moderately efficient in allocative efficiency than public-owned banks.
Tser-Yieth Chen and Tsai-Lien Yeh (2000)	DEA-BCC	34 Taiwanese commercial banks for the year 2000.	Inputs: (1)bank staff, (2)assets, (3)bank deposits Output: (1)loans, (2)investments, (3) non-interest revenue	1. Private banks outperform publicly-owned banks. 2. The poor performance in pure technical efficiency causes the inefficiency of publicly-owned banks.

Table 1. Studies of bank efficiency (cont.)

Author(s)	Model	Units	Variables	Concluding Remarks
Milind Sathye (2001)	DEA-BCC Used DEAP software developed by Coelli (1996)	29 Australian banks for the year of 1996	Follows the studies by Aly et al. (1990) and Hancock (1986) Inputs: (1)labor number, (2)capital, (3) loanable funds (time deposits, savings deposits, other borrowed funds) Price: price of the three inputs(dividing the total dollar expenditure on employees by the total number of employees, total expenditures and premises and fixed assets divided by book value, interest expenses divided by loanable funds) Output: (1)loans, (2)demand deposits	1. The DMUs used in this study have lower overall efficiency compared with the banks in the European countries and in the US. 2. Technical inefficiency is more serious than allocative inefficiency. In other words, the inefficiency in DMUs can be attributed to the wasting of inputs rather than choosing of incorrect input combinations. 3. Domestic banks were found to be more efficient than foreign-owned banks.

Table 1. Studies of bank performance (cont.)

Author(s)	Model	Units	Variables	Concluding Remarks
Raman et al. (2002)	DEA-CCR Output-oriented	None	Model A: internal service quality efficiency Inputs: (1)personnel expenses,(2)supplies, office space, (3)technology Output: internal service quality survey which include four parts of questions about (1)market focus, (2)flexibility, (3)internal organizational efficiency and (4)empowerment. Model B: operating efficiency Inputs: (1)labor, (2)supplies, (3)office space, (4)technology and (5)account structure which include deposits, personal loans and commercial loans. Output: (1)transactions as work-output and (2)service quality, which are derived from the survey results as customer satisfaction Model C: profitability efficiency Inputs: (1)interest expenses, (2)non-interest expenses Output: (1) interest revenue, (2)non-interest revenue	The authors suggest us to account for intangible aspects for inputs that describe the internal service quality of branches into the model. Thus we can better evaluate a bank's performance by examining the quality of service delivery to external customers.

Table 1. Studies of bank performance (cont.)

Author(s)	Model	Units	Variables	Concluding Remarks
Elyas Elyasiani et al. (2003)	DEA-BCC Malmquist Index	83-95 cooperative banks for the years 1989-1995 obtained from the Call Report tapes	Inputs: (1) labors, (2)capital, (3)borrowed funds by the sum of interest-bearing deposits plus other borrowed funds Output: (1) loans to individuals for the household, family and other personal expenditures, (2) real estate loans, (3) securities, (4)other earning assets	1. Cooperative banks were highly efficient relative to the industry-wide year-specific frontiers. 2. The trend of productivity change seems uneven over time. 3. The main source of productivity improvement was from the increasing of technical efficiency.
Jesus T. Pastor et al. (2003)	DEA-BCC FDH	573 branches of a large European savings banks account for a recent six-month accounting period	Inputs: (1) personnel expense, (2) other operating expense, (3) deposits interest expense, (4) delinquencies Output: (1) deposits, (2) assets, (3) number of regular customers, (4) number of high income customers	Improving efficiency of the worst-performing branch offices can be a good way to generate a substantial increase in profits for the bank.
Muhammet Mercan et al. (2003)	DEA-CCR	545 observations choosen from Turkish banks for the years between 1989 and 1999	Inputs: (1) personnel expenses/earning assets, (2)total expense/total income Output: (1) earning assets/total assets, (2)(shareholders' equity + net profit)/total liabilities, (3) average return on equity (net profit/ average shareholders' equity)	1. The performance of banks improved after deregulation. 2. The policy differences which occurred in the forex allowed private banks to attain high ROE values. 3. Medium and small scale banks were significantly harmed by the 1994 financial crisis.

Table 1. Studies of bank performance (cont.)

Author(s)	Model	Units	Variables	Concluding Remarks
Xueming Luo (2003)	DEA-CRS Input-oriented DEA BCC Input-oriented	245 American large banks with assets in excess of 1 billion dollars, which come from the Compustat Disk, in the year 2000.	Adapted from Seiford and Zhu's (1999) original work. Stage1: profitability efficiency Inputs: (1) employees, (2) total assets, (3) equity Output: (1) revenue and (2) profits Stage2: marketability efficiency Inputs: (1) revenue and (2) profits Output: (1) market value, (2) return to investors, and (3) EPS	1. Lager banks perform lower efficiency in marketability. 2. The geographical location of banks seems to not be related to either the profitability or marketability efficiency.
Chiang Kao, Shiang-Tai Liu (2004)	DEA- efficiency intervals (Kao and Liu (2000)	24 Commercial Taiwanese banks for year 2000	Inputs: (1) total deposits, (2) interest expenses, (3) non-interest expenses Output: (1) total loans, (2) interest income, (3) non-interest income	The efficiency scores calculated by the data from the financial statements which were published afterwards fall into the range of predicted efficiency scores.
George E. Halkos et al. (2004)	DEA BCC Output–oriented	15 -18 Greek commercial banks members of the Union of Greek banks from 1997-1999	Inputs: No inputs Output: (1) RDIBA, (2) ROE, (3) P/L, (4) EFF and (5) NIM	1. Bigger banks show more efficiency. 2. The efficiency improvement in the banking sector shows acompany with a reduction in the number of small banks by mergers.
Laurent Weill (2004)	DEA SFA DFA	Unconsolidated accounting data for 688 banks; 135 in France, 296 in Germany, 99 in Italy, 85 in Spain, and 73 in Switzerland for the years 1992-1998.	Inputs: (1)Personnel expenses, (2) Other non interest expenses, (3) Interest paid Output: (1) Loans, (2) Investment assets Input prices (in %): (1) Price of labor, (2) Price of physical capital, (3) Price of borrowed funds	It can be found that there is a lack of consistency in the evaluation results among the DEA, DFA and SFA. However, it has some correlation in their evaluation results between all frontier approaches.

Table 1. Studies of bank performance (cont.)

Author(s)	Model	Units	Variables	Concluding Remarks
J.C. Paradi et al. (2004)	Model A: DEA-Input-oriented CCR and BCC Model B: DEA-AR output multiplier constraints introduced by Schaffnit et al. (1997)	90 branches of a Canadian Bank	Model A: Production model Inputs: (1) number of five different categories of staff(manager, account manager, assistant, secretary, cash manager), (2) IT expense, (3) rent, (4) non-interest expenses Output: (1) deposits, (2) loans, (3) fee income, (4) average annual revenue from five maintenance activities Environmental factors: (1) growth factor (average rate of change of the real provincial gross domestic product between the years 1993 and 1996), (2)BRR (weighted average borrower risk rating) Model B: Strategic model Inputs: (1) number of five different categories of staff , (2) IT expense, (3) rent, (4) non-interest expenses, (5)non-accrual loans(principal and interest unpaid for at least 90 days) Output: (1) deposits, (2) loans, (3) operating expense, (4) deposit spread, (5)loan spread Environmental variables: (1) BBR, (2) growth factor	This research results were accepted by the authority of the Canadian Bank. In addition, bank managers made some decisions based on these results. Thus, it's evident that this model introduced in this paper would be used in the practical areas.

Table 1. Studies of bank performance (cont.)

Author(s)	Model	Units	Variables	Concluding Remarks
TSER-YIE TH CHEN (2004)	DEA Input-oriented	44 Taiwanese banks for year 1994 – 2000	Inputs: (1) bank staff, (2) assets, (3) deposits Output: (1) loan services, (2) portfolio investment and (3) non-interest revenue	1. Privately-owned banks had a higher cost efficiency than those found in publicly-owned banks in 1994-1996. 2. Privately-owned banks had lower cost efficiency than that of publicly-owned banks in 1997-2000 when the problem of non-performing loans seems serious in privately-owned banks.
Yang Li (2004)	DFA Output-Oriented	40 Taiwanese banks for the year 1998 -2000	Inputs : (1) bank staff, (2) fixed assets, (3) total deposits Output:(1) NPL, (2) loans, (3) portfolio investments	1. Publicly-owned banks spend more resources to cut their non-performing loans (NPL) as compared to private banks. 2. Compared to old banks, new banks need more resources to reduce NPL.
A.S. Camanho et al.(2005)	DEA cone assurance regions Input-oriented	144 branches from a Portuguese commercial bank	Inputs: (1) number of branch and account managers, (2)number of administrative and commercial staff, (3) number of tellers, (4) operational costs(excluding staff cost). Output: (1) number of general service transactions. Input Prices: (1) average salary and fringe benefits of branch and account managers, (2) average salary and fringe benefits of administrative/commercial staff, (3) average salary and fringe benefits of tellers	DEA models can provide robust estimates of cost efficiency even in situations of price uncertainty.

2.2 FINANCIAL HOLDING COMPANY, FINANCIAL CONGLOMERATES AND UNIVERSAL BANKS

This thesis aims to investigate whether bank subsidiaries would outperform independent banks. Therefore we review the related research first. However, we can found some similar but different terms like financial conglomerates, universal banks and financial holding companies in the research literature, thus we first state definitions of these terms.

According to Fitch, Thomas P. (2002), in DICTIONARY OF BANKING TERMS, Universal Banking is "*banking system in several European countries where commercial banks make loans, underwrite corporate debt, and also take equity positions in corporate securities. For example, in Germany commercial banks accept time deposits, lend money, under-write corporate stocks, and act as investment advisors to large corporations. In Germany, there has never been any separation between commercial banks and investment banks, as there is in the United States. The advantages of this type of banking system have been debated. Universal banking permits better use of customer information and allows banks to sell more services under one roof as a FINACIAL SUPERMARKET. The main disadvantage is that universal banking permits concentration of economic power to a handful of large banking institutions that hold equity positions in companies that are also borrowers of funds.*" A Financial Holding Company (FHC) is a "*financial entity engaged in a broad range of banking-related activities, created by the GRAMMLEACH-BLILEY ACT OF 19999. These activities include: insurance underwriting, securities dealing and underwriting, financial and investment advisory services, merchant banking, issuing or selling securitized interests in bank-eligible assets, and generally engaging in any nonbanking activity authorized by the Bank Holding Company Act.*" Finally, according to Vander Vennet (2002), Financial Conglomerates are "*financial institutions that offer the entire range of financial services. Next to performing the traditional banking operations, they may sell insurance, underwrite securities, and carry out security transactions on behalf of their clients.*" According to the definitions, financial conglomerates and financial holding companies seem to mean the same thing; both of these

two institutions serve their customers the entire range of financial services: traditional banking operations, insurance and security brokerages. On the other hand, universal bank seems providing narrow services than the other two types of financial institutes.

Nowadays, many countries permit financial conglomeration including all European Union member states and the Gramm-Leach-Bliley Act of 1999 allows the establishment of Financial Holding Companies in the U.S. Since relaxing the historical barriers among traditional banking operations and other financial services like insurance and security brokerages, proponents advocate bank subsidiaries would benefit from the diversification and marketing advantages. (Arnoud W.A. Boot, 1999; Vander Vennet, 2002) However, these benefits are debated by researchers; opponents claim that there are some disadvantages in financial holding companies. For example, fewer managers' expertise in all financial fields, thus scope diseconomies may occur. (Allen N. Berger, 2003; Bertrand Rime et al., 2003) We summarize some related literature in Table 2.

Table 2. Literature review about conglomeration, universal banking and the financial holding companies

Author(s)	Country	Method	Concluding Remarks
Arnoud W.A. Boot(1999)	Europe U.S.	Literature review	Consolidation has benefited financial institutions in scale and scope economies.
Lown et al. (2000)	U.S.	Comparing the average rate of return on accounting equity, the standard deviation on the rate of return on equity and Z-score with 462 Bank holding Companies, 57 security firms, 48 Life insurance firms, 101 property and casualty insurance firms, 45 Insurance agents and 58 other financial institutions from 1984 to 1998.	1. There are clearly diversification benefits and lower risks to the Bank Holding Company (BHC) and life insurance mergers. 2. Mergers with securities and property and casualty firms will raise BHC probability of bankruptcy.
Vander Vennet (2002)	Europe	Stochastic Frontier Approach (SFA) 2375 EU banks from 17 countries for the years 1995 and 1996	1. Conglomerates are more revenue efficient than their specialized rivals. 2. Both cost and profit efficiency were higher in universal banks than in non-universal banks. 3. Operational efficiency has become the major determinant to bank profitability but oligopoly rents have become rare.
Allen N. Berger (2003)	Europe	Literature review	1. Very little cost scope economies from universal banking but possibly some cost scope diseconomies exist because of fewer managers with expertise in all of insurance, security and banking fields. 2. Universal institutions may benefit from the revenue economies, because of diversification benefits, expanding of brand reputation, or “one-stop shopping” marketing advantages.
Bertrand Rime et al. (2003)	Switzerland	Distribution-Free Approach (DFA) 289 banks from 1996 to 1999	1. Larger banks with broader product mixes (insurance, security breakage….etc.) would not necessary lead to improved efficiency. 2. Evidence on scope economies is weak for banks that are involved in a wide variety of financial activities.
Dean Amel et al. (2004)	Major industrialized countries	Literature review	There are organizational diseconomies in universal-type consolidation but gains from diversification also exist.

CHAPTER THREE
METHODOLOGY

3.1 THE TECHNIQUE

Far from the first DEA model has been developed in 1978, the efficiency concept has been proposed by Farrell in 1957. Farrell (1957) proposed that the efficiency of a firm consists of two components: technical efficiency and allocative efficiency. Technical efficiency reflects the ability of a firm to obtain maximal output from a given set of inputs and allocative efficiency reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices and production technology. These two measures are then combined to provide a measure of total economic efficiency. Charnes, Cooper and Rhodes (1978) (CCR models) proposed a model which had an output orientation and assumed constant returns to scale (CRS), thus technical efficiency has been discussed when using the CRS model. Later in 1984, Banker, Charnes and Cooper (BCC models) have considered both technical efficiency and allocative efficiency within a model, so we can also account for variable returns to scale (VRS) situation. The CCR and BCC models do not relate to price information and just consider input and output quantities.

The choice between constant returns to scale (CRS) and variable returns to scale (VRS) is hard. Necmi K. Avkiran (2001) suggested that " *An alternative approach that removes much of the guesswork from choosing between CRS and VRS is to run the performance models under each assumption and compare the efficiency scores.*" *If a majority of the DMUs emerge with different scores under the two assumptions, then it is safe to assume VRS. Put another way, if the majority of DMUs are assessed as having the same efficiency, one can employ CRS without being concerned that scale inefficiency might confound the measure of technical efficiency.*" By the suggestion from N.K. Avikiran (2001), we have both run BCC and CCR models and found that the majority of DMUs emerge with same efficiency scores, thus we

have employed the CCR model in this thesis. In addition, we also use context-dependent DEA(Seiford and J. Zhu(2003) to rank the efficient and inefficient DMUs, and then create benchmark-learning roadmap as a tool for DMUs to realize the relative attractiveness and progress against to competitors.

3.1.1 DEA CCR model

In our analysis, the efficiency measure is calculated by using the Output-Oriented version of the Charnes, Cooper and Rhodes (1978) DEA model. Assume that the objective of each DMU is to maximize its output while keeping the input level constant. Eq.(1) is the original envelopment Output-Oriented CCR DEA model, in which both inputs and output included. Unit assessed in DEA model is called DMU. Each DMU tries to maximize all their output $y_1, y_2, \ldots\ldots y_s$ and maintain the level of their inputs $X_1, X_2 \ldots\ldots X_m$. By the definition, the performance of DMU is fully (100%) efficient if and only if both θ_0=1 and all slacks equal to zero. If smaller than 1; then we called DMU is technically inefficient.

However, Eq. (1) considers both inputs and output within the model and notes that no inputs are considered in our model because we assume every DMU operated by similar and equal inputs and provide same services in the same markets thus the input constraint normally found in DEA envelopment problems is redundant (Lovell, Pastor and Turner (1995), Lovell (1995)). We then modified the conventional model as below. Considering n(set j=1,2,……n) banks which produces a matrix of output Rr (set r=1,2…,s), according Halkos et al.(2004), Lovell, Pastor and Turner (1995) and Lovell (1995), we thus can revise equation Eq.(1) to Eq.(2) which we have used to analyze the efficiency of banks assessed. A bank is efficient if and only if θ_0=1 and slacks zero.

$$Max\theta_0$$
$$s.t.$$
$$\sum_{j=1}^{n}\lambda_j x_{ij} \le x, i = 1,2,.....,m \qquad (1)$$
$$\sum_{j=1}^{n}\lambda_j y_{rj} \ge \theta y_{r0}, r = 1,2,.....,s$$
$$\lambda_j \ge 0,\ j = 1,2,....,n$$

$$Max\theta_0$$
$$s.t.$$
$$(2)$$
$$\sum_{j=1}^{n}\lambda_j R_{rj} \ge \theta_0 R_{r0}, r = 1,2,.....,s$$
$$\theta_0, \lambda_j \ge 0,\ j = 1,2,.....n$$

Let us start to describe the DEA CCR ratio model which is used in our analysis diagrammatically. Assume that we examine the efficiency of eight commercial banks (B_1, B_2, B_3,….B_8) as shown in Figure 4; to simplify this example, we use two efficiency ratios as output: (a) R_1=ROE and (b) R_2=income before tax / operating revenue. In the two output CCR model solution, we draw scatter picture first; then we can find out there are four DMUs including B_1, B_2, B_3 and B_4 which achieved optimal efficiency and these four DMUs comprised efficiency frontier. We call a DMU is optimal or efficient DMU if it is on the efficiency frontier. Therefore, B_5, B_6, B_7 and B_8 are inefficient DMUs. We then can identify the efficient values by the distances between DMUs and efficiency frontier. The longer the distances are; the smaller efficient values are.

The point T_μ indicates intersection of the efficiency frontier and line O T_μ. DMU located on the line O T_μ, a linear combination of B_2 and B_3, like B_6 is with the same proportion between R_2 and R_3. Therefore, we call B_2 and B_3 as the reference set of B_6 while

considering performance evaluation with DEA. The efficiency value of DMU B_6 is found by taking the ratio of the distances $OB_6/O\,T_\mu$.

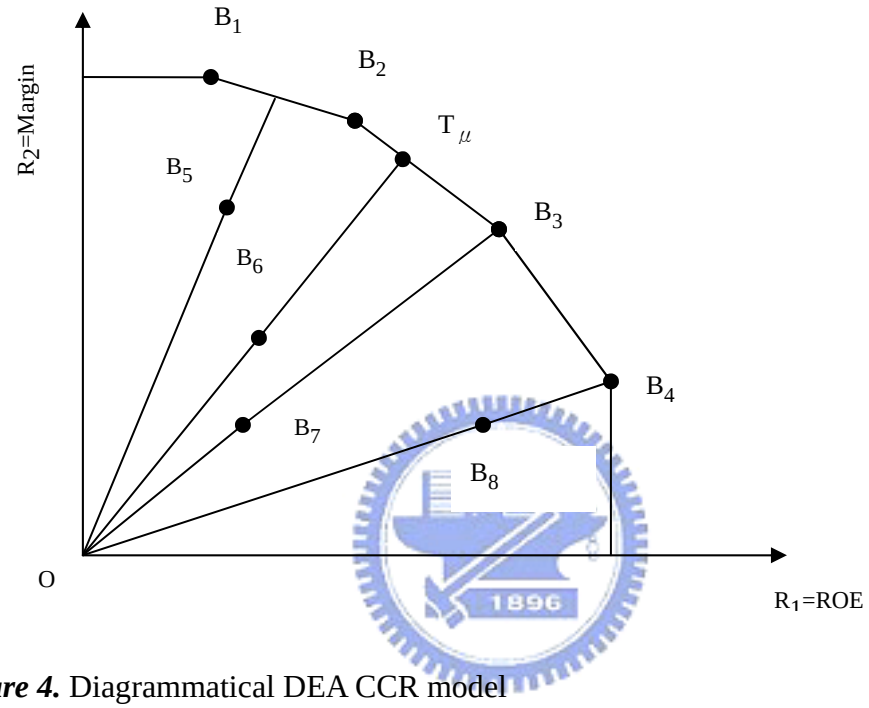


Figure 4. Diagrammatical DEA CCR model

3.1.2 Context-dependent DEA

One of the criticisms on CCR DEA model is its lower level of discrimination, because it only can distinguish DMUs into efficient or inefficient categories. In fact, the ranking methods have been developed to solve this lower discrimination issue. Adler et al. (2002) have divided the ranking methods into six general areas, including C*ross-efficiency models*, *Super-efficiency model*, *Benchmarking*, *Statistics-based models*, *Ranking of inefficient units* and *multiple-criteria decision-making (MCDA/DEA)*[1]. However, according to Adler et al. (2002), these six areas, somewhat overlapping, are useful in a specialist area but none of them can be prescribed as the complete solution to the ranking question.

[1] For a detailed description of the classification, refer to Adler et al. (2002).

Some researchers have incorporated the concept “Context-Decision”, which from consumer behavior, into DEA technique to identify the efficiency differences between DMUs. Before the term” Context-Decision” has been used in the field of consumer behavior, it originated from Psychology. Psychologists said that the choice made by people would be influenced by context. Take a typical example, a small circle in a circle called circle A would make circle A look smaller; circle A surrounded with a bigger circle would make circle A look bigger. Based on this concept, Seiford and J Zhu (1996, 1999, 2003)[2] suggest that context-dependent DEA can help us to differentiate relative attractiveness and progress for a particular bank from their peers. To create a benchmark-learning roadmap, we need to stratify DMUs first. We can then calculate attractiveness and progress measure values.

3.1.2.1 Stratification DEA Method

Context-dependent DEA is a DEA technique to rank the efficiency of DMUs. We applied the context-dependent DEA model described by Seiford, J Zhu (2003) in this analysis. Consider a case with n(n=1,…..,j) DMUs produced a vector of output $y_{rj}=(y_{1j},….y_{sj})$ by using a vector of inputs $x_{ij}=(x_{1j},…..x_{mj})$.

Let $J^1=\{DMU_j, j=1,….,n\}$ be the set of all n DMUs and define $J^{l+1}=J^l-E^l$ where El= $\{DMU_k \in J^l \mid \phi^*(l,k)=1\}$, and $\phi^*(l,k)$ is the optimal value to the following linear programming problem:

$$\begin{aligned} &\phi^*(l,k) = \max_{\lambda_j,\phi(l,k)} \phi(l,k) \\ &s.t. \\ &\sum_{j\in F(J^l)} \lambda_j y_j \geq \phi(l,k) y_k \qquad (3) \\ &\sum_{j\in F(J^l)} \lambda_j x_j \leq x_k \\ &\lambda_j \geq 0,\ j \in F(J^l) \end{aligned}$$

[2] It seems that it is categorized into MCDA, according to the taxonomy by Adler et al. (2002)

where $j \in F\left(J^l\right)$ means $DMU_j \in J^l$, i.e., $F(.)$ represents the correspondence from a DMU set to the corresponding subscript index set. When $l=1$, Eq.(3) is the original Output-oriented CCR model, and Eq.(1) and E^1 consists of the entire frontier *DMUs*. These *DMUs* in set E^1 define the first-level best-practice frontier. When $l=2$, Eq.(3) gives the second-level best-practice frontier after the exclusion of the first-level frontier *DMUs*, and so on. By this way, we identify several levels of best-practice frontiers. We call E^l the *l*th-level best practice frontier. It has been mentioned in the preceding section that input constraint is redundant in our model, therefore, we amended Eq.(3) to form Eq.(4).

$$\begin{aligned} &\phi^*(l,k) = \max_{\lambda_j, \phi(l,k)} \phi(l,k) \\ &s.t. \\ &\sum_{j \in F(J^l)} \lambda_j y_j \geq \phi(l,k) y_k \\ &\lambda_j \geq 0,\ j \in F(J^l) \end{aligned} \qquad (4)$$

The following algorithm accomplishes the identification of these best-practice frontiers by Eq.(4).

- Step 1: Set $l=1$. Evaluate the entire set of *DMUs*, J^1, by Eq.(4) to obtain the first-level frontier *DMUs*, set E^1 (the first-level best-practice frontier).
- Step 2: Exclude the frontier *DMUs* from future DEA runs. $J^{l+1} = J^l - E^l$. (If $J^{l+1} = \varnothing$, then stop).
- Step 3: Evaluate the new subset of 'inefficient' *DMUs*, J^{l+1}, by Eq.(4) to obtain a new set of efficient *DMUs*, E^{l+1} (the new best-practice frontier).
- Step 4: Let $l = l+1$. Go to step 2.
- Stopping rule: $J^{l+1} = \varnothing$, the algorithm stops.

3.1.2.2 Attractiveness Measure

Based upon these evaluation contexts E^l $(l = 1,\ldots,L-1)$, we can obtain the relative attractiveness measure by the following LP:

$$\begin{aligned}
&\Omega_q{}^*(d) = \max_{\lambda_j,\Omega_q(d)} \Omega_q(d), d = 1,...L - l_0 \\
&s.t. \\
&\sum_{j\in F(E^{l_0+d})} \lambda_j y_j \geq \Omega_q(d) y_q \\
&\sum_{j\in F(E^{l_0+d})} \lambda_j x_j \leq x_q \\
&\lambda_j \geq 0, j \in F(E^{l_0+d})
\end{aligned} \tag{5}$$

where $\text{DMU}_q = (x_q, y_q)$ is from a specific level E^{l_o}, $l_o \in \{1,\ldots,L-1\}$. We amended Eq. (5) to form Eq. (6) to fit our study design as mentioned previously.

$$\begin{aligned}
&\Omega_q{}^*(d) = \max_{\lambda_j,\Omega_q(d)} \Omega_q(d), d = 1,...L - l_0 \\
&s.t. \\
&\sum_{j\in F(E^{l_0+d})} \lambda_j y_j \geq \Omega_q(d) y_q \\
&\lambda_j \geq 0, j \in F(E^{l_0+d})
\end{aligned} \tag{6}$$

In Eq. (6), each best-practice frontier of E^{l_o+d} represents an evaluation context for measuring the relative attractiveness of *DMUs* in E^{l_o}. If one DMU_q owns the larger $1/\Omega_q{}^*(\text{d})$ value, the more attractive the DMU_q. Because this DMU_q makes itself more distinctive from the evaluation context E^{l_o+d}, we are able to rank the *DMUs* in E^{l_o} based upon their attractiveness scores and identify the best one.

3.1.2.3 Progress Measure

To obtain the progress measure for a specific $\text{DMU}_q = (x_q, y_q) \in \text{E}^{l_0}$, $l_o \in \{2,...,L\}$, we

use the following LP:

$$
\begin{aligned}
&\mathrm{P}_q{}^*(g) = \max_{\lambda_j, P_q(g)} P_q(g), g = 1,...l_0 - 1 \\
&s.t. \\
&\sum_{j \in F(E^{l_0-g})} \lambda_j y_j \geq P_q(g) y_q \\
&\sum_{j \in F(E^{l_0-g})} \lambda_j x_j \leq x_q \\
&\lambda_j \geq 0, j \in F(E^{l_0-g})
\end{aligned}
\tag{7}
$$

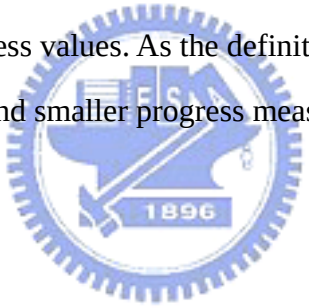
As we have discussed in the preceding section, input constraint is redundant due to the design of this thesis, we amended Eq.(7) to form Eq.(8).

$$
\begin{aligned}
&\mathrm{P}_q{}^*(g) = \max_{\lambda_j, P_q(g)} P_q(g), g = 1,...l_0 - 1 \\
&s.t. \\
&\sum_{j \in F(E^{l_0-g})} \lambda_j y_j \geq P_q(g) y_q \\
&\lambda_j \geq 0, j \in F(E^{l_0-g})
\end{aligned}
\tag{8}
$$

Each efficient frontier, E^{l_o-g}, contains a possible target for a specific DMU in E^{l_o} to improve its performance. The progress measure here is a level-by level improvement. For a larger $\mathrm{P}_q{}^*(g)$, more progress is expected for DMU_q. Thus, a smaller value of $\mathrm{P}_q{}^*(g)$ is preferred.

Let us start to describe the context-dependent DEA model which was developed by Seiford, J Zhu (2003) diagrammatically as shown in figure 5. Assume that we examine the efficiency for 13 commercial banks (B_1, B_2, B_3,….B_{13}). To simplify this example, we use two efficiency ratios: (a) R_1=ROE and (b) R_2=Margin (Income before Tax / Operating Revenue). We can stratify all 13 commercial banks into three levels by Eq.(4)and calculate activeness measure values and progress measure values by Eq.(6) and Eq.(8) , respectively. We can construct First Level, Second Level and Third Level efficiency frontiers by only

including DMU B_1, B_2,…,B_5 ,DMU B_6,B_7,..,B_9 and DMU B_{10},B_{11},..,$B_{13,}$, respectively. In this three levels case, we can both calculate their attractiveness and progress measure values to those DMUs in the Second Level. To DMUs in the First Level, we can only calculate attractiveness measure values. To DMUs in the Third Level, we can only calculate progress measures. We now take the B8 which in the Second Level as an example to explain how to calculate attractiveness and progress measure values. We identify the attractiveness measure values by the distances between B8 and the Third Level efficiency frontier. The distance of line OT_2 is called the 1st –degree[3] attractiveness measure value. Similarly, the 1st-degree progress measure values can also be measured by the distances between B8 and the First Level efficiency frontier as the distance of line OT_1. The longer the distances are, the bigger are the attractiveness and progress values. As the definition, the great performers have bigger attractiveness measure values and smaller progress measure values.



[3] Note: In this three level case, 1st-degree and 2nd-degree attractiveness measured values can be calculated for First Level Context DMUs; 1st-degree attractiveness measure and 1st-degree progress measure values can be calculated for the Second Level Context DMUs; and 1st-degree and 2nd-degree progress measure values can be calculated for the Third Level Context DMUs.

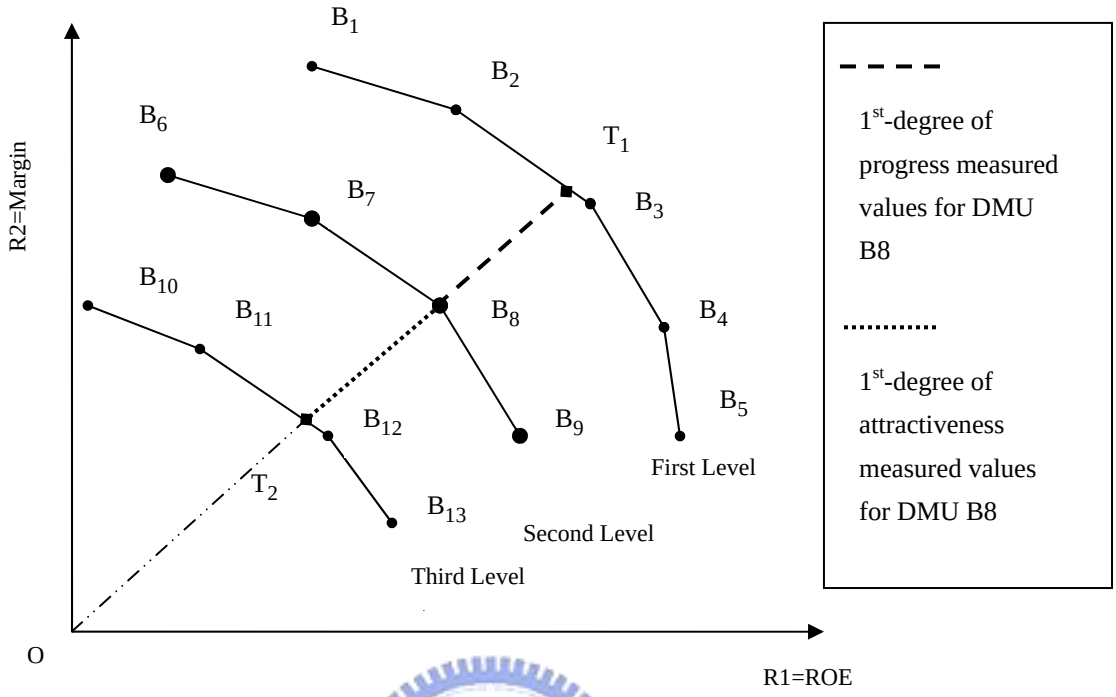


Figure 5. Attractiveness and Progress measurement values

3.2 DATA COLLECTION AND DECISION-MARKING UNITS SLECTION

According to the Financial Statistics prepared by the Banking Bureau, Financial Supervisory Commission, Executive Yuan for the year of 2005[4], Taiwanese enjoy services from 45 domestic and 36 foreign bank subsidiaries, which manage over 26,875.3 billion and 2,040.5 billion ($NTD) in assets individually. 36 foreign bank subsidiaries are integrated by 15 foreign countries, including 5 from South East Asia, 4 from Japan, 2 from Hong Kong, 6 from West Europe, 6 from Middle Europe, 1 from Africa, 1 from Australia, 2 from Canada and 9 from the USA. Domestic Taiwanese banks also provide overseas services served by their overseas branches aggregating the number on a yearly basis. There were 79 overseas branches of Taiwanese banks for the year end of 2005 and they provided services in the main cities located on many countries.

Homogeneity of DMUs assessed is the basic requirement while using DEA approaches.

[4] Data from website《http://www.banking.gov.tw》

However, there are many differences among banks in reality including asset sizes, scopes of business, strategies focused….etc. In order to minimize the differences among our banks assessed, we designed a process to select similar banks from 45 Taiwanese banks as shown in Figure 6[5]. As the description in Figure 6 shows, in this thesis, we focus only on commercial banking where all the products and services are similar to each other and we can ensure the homogeneity of all peer banks to satisfy the assumption of the DEA technique. Without this assumption, we can't treat the inputs and output as comparable for all DMUs. As a result, there are 24 domestic commercial banks in our final lists of DMUs as shown in Appendix 3 and we use data from the publications of ***Condition and Performance of Domestic Banks*** for the year end of 2005 prepared by the Central Bank of China (CBC). It is noteworthy to mention that the data obtained from the ***Condition and Performance of Domestic Banks*** are collected based on unaudited figures submitted by each domestic bank's headquarters, including the domestic banking units, offshore banking units and overseas branches, in order to publish this report on time. Thus the figures used in this thesis may differ from the information disclosed on the banks' website which was audited by the banks or Certified Public Accountant (CPA).

[5] Non-commercial banks include two industrial banks, four business banks, one export-import banks, one commercial saving bank and other specialty banks. 5 banks with more branches in any individual city other than Taipei include the Bank Of Panhsin, Cota Bank, Luckybank, Hsinchu International Bank and Taichung Commercial Bank. To identify more similar DMUs, we limit our DMUs on those banks with headquarters in Taipei, so we can minimize the differences among DMUs. After all, banks operating in different cities may have different strategies and business scopes. Why choose Taipei? According to the Financial Statistics prepared by the Banking Bureau, Financial Supervisory Commission, Executive Yuan for the year of 2005, there are 10,223.554 billion and 6,822.296 billion NT dollars in deposits and loans provided by domestic Taiwanese banks respectively and almost half (42% and 48% of total deposits and loans) of them are concentrated in Taipei City alone. Therefore, we want to focus on those banks owning more branches located on Taipei. Moreover, this type of domestic Taiwanese banks usually have their head offices located in Taipei, except Chang Hwa Commercial Bank. Therefore, we adjusted this to limit that they should have more branches in Taipei than any other individual city.

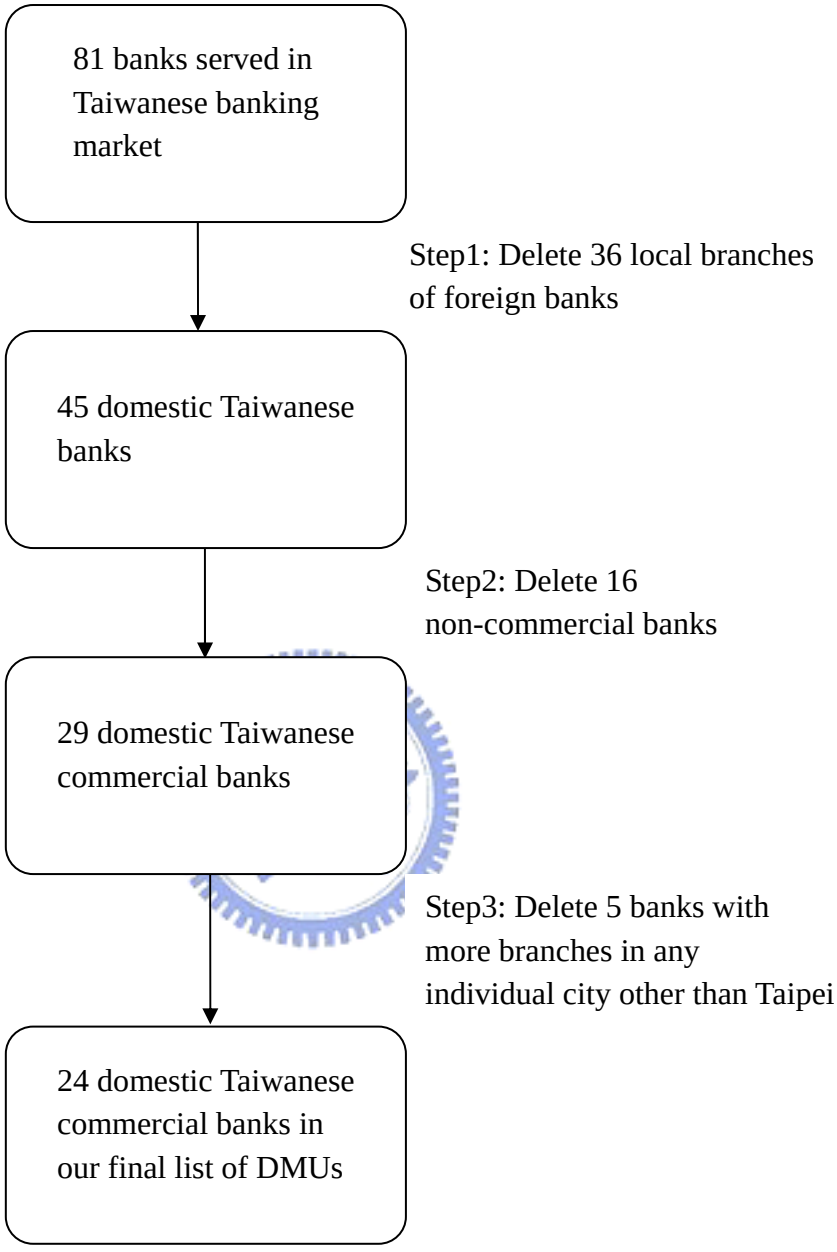


Figure 6. Process of DMUs selection

3.3 SELECTION OF INPUTS AND OUTPUT

3.2.1 Choice of Inputs/Output

How to choose inputs and output when using DEA model is debated in the academic literature. The choice of inputs and output will influence the efficiency value evaluated, so we need to think thoroughly beforehand and choose the most important ones. Basically, there is a common consensus in the choice of inputs and output while calculating efficiency values

employing the conventional DEA model. For example, the intermediation approach and production approach. In our paper, we choose some important financial ratio indices to capture the performances of banks assessed. 25 financial ratios, can be divided into five parts including, are Main Financial and Performance Ratios for domestic banks collected by the CBC (Central Bank of China, Taiwan) which are summarized in Appendix 4. All of these 25 indices are important but not all of them can be included into our model. We include three key factors as output to evaluate performance, which are Profitability, Asset Quality and Growth Ability, although the conventional intermediation or production approaches have not taken the measurement of risk and growth ability into account.

It goes without saying of the importance of Earning Indices, so we have chosen ROE, ROA, P/L and Margin rate, all four of these are popular in practice as measurements of earning performance. Bertrand Rime et al. (2003) have mentioned that "*the most obvious way to compare the performance of different size institutions is to look at familiar accounting ratios like ROA, ROE*." Muhammet Mercan et al. (2003) have used ROE as an indictor to measure the profitability. Dean Amel et al. (2002) have mentioned that "*The simplest approach consists of comparing balance sheet ratios that describe costs (e.g., operating costs over gross income) and profitability (e.g., return on* assets *or on equity)*." George E. Halkos et al. (2004) have employed ROE, P/L and ROA as profitability indicators. Hugh Crowford et al. (2004), in THE ART OF BETTER RETAIL BANKING, have mentioned that ROE is the most widely used and ROA is a common used performance measurement. In addition, the two indices are *high-level and catch all measurements of performance.* In fact, ROA and ROE may be treated as similar indices, however *if banks are listed in order of their ROE(s), which is an approximation to a listing from best to worst, it is not the same order as their ROA(s).* (p.28) Note that Margin rate is a percentage that how many net-earnings earned by firms from $100 dollar operational revenue, so we can realize the net-earning structure in operational revenue. Furthermore, the higher the Margin rate is, the more the cost efficient it is, thus to a certain extent, we can regard the Margin rate as a cost efficiency index.

We can't obtain the finest picture of a bank's performance if we don't include risk into consideration. In fact, authorities have focused on the risk control since 1998, because of the eruption of many crucial financial events and bankruptcy in financial sectors which were blamed to their poorer performance in risk control. In addition, authorities have given some incentives to encourage banks to reduce their Non-performing loan ratio. Therefore, we used the Non-performing loan ratio (NPL) to capture the concept of risk assessment in this paper, although NPL only captures Credit Risk of loans, not all risks faced by banks. The main reason we didn't include all the risks is because we can't explain those risk ratios in only one side. Take Leverage Rate as an example. According to Vasconcelos (2003), the Leverage rate *expresses the institution's ability in "circulating" more money without increasing by the same proportion its own capital, or rather, its capacity in levering assets by third party's resources. The higher the leverage rate, the greater is the liquidity risk borne by the institution. Thus, a higher leverage rate indicates a less risk-averse institution. It is, however, more prone to insolvency if assets fall abruptly and in great numbers.* By the introduction of the Leverage rate, we can understand that we can't judge a higher leverage rate as good or bad because it may be explained by higher risk (bad) and more profit potential (good), therefore, we can't use it as the output in the DEA model. Similar stories also happened in other risk ratios, so we don't take them as output in our DEA model. Note that the NPL ratio is negative as related to other output values, so we should do some adjustments which will be discussed in the next section.

Finally, according to (Dyson 2001) what about the so-called *Target* and *Objectives* which we have used as goals to evaluate efficiency of units of assessment usually has influenced a manager's behaviors, and furthermore, it ultimately changes the performance of a firm. However, profitability indices are common targets for banks, although they are short-run operating outcomes. In order to make balances between long-term and short-term objectives when we measure performance of units assessed, managers should consider both long-run and short-run cases. In this thesis, we choose growth ratios of deposits and loans into

our DEA model as long-run targets for banks. Note that there are four required growth ratios regulated by the CBC and we only selected two of them, since the most important and conventional activities of banks are deposits and loans businesses. Therefore we intuitively characterize banks as outstanding performers if their market share of loans and deposits are larger. In other words, the proportion of deposits and loans to the entire market and the market share of deposits and loans, can be treated as monopoly indicators. The higher of these two ratios would indicate higher profitability. The higher of the growth rate of these two ratios would indicate higher profitability prospects. As a result, we include growth rates of loans and deposits as output. In summary, we include three parts of performance measurement indices, which are asset quality, profitability and growth, and seven indicator ratios in our final list of choices of inputs and output as described below:

1. Asset quality:

   Non-performing loan ratio (NPL) (%)

   =Non-performing loans[6] divided into total loans

2. Profitability:

(1) Income [7]-to-Average Equity (ROE) (%)

(2) Income-to-Average Asset (ROA) (%)

(3) Income-to- Operating Revenue (Margin) (%)

(4) Income-to-number of Employee (PL) (thousand NT dollars / per employee)

3. Growth Ability:

(1) Growth rate of Deposit (GDR) (%)

(2) Growth rate of Loan (GLR) (%)

3.2.2 Examinations and Adjustments of Output Data

[6] The use of the new definition of NPLs has started from 1 July 2005. We know the old definition of NPLs before 30 June 2005 from the website of the CBC (Central Bank of China, Taiwan). According to the new definition of NPLs regulated by the CBC since 1 July 2005, the items of new NPLs' definition includes loans which the repayment of principal or interest have been overdue for more than 3 months and any loan of which the principal debtors and surety has been disposed, although the repayment of principal or interest have not been overdue for more than 3 months.

[7] Income before tax

The efficiency values can be easily obtained by using the DEA Excel Solver provided in Cooper, Seiford and Tone (2000). However, there are several adjustments should be done before we run the DEA Excel Solver software, when certain situations described below occur: (1) Negative values exist in data set, (2) The data set violated the basic correlation assumption required by DEA model, and this two situations can be found in our data set.

Descriptive statistic of original data for year of 2005 has calculated and shown in Appendix 5. We can find out negative values and negative correlation in our output data. As shown in Appendix 5, values of ROE, ROA, Margin, PL, GDR, and GLR exit negative values, so we have paralleled the negative values to solve the negative value problem. Take ROE as an example, the parallel steps include: (1) Adding the modulus of minimum value of ROE to all ROE data; then (2) Adding one to all adjusted ROE data. There are no negative values in our data set after this adjustment process has been done.

Appendix 6 is shown the coefficient correlation of the original data set for the year of 2005. It's clearly that NPL data is negative related to all the other data, because Non-performing Loans are undesirable outputs for banks. We have done several adjustment processes by the suggestion of Seiford and J Zhu (2002, 2005): (1) Calculate the maximum value of NPL and minus all NPL to obtain a set of new data; then (2) Adding 1 to all NPL data. There are positive relationships between any of two outputs in our data set since the adjustment has been done.

CHAPTER FOUR
EMPIRICAL RESULTS

4.1 DESCRIPTIVE STATISTICS AND CORRELATION COEFFICIENTS OF THE RATIO MODEL

We summarize the descriptive statistics and correlation coefficients of the output employed in our DEA model as shown in Table3 and Table 4, respectively. All output are positively correlated, which fit the requirement of DEA approaches. As shown in Table3, we can find out the minimum values of all output are one, due to the adjustments described in Section 3.2.2. We have done several adjustments because the negative related between NPL ratio (hereafter, NPL) and other ratios in original data. Another adjustment is done because negative values exist in our data. As the results after adjustment, the all of the Min. value are one and several ratios exceed 100%.

Table 3. Descriptive Statistics of 2005

	NPL	ROE	ROA	Margin	PL	GDR	GLR
Mean	9.90	64.97	4.83	115.55	8127.78	19.36	29.82
Median	10.55	69.94	5.14	124.38	8220.62	12.17	27.43
SD	2.45	19.78	1.18	30.00	2123.32	14.66	14.26
R range	11.30	83.66	5.35	143.31	11581.23	57.12	68.86
Min	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Max	12.30	84.66	6.35	144.31	11582.23	58.12	69.86
Number of DMUs	24	24	24	24	24	24	24

Table 4. Correlation Coefficients of 2005

	NPL	ROE	ROA	Margin	PL	GDR	GLR
NPL	1						
ROE	0.218856	1					
ROA	0.221813	0.988511	1				
Margin	0.170603	0.975961	0.96879	1			
PL	0.196741	0.938411	0.937162	0.977281	1		
GDR	0.300131	0.202038	0.186485	0.199303	0.173091	1	
GLR	0.274047	0.311229	0.28011	0.305155	0.259899	0.904535	1

4.2 RATIO OUTPUT-ORIENTED DEA MODELS

We summarize the technical efficiency values for the year of 2005 calculated by Ratio Output-oriented DEA model which is described in Eq.(2) as shown in Table 5. Of the total results of the DMUs, the mean technical efficiency score is quite high (0.992). This implies that the gap in efficiency difference among the 24 commercial banks is not too large in 2005, since all banks have operated in a highly competed environment in Taiwan and have already improved their efficiency as the same conclusion in TSER-YIETH CHEN(2000). Among 24 commercial banks, five of them (First, Bank Of China, E.Sun, Taishin, Shin Kong) are categorized as technically efficient banks because their efficiency scores are equal to one. Note that all of these technically efficient banks are the bank subsidiaries in Financial Holding Companies (FHCs). Thus we conclude that the 11 bank subsidiaries in the FHC do outperform independent banks and also supported by three other findings: First, the mean technical efficiency scores of bank subsidiaries in FHC is 0.984 and independent banks is 0.922. Second, the six poorest efficiency rating banks in 2005 among 24 commercial banks include Union(0.928), Cosmos(0.921),Ta Chong(0.915), Chinese Bank(0.849),Chinfon(0.821), and Bowa(0.808); however, all of these six are independent banks. Third, none of the independent banks defines as optimal-efficient bank. All of the findings described above have supported that bank subsidiaries in FHC are relative efficiencies than independent banks.

We further conduct a Wilcoxon-Mann-Whitney test which serves to test the hypothesis that the two groups include bank subsidiaries and independent banks are in the same population. In fact, Wilcoxon-Mann-Whitney test, also called Rank-Sum-Test, is one of the non-parametric tests. Since T^{1}= -3.2 < -1.96= $-T_{0.025}$, we reject the null hypothesis at the

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[1] $T = \dfrac{S - m(m+n+1)/2}{\sqrt{mn(m+n+1)/12}}$

where *m* is the number of DMUs which are bank subsidiaries in Financial Holding Companies(Group one); *n* is the number of DMUs which are independent banks (Group two). S is the sum of rankings for all DMUs in group one

In our case, m=11, n=13, C= { 1, 1, 1, 1, 1, 0.998 , 0.989, 0.988, 0.977, 0.975, 0.968, 0.966, 0.964, 0.963, 0.949, 0.948, 0.945, 0.938, 0.928, 0.921, 0.915, 0.849, 0.821, 0.808 } ; R= { 3, 3, 3, 3, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24 } ; (the underlined numbers indicate they are group one);

significance level of 5%.

There is another finding that should be addressed that the types of main businesses of FHC do have influences on the efficiency of its bank subsidiary. For a clear explanation, we first divide bank subsidiaries of FHCs into three groups by the main businesses of FHCs. The main businesses can be categorized into securities, insurance and banking. By comparing the mean technical efficiency scores, we can find an interesting result that is those main business whose categories are not banking perform poorer than those whose main business is banking. As shown in Table 5, the mean technical efficiency scores are 0.996, 0.983, and 0.943 which correspond to the main businesses of banking, insurance and security, respectively. It's easy to explain these results, because after all, when banks are not the main business in FHC, the big part of resources would not be concentrated in the banks. Therefore, the performance of bank subsidiaries in FHCs which the main business is banking outperforms other types. The other reason may be explained by strategies of the company, when banks are not the main business in the FHC, the FHC may sacrifice benefits from their unimportant subsidiaries to trade off more benefits in their subsidiary main business.

We further summarize the technical efficiency scores and Financial Ratios which we used as output in our DEA model as shown in Table 6 for comparison. We have calculated the specific maximum, 2nd maximum, minimum and 2nd minimum values of seven financial ratios. We have used NPL as measurement of risk control, so that the smaller the NPL value is; the better the performance of banks is. The minimum and 2nd minimum values of NPL are 0.5 and 0.79, which performed by Bank of China and E. Sun., respectively and both are categorized as efficient banks because their technical efficiency values are one. ROE, ROA, Margin and P/L are the measurements of profitability; thus the more the values are, the better the performance of banks are. The maximum (2nd maximum) values in ROE, ROA, Margin and P/L are 19.95(18.22), 1.61(1.19), 29.77(26.43), and 3700.42(2200.26), respectively. We can easily find that three of the optimal-efficient banks include the First Commercial bank, Bank Of

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S=3+3+3+3+3+3+6+7+8+12+16+18=82

China and Taishin have higher values in at least two of these profitability financial ratios. In this case, we can realize why those three banks are categorized as optimal-efficient.

We use Growth Rate of Deposits (hereafter, GDR) and Growth Rate of Loans (hereafter, GLR) to measure Growth ability of banks. Usually, the higger value means the higher growth potential the bank is. The maximum (2^{nd} maximum) of GDR and GLR are 53.02(38.98) and 52.56(33.34) performed by Shin Kong and E. Sun which are technically efficient since their technical efficiency values are one. In summary, the optimal-efficient banks have good values in at least two of these seven ratios, and we can divide these efficient banks into three categories. First, banks performed well in at least two of three abilities, such as the Bank of China (Risk Control, Profitability) and E. Sun(Risk Control and Growth). Second, banks performed well in Profitability Ability, like the First (ROE, Margin) and Taishin(ROE and ROA) banks. Third, banks performed exceptionally well in Growth Ability, like Shin Kong. It's worth noting that Shin Kong as a relatively new bank only performed well at Growth Ability, but worst in other two abilities. In the conventional DEA model which has not considered the Growth Ability, the performance of Shin Kong would not be categorized as efficient. However, as we have mentioned in Chapter Three, the indices which were used to measure performance should also consider the potential growth in the future. We can thus include the growth ability index into our model for encouraging those long-term growth policies. We can suggest that Shin Kong Bank would have great potential to be a good performer in the following year.

In order to find out the trend of efficiency for DMUs, we calculate a five year technical efficiency comparison by the method of Window Analysis as shown in Table 7. In Window Analysis, we treat every observation as an independent DMU, thus we have 120 DMUs evaluated. Since the data covers five years, we have a deflated P/L variable by CPI. The CPI indices for five years are shown in Appendix 7. Since the Legislative Yuan passed the Financial Holding Company (FHC) Act in November 2001, Hua Nan Commercial Bank joined into Hua Na FHC in 2001 and Taishin, E. Sun, Chinatrust, Sinopac, Bank of China,

Cathay, Jih Sun, Fuhwa joined into FHC in 2002. First Commercial Bank has joined into First FHC since 2003. Shin Kong and Macoto Bank were merged by Shin Kong FHC in Oct. 2004 and Oct. 2005, respectively and two affiliated banks merged in Dec. 2005. In order to confirm the results of bank subsidiaries of FHCs outperforming independent banks, we thus categorize the 120 DMUs into several groups: Group One, if banks are independent banks in 2005, and Group Two, if banks are subsidiaries of FHC in 2005. Furthermore, we also separate those DMUs in Group Two into three groups by the main businesses of FHCs. For instance, Cathay Bank is in Cathay FHC with its main business focused on Cathay Insurance, therefore we classify it into Group B which is under Group Two. Chinatrust Bank is in Chinatrust FHC in which its main business is Chinatrust Insurance Brokerage, thus we classify it into Group A under Group Two.

The five-year averages technical efficiencies are 0.8118 for Group One and 0.9104 for Group Two. The average technical efficiencies for Group One are 0.7328, 0.7448, 0.8107, 0.86 and 0.9108 from 2001 to 2005. The average technical efficiencies for Group Two in 2005 are 0.8194, 0.8719, 0.9287, 0.9563 and 0.9759 from 2001 to 2005. It seems to be an increasing trend of technical efficiency, no matter for banks in Group One or Two. Obviously, the performance of banks in Group One outperform than Group Two. We thus conclude that the bank subsidiaries in FHCs do outperform independent banks and the successful banks will succeed again.

On the other hand, the ranking of performance within Group Two is Group A, Group B and then Group C in all five years (0.8486〔Group A〕>0.7830〔Group B〕>0.7535〔Group C〕>0.7328〔Group One〕in 2001). Therefore, we can conclude that the bank subsidiaries in FHCs in which their main business are banking outperform others which focus their main business in insurance or securities. It confirms that main business of FHC does have influences on the performance of their bank subsidiaries. This conclusion is intuitive, because the big part of financial funds and all kinds of resources would support the main business in FHC. Thus bank subsidiaries in FHC whose main business is banking would perform better.

We also find those technical efficiency banks on the list of good performers which is evaluated by The Banker. For example, E. Sun Commercial Bank, which is categorized on the list of technically efficient banks in 2004 and 2005 in our analysis, won the awards of “Bank of the Year”, which reflect the best overall performance by banks in the calendar year 2004. The awards, decided by The Banker’s global editorial team, is not only based on the assessment of the latest results and performance data provided by the banks but also analyzes strategic developments and overall achievements. E. Sun is one of the 510 selective banks from a record of 138 countries announced by The Banker (Sep. 05 2005). In addition, E. Sun Commercial Bank established the strategic alliances with the UK’s Prudential, thus E. Sun Bank can extend its services in 2004. On the other hand, according The Banker, much of the IT establishment has been achieved on the risk management front in preparation for Basel II, and E.SUN Bank is deemed to continue to be the leader in asset quality compared to its peers. Taishin Bank which was categorized as technically efficient in 2002 is also the focus for foreign investment. (The Banker, July 04, 2005, pp.154).

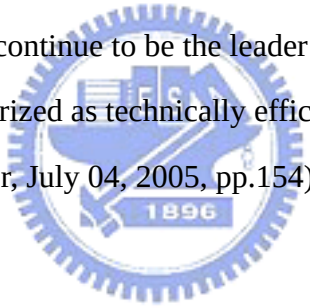


Table 5. Summary of technical efficient values for the year of 2005

		Technical Efficiency Scores	Mean of Technical Efficiency Scores
Subsidiary of a FHC			**0.984**
Main business of FHC			
Banking			**0.996**
	First #	**1.000**	
	Bank Of China #	**1.000**	
	E.Sun #	**1.000**	
	Taishin #	**1.000**	
	Chinatrust #	**0.998**	
	Sinopac #	**0.989**	
	Hua Nan #	**0.988**	
Insurance			**0.983**
	Shin Kong #	**1.000**	
	Cathay #	**0.966**	
Security			**0.943**
	Fuhwa #	**0.948**	
	Jih Sun #	**0.938**	
Independent Banks			**0.922**
	Sunny	**0.977**	
	Far Eastern	**0.975**	
	Chang Hwa	**0.968**	
	Hwatai	**0.964**	
	Bank Of Taipei	**0.963**	
	Overseas Chinese	**0.949**	
	Entie	**0.945**	
	Union	**0.928**	
	Cosmos	**0.921**	
	Ta Chong	**0.915**	
	Chinese Bank	**0.849**	
	Chinfon	**0.821**	
	Bowa	**0.808**	

Table 6. Summary of technical efficiency scores and ratios

DMUs	Technical Efficiency Scores	Risk Control	Profitability				Growth	
		NPL	ROE	ROA	Margin	P/L	Growth Rate of Deposits	Growth Rate of Loans
First[12] #	1.000	1.720	**18.22****	0.890	**26.43****	1896.550	3.700	5.740
Bank Of China #	1.000	**0.5*****	16.420	1.100	**29.77***	**3700.42***	12.480	8.640
Shin Kong #	1.000	2.390	-2.780	-0.140	-2.180	-92.940	**53.02***	**52.56***
E.Sun #	1.000	**0.79********	14.340	0.990	22.760	1527.240	34.390	**33.34****
Taishin #	1.000	1.340	**19.95***	**1.61***	21.370	1599.760	22.120	16.350
Chinatrust #	0.998	1.500	17.240	1.19**	20.920	2200.26**	22.350	12.190
Sinopac #	0.989	1.010	8.940	0.540	12.510	1187.470	21.340	15.970
Hua Nan #	0.988	2.120	17.740	0.770	23.150	1544.710	6.890	6.720
Sunny	0.977	3.090	7.370	0.440	11.840	314.450	38.98**	32.070
Far Eastern	0.975	1.830	13.870	1.080	18.640	1282.480	17.090	23.120
Chang Hwa	0.968	1.670	-63.710	-3.740	-113.540	-7880.810	2.710	-4.720
Cathay #	0.966	1.730	6.040	0.490	9.450	1219.090	6.520	6.780
Hwatai	0.964	1.800	4.330	0.340	10.330	363.170	2.490	2.770
Bank Of Taipei	0.963	1.900	8.300	0.720	17.990	1085.110	7.240	11.970
Overseas Chinese	0.949	2.410	-6.790	-0.300	-8.270	-356.410	6.410	11.610
Fuhwa #	0.948	2.490	0.600	0.040	0.880	37.300	15.060	17.260
Entie	0.945	2.490	0.780	0.050	1.040	80.650	5.750	7.820
Jih Sun #	0.938	2.730	-36.680	-1.950	-39.930	-1840.030	3.070	5.220
Union	0.928	3.760	-21.560	-1.600	-24.750	-1288.660	35.520	28.610
Cosmos	0.921	3.370	4.410	0.360	4.490	265.050	2.320	-0.580
Ta Chong	0.915	3.780	7.290	0.500	10.230	517.890	25.280	16.780
Chinese Bank	0.849	5.960	-3.550	-0.250	-4.250	-183.500	-4.100	-1.890
Chinfon	0.821	11.800	2.280	0.140	2.010	170.200	-1.490	8.520
Bowa	0.808	7.440	-26.760	-1.170	-26.660	-1446.140	2.990	-16.300
	max *	**11.800**	**19.950**	**1.610**	**29.770**	**3700.420**	**53.020**	**52.560**
	2nd max **	**7.440**	**18.220**	**1.190**	**26.430**	**2200.260**	**38.980**	**33.340**
	min ***	**0.500**	**-63.710**	**-3.740**	**-113.540**	**-7880.810**	**-4.100**	**-16.300**
	2nd min ******	**0.790**	**-36.680**	**-1.950**	**-39.930**	**-1840.030**	**-1.490**	**-4.720**
	Mean	2.901	0.262	0.088	1.010	245.971	14.255	12.523
	Median	2.255	5.225	0.400	9.840	338.810	7.065	10.125

bank Subsidiaries in FHC

*maximum value; **2nd maximum value

***minimum value; ****2nd minimum value

[12] Ranked by technical efficiency value.

Table 7. Five year comparable technical efficiencies

Group One				Group Two			
Year	Banks	Efficiency Score	Average	Year	Banks	Efficiency Score	Average
2001			0.7328	2001			0.8194
	Sunny	0.8590		Group A			0.8486
	Bank Of Taipei	0.8340			Chinatrust	0.9160	
	Union	0.7850			Sinopac	0.8990	
	Far Eastern	0.7710			Taishin	0.8860	
	Cosmos	0.7590			Bank Of China	0.8840	
	Hwatai	0.7520			E.Sun	0.8660	
	Ta Chong	0.7330			Hua Nan [13]#[14]	0.7540	
	Chang Hwa	0.7300			First	0.7350	
	Chinfon	0.7130		Group B			0.7830
	Entie	0.7020			Cathay	0.8450	
	Chinese Bank	0.6640			Shin Kong	0.7210	
	Bowa	0.6210		Group C			0.7535
	Overseas Chinese	0.6030			Fuhwa	0.7910	
					Jih Sun	0.7160	
2002			0.7448	2002			0.8719
	Bank Of Taipei	0.8670		Group A			0.9250
	Far Eastern	0.8580			**Taishin[15] #**	**1.0000**	
	Sunny	0.8560			E.Sun[16] #	0.9510	
	Cosmos	0.8410			Chinatrust[17] #	0.9460	
	Union	0.7990			Sinopac[18] #	0.9300	
	Ta Chong	0.7920			Bank Of China[19] #	0.9250	
	Hwatai	0.7760			Hua Nan #	0.8700	
	Chinese Bank	0.7020			First	0.8530	
	Overseas Chinese	0.6870		Group B			0.8075
	Chang Hwa	0.6810			Cathay[20] #	0.8760	
	Entie	0.6390			Shin Kong	0.7390	
	Bowa	0.6120		Group C			0.7505
	Chinfon	0.5720			Jih Sun[21] #	0.7540	
					Fuhwa[22] #	0.7470	

[13] The sign of # characteristices of those banks which are bank subsidiaries in FHC.
[14] Hua Nan Commercial Bank has joined into Hua Na FHC since Dec. 2001.
[15] Taishin Banks has joined into Taishin FHC since Feb. 2002.
[16] E. Sun Commercial Bank has joined into E. Sun FHC since Jan. 2002.
[17] Cinatrust Commercial Bank has joined into Chinatrust FHC since May 2002.
[18] Sinopac Bank has joined into Sinopac FHC since May 2002.
[19] The International Commercial Bank of China has joined into Mega FHC since Dec. 2002.
[20] Cathay United Bank has joined into Cathay FHC since 2002.
[21] Jih Sun Bannks has joined into Jih Sun FHC since Fed. 2002.
[22] Fuhwa Banks has joined into Fuwa FHC since Aug. 2002.

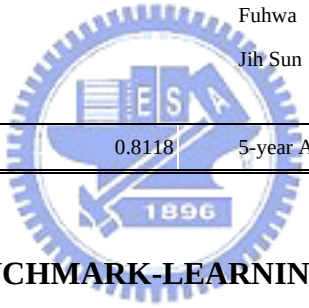
Table 7. Five year comparable technical efficiencies (Cont.)

Group One				Group Two			
Year	Banks	Efficiency Score	Average	Year	Banks	Efficiency Score	Average
2003			0.8107	2003			0.9287
	Far Eastern	0.9520		Group A			0.9551
	Bank Of Taipei	0.9340			E.Sun #	0.9770	
	Sunny	0.9120			Taishin #	0.9740	
	Ta Chong	0.8790			Sinopac #	0.9630	
	Cosmos	0.8780			Bank Of China #	0.9550	
	Union	0.8630			Chinatrust #	0.9530	
	Hwatai	0.8420			First [23] #	0.9460	
	Entie	0.8180			Hua Nan #	0.9180	
	Chang Hwa	0.7540		Group B			0.9010
	Chinfon	0.7210			Cathay #	0.9590	
	Chinese Bank	0.7060			Shin Kong	0.8430	
	Bowa	0.6410		Group C			0.8640
	Overseas Chinese	0.6390			Fuhwa #	0.9040	
					Jih Sun #	0.8240	
2004			0.8600	2004			0.9563
	Bank Of Taipei	0.9690		Group A			0.9791
	Entie	0.9640			**E.Sun #**	**1.0000**	
	Far Eastern	0.9540			Taishin #	0.9960	
	Hwatai	0.9470			Sinopac #	0.9910	
	Sunny	0.9430			Bank Of China #	0.9860	
	Union	0.9140			Chinatrust #	0.9700	
	Cosmos	0.9130			First #	0.9600	
	Ta Chong	0.8930			Hua Nan #	0.9510	
	Overseas Chinese	0.8200		Group B			0.9225
	Chang Hwa	0.8020			**Cathay #**	**1.0000**	
	Chinese Bank	0.7670			Jih Sun #	0.8450	
	Chinfon	0.7070		Group C			0.9100
	Bowa	0.5870			Fuhwa #	0.9230	
					Shin Kong[24] #	0.8970	

[23] The First Commercial Bank was acquired into the First FHC since 2003.
[24] Shin Kong Commercial Bank was acquired into the Shin Kong FHC since Oct. 2004.

Table 7. Five year comparable technical efficiencies (Cont.)

Group One				Group Two			
Year	Banks	Efficiency Score	Average	Year	Banks	Efficiency Score	Average
2005			0.9108	2005			0.9759
	Far Eastern	0.9690		Group A			0.9833
	Chang Hwa	0.9680			**Bank Of China #**	**1.0000**	
	Hwatai	0.9640			**E.Sun #**	**1.0000**	
	Bank Of Taipei	0.9630			Sinopac #	0.9890	
	Sunny	0.9520			Taishin #	0.9860	
	Overseas Chinese	0.9480			Chinatrust #	0.9780	
	Entie	0.9450			First #	0.9700	
	Union	0.9280			Hua Nan #	0.9600	
	Cosmos	0.9200		Group B			0.9830
	Ta Chong	0.9150			**Shin Kong #**	**1.0000**	
	Chinese Bank	0.8490			Cathay #	0.9660	
	Bowa	0.8080		Group C			0.9430
	Chinfon	0.7110			Fuhwa #	0.9480	
					Jih Sun #	0.9380	
	5-year Average		0.8118		5-year Average		0.9104



4.4 CONSTRUCTING A BENCHMARK-LEARNING ROADMAP

After identifying the efficient DMUs, assigning the benchmarks for each inefficient DMU is also important. In this paper, we adopted Seiford, J Zhu (2003, 1999, 1996) to identify the benchmark-learning roadmaps for inefficient DMUs. As described in Chapter Three, there are three steps which should be done before we draw the benchmark-learning roadmap: the first step is to stratify the calculated DEA results; the second and third steps are to calculate progress measurements.

Table 8 shows the five stratification levels calculated by using Eq.(4). We need to calculate five runs for including all DMUs into several stratification levels. According to Morita, Hirokawa, and Zhu (2005), the benchmark targets of the inefficient DMUs in the Third Level should take the DMUs in the Second Level as initial targets to improve efficiency. DMUs in the Fourth level should take DMUs in the Third Level as benchmark and so forth. It should noted that we can find out when DMU is characterized by a larger TE score, it would

be ranked in front, as described in Morita and Zhu (2005) and Seiford and Zhu (2003), the levels obtained using Eq.(4) do not necessarily follow the order of the TE scores. For example, the Overseas Chinese's TE score is 0.949 is larger than Union's 0.928, but Overseas Chinese ranked as Fourth Level and Union ranked as the Third Level. There are more examples like Hwatai(0.964), Cosmos(0.921), Entie(0.945) and Jih Sun (0.938). There is another interesting result that is among 11 bank subsidiaries in the FHCs, there are 5 in the First Level, 3 in the Second Level and 2 in the Third Level. Thus it's evident that bank subsidiaries in FHCs perform better indeed.

The next step is to calculate the attractive measure and progress measure by Eq.(6) and Eq.(8) , respectively and summarize the results in Table 9. The number to the right of each score indicates the ranking position by the attractiveness or progress measure. (the ① represents the top-ranked position) We can rank the performance of DMUs by the attractiveness measure scores directly when they are located in the First Level by different evaluation contexts. As mentioned by Seiford and Zhu (2003), *in fact, for DMUs that are not located on the first or last level of an efficiency frontier, we can characterize their performance by their attractiveness and progress. The most desirable category is the low progress- high attractiveness and the least desirable category is the high progress –low attractiveness. A high progress indicates that the DMU needs to improve its output substantially, and a high attractiveness indicates that the DMU does not have any close competitors.* Also, *the attractiveness measure can be used to (1) identify DMUs that have outstanding performance and (2) differentiate the performance of DEA efficient DMUs*. In other words, high attractiveness indicates a better competitive advantage than other rivals. Therefore, the higher attractiveness measure, the higher the competitive advantage observed. For instance, when the Second Level or Third Level is chosen as the evaluation context, we can rank the performance of DMUs in the order of Shin Kong, E.Sun, Bank of China, Taishin and First Banks. On the other hand, if a Fourth level or Fifth Level is chosen as the evaluation context, the performance of banks can be ranked in the order of Sin Kong, E.Sun, Taishin,

Bank of China and First banks. These two results are similar.

Now we turn to determine the performance of banks in the Fifth Level. Because of the definition of progress and attractiveness, we know that we only can rank the efficiency of the Fifth Level banks by progress measurement values but attractiveness measure values. High progress indicates the banks need to improve their output in a bigger amount. Thus, the smaller the progress measure value is, the better the performance of bank is. As shown in Table 9, no matter which evaluation context we have chosen, the rank of performance is in the order of Jih Sun,Chinese Bank and Bowa.

When we have already gotten the rank of performance for the First and Fifth Level of DMUs, we can start to evaluate the remaining three levels. A good performer should have larger values in attractiveness and smaller values in progress as discussed in the previous two paragraphs. For the DMUs in the Second Level, we try to spot the progress measure value and attractiveness measure values one by one to draw a two-by-two matrix; for example, we can compare the 1^{st}-degree of the progress values with 1^{st}-degree of attractiveness values, 1^{st}-degree of progress values with 2^{nd}-dgree of attractiveness values, or 1^{st}-dgree of progress values with 3^{rd}-dgree of attractiveness values. Because these three pairs were similar, thus we have analyzed 1^{st}-degree progress values with 3^{rd}-degree of attractiveness values when we rank the performance of DMUs in the Second Level. Each bank in the Second Level is classified into a zone by examining (1) whether the attractiveness score is greater than or smaller than 3.3386 which is the mean of attractiveness scores, and (2) whether the progress score is greater than or smaller than 1.0202 which is the mean of progress scores. We have characterized this result into four groups plotted in the zones of LH, H, LL and HL shown in Figure 7. The best performer in the Second Level is Chinatrust. This is the bank subsidiary of Chinatrust FHC, because it is in the Zone HL which means the difference of efficiency between Chinatrust and the First Level is smallest and has better competitive advantages compared to other banks in the Second Level. Hua Nan Bank is in the Zone LL, which means low Progress measure values and high Attractiveness measure values. The suggestion for the

banks in Zone LL is to learn the peer banks which are in the Zone HL as an initial learning benchmark, which is Chinatrust in this case.

The Learning direction for the Second Level is to follow the direction of the arrow. For example, Far Eastern, which is in the Zone LH, can get more knowledge about the peers which are in the Zone LL, like Hua Nan, or Zone HH, like Sinopac and Sunny, as initial learning benchmarks. The performance of Sinopac is not good enough compared to Sunny, and may be explained by two reasons: (1) Sunny own 95 additional branches as compared to Sinopac's 44 branches, and more branches can be treated as better marketability which would affect the efficiency of banks. (2) The main business of the Sinopac FHC which owns Sinopac Bank is in securities brokerage and it appears that Sinopac FHC has not paied more attention in the bank business than their securities brokerage business, thus the attractiveness and progress scores do not beat Sunny which is focused on the bank business and even merged with another commercial banks in November 2005.

Now we turn to analyze the performance of the Third Level. We have analyzed 1st-degree of progress values with 2nd-dgree of attractiveness. Each bank in the Third Level is classified into a zone by examining (1) whether the attractiveness score is greater than or less than 2.662 which is the mean of the attractiveness scores, and (2) whether the progress score is greater than or smaller than 1.134 which is the mean of the progress scores. We have characterized this result into four groups plotted in the zones of LH, HH, LL and HL shown in Figure 8. The best runner under Level Three is Ta Chong located in Zone HL which indicates better performance in both Attractiveness and Progress measurement values. Note that it seems odd that Ta Chong beats Cathay in efficiency, thus we provided two possible reasons to explain this result. First, Ta Chong is twice as small in asset size as compared to Cathay which is located in Zone LL, but the growth rates in both deposits and loans are consistently increasing. For example, the growth rate of deposit is 6.23% in 2001 and 25.28% in 2005. On the other hand, the growth rates in both deposits and loans of Cathay Bank are shown decreasing by years. For example, the growth rate of deposit is 8.89% in 2001 and hits

28.24% in 2003; then falls to 6.52% in 2005. Secondly, we also can explain this result by the conventional wisdom and the historical fact that small banks typically have higher profitability ratios. (A.N. Berger et al.. (1997))

Finally, we start to analyze the performance of DMUs in the Fourth level, and we choose the 1st-degree of progress values with 1st-degree of attractiveness to draw up the two-by-two matrix graph for examination. Each bank in the Third Level is classified into a zone by examining (1) whether the attractiveness score is greater than or less than 1.551 which is the mean of the attractiveness scores, and (2) whether the progress score is greater than or less than 1.176 which is the mean of the progress scores. We have characterized this result into four groups plotted in the zones of LH, HH, LL and HL shown in Figure 9. The best performer in the Fourth level is Overseas Chinese because of its higher attractiveness measure ratio, which means that it would be harder for banks in the Fifth Level to replicate Overseas Chinese Bank's success cases and lower the progress measurement ratio, which means it would be more easy for Overseas Chinese Bank to beat banks in the First Level compared to other banks in the Fourth Level. The suggestion to Overseas Chinese Bank, which located on Zone HL, is to learn the strategies of the banks which are located in the Third Level. The best strategy for Hwatai, located in Zone LL, or Entie, which is located in Zone HH, is to learn the success tactics of Overseas Chinese Bank as the first step to improve their efficiency. Cinfon and Cosmos Banks which are located in Zone LH should take the banks located in Zone LL or HH as a benchmark for study.

Table 8. Levels

First Level		**Second Level**		**Third Level**		**Fourth level**		**Fifth Level**	
DMU Name	TE	DMU Name	TE	DMU Name	TE	DMU Name	TE	DMU Name	TE
First #	1	Hua Nan #	0.988	Chang Hwa	0.968	Overseas Chinese	0.949	Chinese Bank	0.849
Bank of China #	1	Sunny	0.977	Cathay # *	0.966	Hwatai	0.964	Bowa	0.808
Shin Kong # *	1	Far Eastern	0.975	Union	0.928	Cosmos	0.921	Jih Sun # **	0.938
E.Sun #	1	Sinopac #	0.989	Fuhwa # **	0.948	Entie	0.945		
Taishin #	1	Chinatrust #	0.998	Ta Chong	0.915	Chinfon	0.821		
				Bank Of Taipei	0.963				

Table 9. Attractiveness and progress scores for the 24 commercial banks

	Evaluation Context			
First Level				
	Second Level	**Third Level**	**Fourth Level**	**Fifth Level**
	1st-Degree*	2nd-Degree*	3rd-Degree*	4th-Degree*
Shin Kong #	1.415①***	1.522①	5.050①	7.114①
E.Sun #	1.151②	1.311②	3.431②	4.834②
Bank of China #	1.149③	1.284③	1.533④	2.301④
Taishin #	1.074④	1.191④	2.365③	3.332③
First #	1.027⑤	1.136⑤	1.201⑤	1.800⑤
Second Level				
	First Level	**Third Level**	**Fourth Level**	**Fifth Level**
	1st -Degree**	1st-Degree*	2nd-Degree*	3rd-Degree*
Hua Nan #	1.012②	1.129(5)	1.235(5)	1.984(5)
Sunny	1.024③	1.245①	3.830①	5.395①
Far Eastern	1.031④	1.163③	1.928④	2.718④
Sinopac #	1.032⑤	1.160④	2.297③	3.236③
Chinatrust #	1.002①	1.165②	2.385②	3.360②
Third Level				
	First Level	**Second Level**	**Fourth Level**	**Fifth Level**
	1st -Degree**	2nd-Degree**	1st-Degree*	2nd-Degree*
Chang Hwa	1.105②	1.059③	1.013⑥	1.105⑥
Cathay #	1.110③	1.046②	1.135⑤	1.801⑤
Union	1.229⑥	1.075⑤	3.529①	4.972①
Fuhwa #	1.176⑤	1.093⑥	1.752③	2.468③
Ta Chong	1.111④	1.062④	2.639②	3.718②
Bank Of Taipei	1.073①	1.023①	1.153④	1.906④
Fourth Level				
	First Level	**Second Level**	**Third Level**	**Fifth Level**
	1st-Degree**	2nd-Degree**	3rd-Degree**	1st-Degree*
Overseas Chinese	1.175②	1.135③	1.040②	1.647②
Hwatai	1.118①	1.050①	1.004①	1.519③
Cosmos	1.185③	1.143④	1.056③	1.490④
Entie	1.189④	1.126②	1.065⑤	1.690①
Chinfon	1.214⑤	1.166⑤	1.090④	1.409⑤

* Attractiveness measurement values.

**Progress measurement values.

***The number to the right of each score indicates the ranking position.

Bank subsidiaries of FHCs

Table 9. Attractiveness and progress scores for the 24 commercial banks (Cont.)

	Evaluation Context			
Fifth Level				
	First Level	**Second Level**	**Third Level**	**Fourth Level**
	1st-Degree**	2nd-Degree**	3rd-Degree**	4th-Degree**
Chinese Bank	1.305②***	1.244②	1.172②	1.071②
Bowa	1.640③	1.546③	1.414③	1.247③
Jih Sun #	1.220①	1.171①	1.097①	1.065①

** Progress measure Values.

***The number, for example ①, to the right of each score indicates the ranking position.

Bank subsidiaries of FHCs

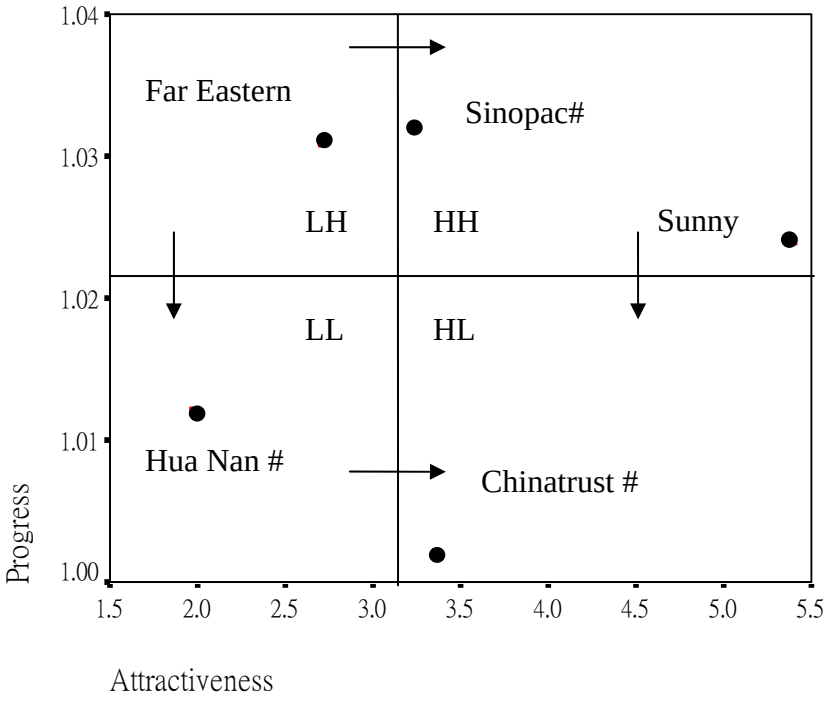


Figure 7. Attractiveness and Progress for the Second Level

⟶ is the suggested movement to improve performance.

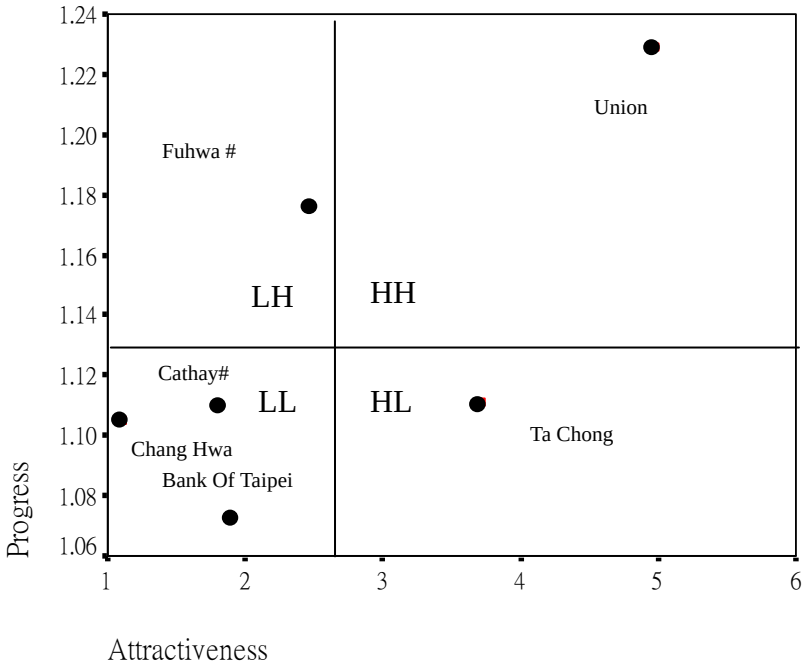


Figure 8. Attractiveness and Progress for the Third Level

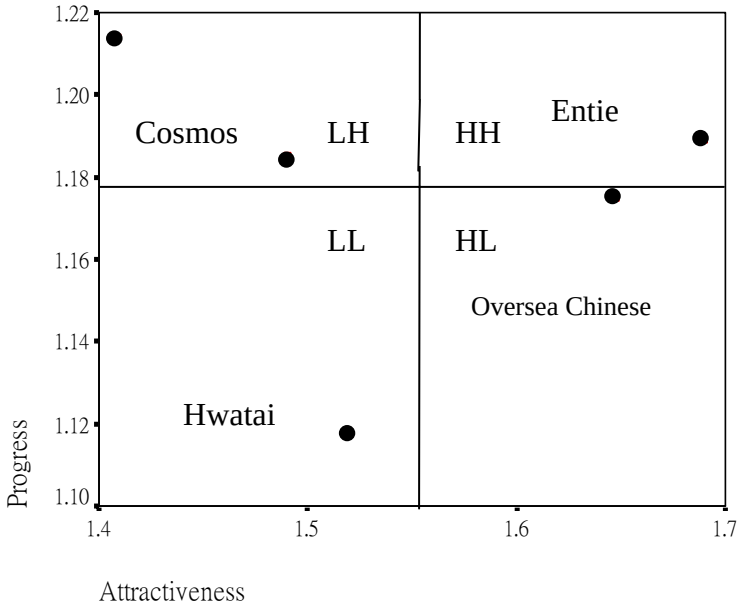


Figure 9. Attractiveness and Progress for the Fourth level

CHAPTER FIVE
CONCLUDING REMARKS, LIMITATIONS AND SUGGESTIONS

5.1 CONCLUDING REMARKS

Taiwanese authorities have advocated the advantages of establishing a Financial Holding Company to banks for years since the Legislative Yuan passed the Financial Institutions Merger Act in November 2000 and the Financial Holding Company Act in November 2001. These two laws allow banks, insurance companies, securities brokerage firms and other financial institutions to acquire or merge with each other and establish a Financial Holding Company. The laws also provide a legal framework for setting up asset-management companies to help local banks manage their non-performing loans and assets.

Most previous bank efficiency studies used both inputs and outputs reflecting operational profitability, marketability, asset quality, internal control quality and customer satisfaction. However, Lovell, Pastor and Turner (1995), Lovell (1995) expanded a new way to evaluate efficiency of banks which incorporated output ratios into DEA models. Without the consideration of the input side, this model would be easily to explain the DEA evaluation results by the output ratios, thus we can also use conventional Ratio Analysis which is popular in practice to interpret the DEA evaluation results. In other words, we can treat the DEA evaluation results as a comprehensive index and explain it by several ratio indices which had used as output in DEA model.

The purpose of this research is to determine whether a bank subsidiary in FHC or independent bank has a greater efficiency and ascertain whether different main businesses (banking, insurance, security) of a FHC affect the performance of its subsidiary. Applying a non-parametric frontier approach, data envelopment analysis (DEA), to evaluate the relative efficiencies of 11 bank subsidiaries of Financial Holding Companies (FHCs) and 13

independent commercial banks in Taiwan, we have several conclusions for what we found as described below.

First, all of the technically efficient banks defined by our DEA- Output-oriented model are the bank subsidiaries in the Financial Holding Company (FHC). Furthermore, we conclude that the 11 bank subsidiaries in FHCs do outperform independent banks with the evidences of three other findings. First, the mean technical efficiency scores of banks as bank subsidiary in FHC in 2005 is 0.984 and those independent banks is 0.922. Second, the six poorest efficiency rating banks in 2005 among 24 commercial banks are independent banks. Third, none of the independent banks are defined as optimal-efficient banks. All of the findings in this thesis have supported that bank subsidiaries in FHC are relative efficiencies than independent banks.

Second, the optimal-efficient banks have good values in at least two of these seven ratios, and we can divide these efficient banks into three categories. First, banks performed good at least two of three abilities, like the Bank of China(Risk Control, Profitability), E. Sun(Risk Control and Growth). Second, banks performed well in Profitability Ability, like First (ROE, Margin) and Taishin(ROE and ROA). Third, banks performed great at Growth Ability, like Shin Kong.

Third, in order to find out the trend of efficiency for DMUs, we calculate a five year technical efficiency comparison by the method of Window Analysis. By the comparison of the Window Analysis results, we categorize the 120 DMUs into several groups: Group One, if banks are independent banks. Group Two, if banks are subsidiaries of FHC in 2005. Furthermore, we also separate the DMUs in Group Two, which are bank subsidiaries in FHC in 2005, into another three groups by the main businesses of FHCs. For instance, Cathay Bank is in Cathay FHC in which its main business is Cathay Insurance, thus we classify it into Group B which is under Group Two. Chinatrust Bank is in Chinatrust FHC with its main business being Chinatrust Bank but Chinatrust Insurance Broker, thus we classify it into Group A under Group Two. The five-year averages technical efficiencies are 0.8118 for Group

One and 0.9104 for Group Two. In addition, the average technical efficiencies for Group One are 0.7328, 0.7448, 0.8107, 0.86 and 0.9108 from 2001 to 2005. The average technical efficiencies for Group Two in 2005 are 0.8194, 0.8719, 0.9287, 0.9563 and 0.9759 from 2001 to 2005. It seems to be an increasing trend of technical efficiency no matter if banks are in Group One or Group Two, and obviously the performance of banks in Group One outperforms those in Group Two. We thus conclude that the bank subsidiaries in FHCs do outperform the independent banks and the successful banks will succeed again. On the other hand, the ranking of performance within Group Two is Group A, Group B and then Group C in all five years (0.8486〔Group A〕>0.7830〔Group B〕>0.7535〔Group C〕>0.7328〔Group One〕in 2001). It verifies again that the main business of the FHC does have influences on the performance of their bank subsidiaries. This result may be explained that a big part of financial funds and all kinds of resources would support the main business of a FHC, thus bank subsidiaries in FHC which main business is banking would perform better.

Finally, this thesis measures context-dependent bank performance for different efficiency levels. This context-dependent DEA model allows (1) benchmarking of our Decision-Making units (DMUs) against its competitors; (2) measuring attractiveness and progress and drawing benchmark-learning roadmap as a tool for ranking all DMUs.

5.2 LIMITATIONS

There are several limitations on this analysis as described below:

First, although the model suggested by this thesis has the concepts of risk and growth in the model other than the conventional model, we can't apply every ratio into this model because they can be explained both in good and bad ways. Take the leverage rate as an example; the more leveraged, the more profitable the banks are, on the other hand, a higher leverage rate may indicate the more risky the banks are. Thus, we should examine the definitions of ratios before we use them. Secondly, we didn't take the quality indices into consideration, because of the limitation of resources. By this limitation, we can't claim that the technical efficiency scores calculated in this thesis is a *real* comprehensive efficiency

score. On the other hand, it's worthy to mention that with different purposes and targets, we can have hundreds of combinations in choices of input-output and several performance assessment approaches. However, it's clear and has been confirmed by many researchers that efficient values change while the combinations of input-output change. Therefore, when we adopted the DEA approaches in practice, investors and policy makers should not ignore this effect. Thirdly, like much other research, we don't distinguish whether the operation results is from retail or wholesale banking which own different risk structures. In fact, many banks provide both types of services, but it would add to the complexity into our research. Therefore, we only concerned with retail banks in our analysis and neglect the existence of wholesale banking. Finally, we didn't consider the relative importance between each output, thus we may lose several interesting findings in this thesis.

5.3 SUGGESTIONS

Since deregulation in banking industry since 1990s, the competition in the domestic banking industry has become fiercer. That Taiwan followed China's accession to the WTO has also opened up the domestic banking market to more foreign investors which has worsened this situation. In addition, the Taiwanese banking sector is too fragmented compared to other developed countries. For instance, EIU ViewsWire (Nov. 28, 2005) reported that *Taipei city has 850 branches, or 3.4 for every 10,000 people—almost three times as many as New York and two-thirds more than it needs, reckons McKinsey, a consultancy. Also the Taiwan of 23m people has about 45 commercial banks, 14 financial holding companies (FHCs, which own at least one bank plus insurance and broking subsidiaries) and over 300 rural credit co-operatives. Most are tiny. The top five lenders have just 35% of the market, versus 60-80% in most developed countries*.

Therefore, we can reasonably believe that reinforcing the competitive strength and creating the advantage of competition would be the most pressing target for domestic banks. Fortunately, the deregulations in mergers including the Financial Institutions Merger Act and the Financial Holding Company Act opened up a great way for banks to strengthen their

competitive advantages. Moreover, in order to earn profitability and marketability in Taiwanese banking markets, banks should rethink their strategies no matter in risk control, market penetration strategy and identifying appropriate customer target groups.

Take example, some banks with great financial structure should try to operate overseas to facilitate the performance of domestic business. Independent banks should expand their business scope and new products in the market and search for strategic alliance with security and insurance business. However, operating some unfamiliar business may conceal unnoticeable but huge risk. Therefore, when evaluating the performance of these new business must take risk into consideration. Finally, mergers and acquisitions would be a possible way to expand the size of banks, but there are some risks involved.

In summary, to compete in an increasingly price driven markets, there is a growing need for banks to examine their operation efficiency compared to their peers, ensure their competitive advantages compared to their rivals, and establish a long-term market position. By examining the relative efficiency compared to their peers, banks can easily set up their benchmarks. By reinforcing their competitive advantages among their rivals, banks can earn oligopoly rents from their unique and leading businesses. Finally, a possible way exists at present as the experience of developed countries to establish a long-term market position is to earn a big bank oligopoly by merger.

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APPENDIXES

APPENDIX 1. 1993-2005 NUMBER OF DOMESTIC AND FOREIGN BANKS

	Head office		Branches		
			Domestic Banks		
	Domestic Banks	Local Branches of Foreign Banks	Number	Increase rate (%)	Local Branches of Foreign Banks
1993	41	37	1 382	-	55
1994	42	37	1 577	14.11%	57
1995	42	38	1 807	14.58%	58
1996	42	41	1 936	7.14%	65
1997	47	45	2 176	12.40%	69
1998	48	46	2 404	10.48%	72
1999	52	41	2 576	7.15%	71
2000	53	39	2 693	4.54%	70
2001	53	38	3 005	11.59%	69
2002	52	36	3 068	2.10%	68
2003	50	36	3 173	3.42%	69
2004	49	35	3 189	0.50%	67
2005Jan.	48	35	3 192	0.09%	67
2005Feb.	48	35	3 192	0.00%	67
2005Mar.	47	35	3 202	0.31%	67
2005Apr.	47	35	3 207	0.16%	67
2005May	47	35	3 208	0.03%	67
2005Jun.	47	35	3 217	0.28%	67
2005Jul.	47	36	3 218	0.03%	68
2005Aug.	47	36	3 221	0.09%	68
2005Sep.	47	36	3 220	-0.03%	68
2005Oct.	47	36	3 223	0.09%	68
2005Nov.	46	36	3 224	0.03%	68
2005Dec.	45	36	3 239	0.47%	68

Source: Summarized by “Financial Statistics: Overview of Banking Sector” prepared by Banking Bureau, Financial Supervisory Commission, Executive Yuan (Online《http://www.banking.gov.tw/public/data/boma/stat/index/index-1.xls)

APPENDIX 2. OVERALL ASSET STRUCTURE OF TAIWANESE BANKS FROM 1993 TO 2005

	Domestic Banks				Local Branches of Foreign Banks			
	Assets	Net Worth	Deposits	Loans	Assets	Net Worth	Deposits	Loans
1993	104 404	6 107	60 702	65 461	5 241	218	1 225	2 634
1994	121 017	7 324	70 183	77 819	5 950	253	1 483	2 806
1995	132 060	7 922	78 061	85 369	6 736	313	1 887	3 252
1996	144 127	9 259	86 068	90 276	7 408	357	2 390	3 495
1997	155 028	10 831	99 248	105 953	9 753	426	3 585	4 083
1998	175 479	13 392	112 500	114 059	8 738	427	3 594	3 899
1999	192 601	15 066	122 419	121 483	9 004	390	4 084	3 889
2000	207 751	15 991	131 304	128 962	13 187	475	5 470	3 993
2001	217 408	15 964	140 610	127 151	13 233	508	4 889	3 795
2002	220 971	14 228	144 679	125 049	14 091	542	4 944	3 681
2003	237 408	14 420	153 911	131 311	18 368	551	5 552	3 736
2004	255 053	15 744	164 954	145 987	19 842	608	5 878	4 304
Jan.2005	253 078	15 860	164 005	146 045	20 100	604	5 887	4 412
Feb.2005	253 852	15 971	164 280	146 397	20 017	607	5 847	4 405
Mar.2005	254 400	16 635	165 636	148 264	20 591	615	5 832	4 459
Apr.2005	255 447	16 460	165 445	148 224	21 242	614	5 787	4 467
May-05	255 439	16 542	165 435	149 894	20 308	620	5 569	4 598
Jun.2005	258 098	16 649	169 950	151 549	19 231	524	5 676	4 591
Jul.2005	259 485	16 857	169 676	151 275	19 396	503	5 754	4 656
Aug.2005	260 183	16 989	169 656	151 979	19 872	525	5 687	4 700
Sep.2005	260 588	17 016	170 034	153 794	20 403	538	5 783	4 870
Oct.2005	261 107	17 539	169 609	153 142	20 825	548	5 811	4 979
Nov.2005	262 996	17 411	171 720	154 363	20 907	545	5 781	4 937
Dec.2005	268 753	16 977	175 888	157 631	20 405	532	5 877	4 858

Source: Summarized by “Financial Statistics: Overview of the Banking Sector” prepared by the Banking Bureau, Financial Supervisory Commission, Executive Yuan (Online 《http://www.banking.gov.tw/public/data/boma/stat/index/index-2.xls, http://www.banking.gov.tw/public/data/boma/stat/index/index-3.xls and http://www.banking.gov.tw/public/data/boma/stat/index/index-8.xls》)

APPENDIX 3. REFERENCE OF NAME OF BANK AND ITS ABBREVIATION USED IN THIS THESIS

Abbreviation	**Full name of banks**
Bank Of China #	The International Commercial Bank Of China
Bank Of Taipei	International Bank Of Taipei
Bowa	Bowa Bank
Cathay #	Cathay United Bank
Chang Hwa	Chang Hwa Commercial Bank
Chinatrust #	Chinatrust Commercial Bank
Chinese Bank	The Chinese Bank
Chinfon	Chinfon Bank
Cosmos	Cosmos Bank, Taiwan
E.Sun #	E.Sun Commercial Bank, Ltd.
Entie	Entie Commercial Bank
Far Eastern	Far Eastern International Bank
First #	First Commercial Bank
Fuhwa #	Fuhwa Commercial Bank
Hua Nan #	Hua Nan Commercial , Ltd.
Hwatai	Hwatai Bank
Jih Sun #	Jih Sun International Bank
Overseas Chinese	Bank Of Overseas Chinese
Shin Kong #	Taiwan Shin Kong Commerical Bank
Sinopac #	Bank Sinopac Company Limited
Sunny	Sunny Bank Ltd.
Ta Chong	Ta Chong Bank
Taishin #	Taishin International Bank
Union	Union Bank Of Taiwan

Note: Names with remark "#" indicate that these banks are subsidiaries of a Financial Holding Company.

APPENDIX 4. MAIN FINANCIAL AND PERFORMANCE RATIOS OF DOMESTIC BANKS REGULATED BY THE CBC

Items
【C】
Total risk based capital / Risk-weighted assets
Tier 1 capital / Risk-weighted assets
Liability / Equity (multiple)
Equity / Asset
【A】
Non-performing loan ratio
Loan loss reserves / NPLs
The possible loss of classified assets / reserves
【E】
Net income before tax(NIBT) / Average equity
(NIBT + loan loss provision) / Average equity
NIBT / Average asset
(NIBT + loan loss provision) / Average asset
Net interest income / NIBT
NIBT / Operating revenue
NIBT / Employees (in thousand of NT dollars)
【L】
Liquidity ratio (monthly average of daily data)
Loans / Deposits
Time deposits / Deposits
NCDs / Time deposits
Accumulated gap of assets and liabilities(180 days) / Equity
【S】(Interest rate sensitivity less than 1 year)
Interest rate sensitivity assets /Interest rate sensitivity liabilities
Interest rate sensitivity gap/Equity
【G】
Deposit growth rate
Loan growth rate
Investment growth rate
Guarantee growth rate

APPENDIX 5. DESCRIPTIVE STATISTICS OF THE UNADJUSTED DATA SET

	NPL(%)	ROE(%)	ROA(%)	Margin(%)	P/L (times)	GDR(%)	GLR(%)
mean	2.90	0.26	0.09	1.01	245.97	14.26	12.52
median	2.26	5.23	0.40	9.84	338.81	7.07	10.13
S.D.	2.45	19.78	1.18	30.00	2,123.32	14.66	14.26
Var.	6.01	391.16	1.40	900.15	4,508,508.42	214.88	203.46
Range	11.30	83.66	5.35	143.31	11,581.23	57.12	68.86
Min	0.50	-63.71	-3.74	-113.54	-7,880.81	-4.10	-16.30
Max	11.80	19.95	1.61	29.77	3,700.42	53.02	52.56
N	24.00	24.00	24.00	24.00	24.00	24.00	24.00

APPENDIX 6. CORRELATION COEFFICIENTS OF UNADJUSTED DATA SET

	NPL	ROE	ROA	Margin	P/L	GDR	GLR
NPL	1.00000						
ROE	-0.21886	1.00000					
ROA	-0.22181	0.98851	1.00000				
Margin	-0.17060	0.97596	0.96879	1.00000			
P/L	-0.19674	0.93841	0.93716	0.97728	1.00000		
GDR	-0.30013	0.20204	0.18648	0.19930	0.17309	1.00000	
GLR	-0.27405	0.31123	0.28011	0.30515	0.25990	0.90454	1.00000

APPENDIX 7. CONSUMER PRICE INDICES

2001	100.00
2002	99.63
2003	99.29
2004	100.89
2005	103.26

Source: Price Index Statistic 423, 2006 March Table 1-4 Urban Consumer Price Indices, pg.22-23 《http://www.stat.gov.tw/public/data/dgbas03/bs3/book/cpi5.xls》