



ANALYZING PERFORMANCE OF SUBSIDIARIES OF THE FINANCE HOLDING COMPANIES

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Abstract

This study employs the two-stage data envelopment analysis (DEA) proposed by Liang et al. (2008) and the concept of game theory to evaluate the performance of the finance holding companies in Taiwan (hereinafter referred to as the "FHCs"). Meanwhile, it takes into account the role relationship between the leader and the followers and uses the game-theoretic two-stage DEA method to construct a two-stage DEA model of non-cooperative games. The first stage of this study focuses on the operating efficiency; the second stage is to explore the profit efficiency. In order to evaluate the performance of subsidiaries of different industries, each finance holding company (parent company) is regarded as the leader and subsidiaries the followers.

The empirical results show:

1. Analyzing the FHCs including their subsidiaries makes the efficiency evaluation results more objective and comprehensive, and using the two-stage non-cooperative-game DEA method is less likely to overestimate the efficiency value.
2. Most FHCs have poorer performances in marketing efficiency, and better performances in profit efficiency.\
3. In regards to operating efficiency, the FHCs based on banking and securities perform better than others; in regards to profit efficiency, the FHCs based on securities perform better than others. Overall, the FHCs based on banking and securities have the best performance.

Key Words: Finance, Financial holding company, Two-stage DEA, Game-DEA model, Efficiency

(Editor's Note: Sections of this article are in single column format to facilitate easier viewing of the complex formulas.)

Introduction

Since the opening of new banks after 1991, the bank industry in Taiwan has shown signs of saturation. Because of the excessive number of banks and most of them are inadequate in economic scale and are highly homogeneous, excessive competition has formed, resulting in serious problems such as new peak of NPL ratio in financial industry, deterioration of asset quality and decline of operating performance. In view of this, in 1998 the Taiwan government started to merge financial institutions; in 2000 they passed the "Financial Institutions Merger Act"; and in the following year, they began to implement the "Finance Holding Companies Act". By the end of 2013, a total of sixteen FHCs in Taiwan have integrated different types of financial sectors such as banking, insurance, securities, investment trust, venture capital and wealth management consulting, in hopes of improving their operating performances through diversified business models.

As previously mentioned, the FHCs in Taiwan expand their business scale by combining different types of financial sectors such as banking, insurance, securities, investment trust, venture capital and wealth management consulting. Thus when analyze the performances of FHCs, we should include their subsidiaries to gain a more complete view of the operational status and to understand the business conditions and the resources allocation of each subsidiary. Throughout the past literature, the majority took only a single subsidiary or two subsidiaries as main object to conduct performance evaluation. They were deficient in comprehensiveness and integrity and the FHC analysis results were biased and impractical. In addition, as it will produce biased estimation considering only the different characteristics of FHCs and not the roles of FHCs and their subsidiaries (leaders and followers), this study takes into account the role relationship between the leaders and the followers and analyzes using the game-theoretic two-stage DEA

method to gain a more accurate understanding of FHC performance. In the above context, this study constructs the two-stage DEA model of non-cooperative games. The first stage of this study focuses on the operating efficiency; the second stage is to explore the profit efficiency. In order to evaluate the performance of subsidiaries of different industries and to analyze the impact of their performance to the parent company, each parent company is regarded as the leader and subsidiaries the followers.

Literature Review

In the past, DEA was used by many scholars as efficiency assessment method, not only in finance holding industry (Lo and Lu, 2009), but also in high-tech industries (Thore et al., 1996), communications (Chang and Mashruwala, 2006), banking (Ferrier and Lovell, 1990; Chen and Yen, 2000; Pasiouras, 2008; Ray and Das, 2010) and so on.

Although the traditional DEA method can estimate the relative efficiency of decision-making units and understand their strengths and weaknesses, its shortcoming is that it cannot fully reveal the entire production process through the output converted from only the input of the first stage. Therefore, Seiford and Zhu (1999) unprecedentedly launched the two-stage DEA method to overcome the problem of lacking DEA management information in the first stage. The basic concept of the method was to extend the efficiency relation of the DEA focused input and output to the entire production process. Zhu (2000) developed the DEA method into a two-stage DEA production process, namely market-

ability and profitability; the result showed companies that only had higher revenue were not necessarily the best in performance. Sexton and Lewis (2003) explored the operating efficiency of MLB. In the first stage, the team's front office utilized the resources to acquire techniques; in the second stage, techniques were used to achieve game victories. Thus the inefficiency value that could not be obtained by using single-stage model was detected. Kao and Hwang (2008) explored the factors that affect operating performance using two-stage DEA method and Tobit regression model. Based on their model, Chen et al. (2009) used the two-stage method to measure the overall efficiency, adjusted the input and output efficiency under VRS assumption and took the overall DMU efficiency of each stage as weighted sum efficiency. Chiu and Chen (2009) investigated the effects of external environmental risks on bank performance, considered that external environment variables could affect the efficiency of domestic banks, and that the adjustment of external environment would have greater effect on the efficiency of private banks than mixed banks and public banks. Yu and Chen (2010) broke down the insurance subsidiaries of FHCs into different business types, and then analyzed and compared them using the traditional DEA method and the multiple DEA method to explore whether different types of insurance subsidiaries could bring better overall efficiency to the FHCs. Chang and Chiu (2006) considered credit risk and market risk into the factors of bank efficiency indicators and efficiency effects, used the DEA method and the two-stage method of Tobit regression analysis and discovered that the risk factor could affect

bank efficiency and the non-performing loans or the high degree of the risk value could lead to decreased efficiency.

The performance evaluation of a multi-stage approach keeps with the actual business operations process, and because FHCs have very similar multi-stage management style, such evaluation method can more clearly reflect the efficiency of different stages. Relevant literature in the study of Taiwan financial holding industry began after the pass of the Finance Holding Company Act in 2011. It has become the focal point whether the operating performance of the original financial institutions has improved after their transition into FHCs. Lo and Lu (2009) proposed a new evaluation model integrating SBM and super-SBM. The FHCs were firstly divided into two groups based on their sizes; and then based on different subjects; they were further divided into three groups, namely, banking, insurance and securities. The empirical results show: large-scale FHCs have better profitability; insurance FHCs have better profitability; large-scale FHCs have better stock market liquidity; from a cross-term point of view, the efficient frontier of large-scale FHCs relocates along with corporate expansion, while small-scale FHCs grow rapidly and are likely to catch up with them.

In summary, for the application of the two-stage DEA model in financial industry, the previous literature mostly took banks as the research object, even the FHC performance evaluation were based on the overall input and output of FHCs without considering the status of each subsidiary; as for the studying

method, the output of the first stage was used as the input of the second stage. To more objectively analyze FHC performance, the present study intends to include all FHC subsidiaries into the evaluation process, meanwhile it regards the relationship between each FHC and its subsidiaries as the leader and the followers and conducts analysis using the game-theoretic two-stage DEA method to objectively and comprehensively assess FHC efficiency.

Methodology

The two-stage DEA model is an improved studying method of the DEA model. Its basic concept is that it extends the DEA focused relation between inputs and outputs to the entire production process; while emphasizing on the performance evaluation for DMU, in addition to measuring the efficiency relation of inputs and outputs, “the intermediate process from input to output” must be included into performance evaluation, so that the assessment results will be fully explanatory and not produce bias. This study employs the two-stage data envelopment analysis (DEA) proposed by Liang et al. (2008) and the concept of game theory to evaluate the performance of the finance holding companies in Taiwan (hereinafter referred to as the “FHCs”). This empirical study adopts the two-stage model by Kao and Huang (2008), combines the non-cooperative and cooperative game concept by Liang et al. (2008) and takes the FHCs in Taiwan as sample. The non-cooperative model and the cooperative model are described as follows.

1. Non-Cooperative Game Model

According to Liang et al. (2008) model, if, in the typical CSR DEA, the first stage is the leader and its performance is more important, the efficiency of the second stage could be calculated subject to the first stage. The leader's efficiency can be calculated as formula (3-1). $X_i (i = 1, \dots, m)$ represents manufacturer's input; $Z_d (d = 1, \dots, D)$ is manufacturer's intermediate output; $Z_d (d = 1, \dots, D)$ is retailer's input; $X_{1p} (p = 1, \dots, P)$ is retailer's exogenous input; $Y_r (r = 1, \dots, S)$ represents the final output. E_1 is the efficiency of the first stage (leader).

$$E_1 = \max \sum_{d=1}^D \mu_d z_{dk} \tag{3-1}$$

$$s.t. \sum_{i=1}^m w_i x_{ij} - \sum_{d=1}^D \mu_d z_{dj} \geq 0, j=1, 2, \dots, n$$

$$\sum_{i=1}^m w_i x_{ik} = 1; \quad w_i, \mu_d \geq 0; \quad d=1, \dots, D; \quad i=1, \dots, m$$

then the efficiency of the second stage (follower), E_2 , could be calculated as formula (3-2):

$$E_2 = \max \sum_{r=1}^S \gamma_r y_{rk} \tag{3-2}$$

$$s.t. q \times \sum_{d=1}^D \mu_d z_{dj} + \sum_{p=1}^P w_p x_{pj} - \sum_{r=1}^S \gamma_r y_{rj} \geq 0, j=1, 2, \dots, n$$

$$q \times \sum_{d=1}^D \mu_d z_{dk} + \sum_{p=1}^P w_p x_{pk} = 1; \quad \sum_{d=1}^D \mu_d z_{dk} = E_1^*$$

$$\sum_{i=1}^m w_i x_{ij} - \sum_{r=1}^S \gamma_r y_{rj} \geq 0, j = 1, 2, \dots, n; \quad \sum_{i=1}^m w_i x_{ik} = 1$$

$$\mu_d, w_i, \gamma_r, w_p, q \geq 0, \quad d = 1, \dots, D, \quad i = 1, \dots, m, \quad r = 1, \dots, S, \quad p = 1, \dots, P$$

So, we would substitute the linear processing and figure out the most suitable. Finally, getting the efficiency of the first stage (leader) and the second stage (follower), we could calculate the total efficiency as follow:

$$E(\text{overall}) = \frac{1}{2} (E_1^* + E_2^*) \tag{3-3}$$

2. Cooperative game model

In cooperative model, with the same capability in bargaining, manufacturers and retailers work together to get the maximum efficiency. As intermediate goods is the main factor for their cooperation, the manufacturer and the leader obtain the maximum efficiency, E , on the basis of the optimal intermediate goods. According to Liang et al. (2008) model,

$$E = \max \frac{1}{2} \left[\sum_{d=1}^D \mu_d^1 z_{dk} + \sum_{r=1}^S \gamma_r y_{rk} \right]$$

$$s.t. \sum_{i=1}^m w_i x_{ij} - \sum_{d=1}^D \mu_d^1 z_{dj} \geq 0, j = 1 \dots n \tag{3-4}$$

$$\sum_{d=1}^D k \times \mu_d^1 z_{dj} + \sum_{p=1}^P w_p x_{pj} - \sum_{r=1}^R \gamma_r y_{rj} \geq 0, j = 1 \dots n$$

$$w_i x_{ik} = 1 \quad ; \quad \sum_{d=1}^D k \times \mu_d^1 z_{dk} + \sum_{p=1}^P w_p x_{pk} = 1$$

$$w_i, w_p, \mu_d^1, \gamma_r, k \geq 0, d = 1, \dots, D, i = 1, \dots, m, r = 1, \dots, s, p = 1, \dots, P$$

From $\sum_{d=1}^D k \times \mu_d^1 z_{dk} + \sum_{p=1}^P w_p x_{pk} = 1$ and $\sum_{d=1}^D \mu_d^1 z_{dk} = E_1^*$, the value of k

could be figured out $k = \frac{(1 - \sum_{p=1}^P w_p x_{pk})}{\sum_{d=1}^D \mu_d^1 z_{dk}}$. Then $E_1^* = \mu_d^1 z_{dk}$ and $E_2^* = \gamma_r y_{rk}$.

The difference between this model and noncooperation game model lies in: the former supposes that the two stages are equally important and the efficiency of which is calculated at the same time. While the later supposes that the efficiency of leader is more important than that of follower. This study will test and analyze the results of the two models with empirical research.

Empirical Results and Analysis

Data Sources and Selection of Variables

The present study selects thirteen Taiwan FHCs of 2011 as the main object, and the industry of each subsidiary as the assessment individual. Since the business subject of FHCs has developed from subsidiaries of banking, insurance and securities to bills, investment trust, venture capital, futures and other financial undertakings (investment consulting, information management, etc.), the analysis of this study includes subsidiaries of insurance agents or insurance brokers and subsidiaries of various financial undertakings, and regards them as other subsidiaries, and further divides the empirical study into three parts: 1.

Analysis of FHCs including banking, securities and other subsidiaries; 2. Empirical analysis including only banking and securities subsidiaries; 3.

Under the first two conditions, comparing the status of FHCs including and excluding other subsidiaries.

With regard to the selection of input and output variables, this study defines the input and output items according to the production method and the intermediation method and refers to the research variables from the relevant literature contributed by Yu and Chen (2010), Luo (2003) and others. The variables of this study are shown in Figure 4-1.

Figure 4-1 explains the two-stage operating model and the input and output variables of each stage employed in this study. The first stage of this study is mainly to investigate operating efficiency. It is designed to evaluate the marketability of finance holding companies; to be more specific, finance holding company's ability to turn expenses into revenues. With the same expenses, the company that can earn more revenues have the stronger operating ability and the higher operating efficiency. Inputs require

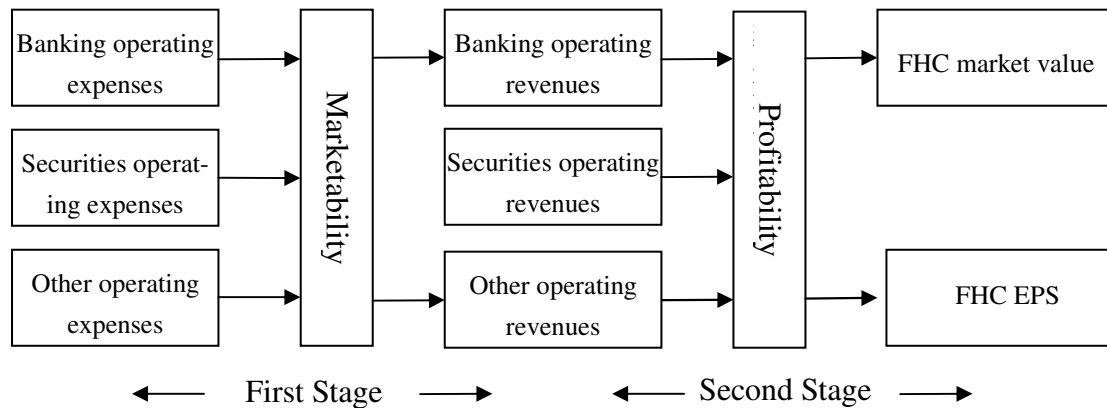


Figure 4-1 Efficiency Assessment Chart of Game-theoretic Two-stage DEA

contribution factors, and outputs represent business objectives. This study selects operating expenses of banking, securities and other subsidiaries as inputs; as for the output variables, the most reliable output data may be measured when the study object is a commercial company that produces tangible goods or services and sales them on the market. In practice, the sales volume of different companies is presented by annual total sales value. If all companies operating in a single market price, the nominal value can be regarded as an appropriate output measurement indicator, while the operating revenues of banking, securities and other subsidiaries are selected as outputs. The second stage of this study focuses on profitability and analyzes the expected value of each company in the profitable side. At this stage the company's performance of turning revenues to market value will be evaluated. With the same revenues, the company that can create higher market values has stronger profitability and higher profitability efficiency. Inputs are selected as the outputs of the first stage: operating revenues of banking, securities and other subsidiaries; while

the selected outputs are: the earnings per share and the market value of the parent company. The input and output variables are described in Table 4-1.

The descriptive statistics data of input and output variables are shown in Table 4-2. The highest variables among all DMU's input variables at the first stage is operating expenses of banking with an average of 11346575.92 thousand NT dollars. The next is operating expenses of securities with an average of 2467444.38 thousand NT dollars. As for the output variables, the highest is the operating revenues of banking with an average of 26674365.31 thousand NT dollars. The second highest is operating revenues of securities with an average of 5094176.38 thousand NT dollars. As to the output variables at the second stage, the average market value of all DMU is 76755690.46 thousand NT dollars with average earnings per share of 2.5%.

Empirical Results and Analysis

- A. According to the game-theoretic two-stage DEA model, regarding the FHCs as leaders and their

Table 4-1 Variable Definition

First Stage : Operating efficiency				
Distin- guish	code	Variable		Variable explanation
Input Variable	BE	Bank subsidi- ary	Operating ex- penses:1 , 000RMB	Refers to the payment processing fees and the cost of staff salaries of the business. The costs are higher, indicating that the resources invested in the business are more. These operating expenses include payroll expense + rent + advertising + taxes + depreciation / amortization + research and development expenses + Doubtful + other operating expenses, etc.
	SE	Securities sub- sidiary		
	OE	Other subsidi- aries		
output Variable	BR	Bank subsidi- ary	Operating in- come:1 ,0 00RMB	Refers to the income earned by the enterprise in sales activities (including the provision of goods and services) and represents the In- flow of economic resources received by the enterprise. These operating income include sales income, commission income, rental in- come, interest income, other income, etc.
	SR	Securities sub- sidiary		
	OR	Other subsidi- aries		
Second Stage : Profitability Efficiency				
Input Variable	BR	Bank subsidi- ary	Operating in- come:1 ,0 00RMB	Refers to the income earned by the enterprise in sales activities (including the provision of goods and services) and represents the In- flow of economic resources received by the enterprise. These operating income include sales income, commission income, rental in- come, interest income, other income, etc.
	SR	Securities sub- sidiary		
	OR	Other subsidi- aries		
output Variable	FM	Financial holding parent company	Market Value:1 ,0 00RMB	Refers to the market value of the asset and the market value of the stock rights from the company's perspective
	FE		Earnings per share :RM B	Earnings per share are a measure of the amount allocated to each share with the profit of the enterprise in a particular year. Earnings per share = Net profit after tax / The weighted number of ordinary shares circulating outside

Table 4-2 Description Table of input variable and output variable

Unit: 1,000 RMB,%

code	Ave	SD	Max	Min
BE	11346575.92	7161543.08	28823676	1762206
SE	2467444.38	2194944.13	8350531	280678
OE	1947791.31	1307507.14	4945729	413850
BR	26674365.31	15139825.21	57324481	4563565
SR	5094176.38	4565134.59	16433530	278908
OR	2896984.92	2041988.70	6866381	409293
FM	76755690.46	26957962.20	113236483	23518557
FE	2.5	0.5	3.79	1.74

Table 4-3 Efficiency evaluation results and analysis (Including banking, securities and other subsidiaries)

DMU Name	Non-cooperative model						Cooperative model					
	E_k^1	rank	E_k^2	rank	E_k	rank	E_k^1	rank	E_k^2	rank	E_k	rank
Hua Nan	0.928	4	0.400	11	0.371	9	0.887	10	0.391	12	0.347	12
Fubon	0.712	8	1.000	1	0.712	4	0.767	11	0.998	5	0.767	6
Cathay	1.000	1	0.414	10	0.414	7	1.000	1	0.421	11	0.421	10
China De.	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1
E.SUN	0.525	11	0.799	7	0.419	6	1.000	1	0.851	6	0.851	5
Yuanta	0.617	9	0.925	5	0.571	5	0.734	13	0.620	7	0.455	7
Mega	1.000	1	0.380	13	0.380	8	1.000	1	0.376	13	0.376	11
Taishin	0.530	10	0.609	9	0.323	10	1.000	1	1.000	1	1.000	2
Shin Kong	0.904	5	1.000	1	0.904	2	0.989	7	1.000	1	0.989	3
SinoPac	0.773	6	0.393	12	0.304	11	0.750	12	0.431	10	0.323	13
CTBC	0.293	12	0.770	8	0.226	13	1.000	1	0.446	9	0.446	8
First	0.290	13	0.810	6	0.235	12	0.958	8	0.449	8	0.431	9
Jih Sun	0.764	7	1.000	1	0.764	3	0.893	9	1.000	1	0.893	4
mean	0.718		0.731		0.509		0.921		0.691		0.638	
The number of efficiency	3		4		1		6		4		1	

subsidiaries followers, this study uses the cross-sectional data from the same point in time to conduct statistical analysis and assess the marketing and profit performances of FHCs.

Analyzing FHCs including banking, securities and other subsidiaries. As the FHCs are regarded as the leaders that lead the subsidiaries as the followers, and profits are important for FHCs, this study takes the measurement of E_k^2 (the second stage) as priority, and later obtains E_k^1 utilizing $E_k^1 = E_k / E_k^2$. The empirical results of non-cooperation and cooperation in games are shown respectively in Table 4-3.

The left part of table 4-3 shows the results of non-cooperative model. In terms of overall efficiency, there is only one company, i.e., China Development Financial Holding Corporation (hereinafter referred to as "CDF"), has reached the optimal efficiency value of 1. Shin Kong Financial Holding Company Limited (hereinafter referred to as "SKFH") ranks second with an efficiency value of 0.90406; in the first stage measuring operating efficiency, companies that have achieved the best efficiency are respectively Cathay Financial Holding Company Limited (hereinafter referred to as "Cathay Holdings"), CDF and Mega Financial Holding Company (hereinafter referred to as "Mega Holdings"); furthermore, in the second stage measuring profitability, companies that have achieved the best efficiency are respectively Fubon Financial Holding Company Limited (hereinafter referred to as "Fubon Financial"), SKFH and Jih Sun Financial Holding Company Limited (hereinafter referred to as "Jih Sun Holding").

As the study of the second stage comes before the first stage, theoretically the efficiency of FHCs is supposed to be better than their subsidiaries, but there are four exceptions, namely, Hua Nan Financial Holdings Company Limited (hereinafter referred to as "HNFHC"), Cathay Holdings, Mega Holdings and SinoPac Financial Holdings Company Limited (hereinafter referred to as "SinoPac Holdings").

Daniel (1978) confirmed that companies of lower overall efficiency would lead to lower profitability values in the second stage. In addition, Kao and Hwang (2008) mentioned that the overall efficiency value was generally less than or equal to the efficiency value of individual stages, and there was not much significance to investigate their efficiency values, and that we should get more information from the ranking of efficiency values. The thirteen FHCs discussed in the present study also show that their overall efficiency is less than or equal to the efficiency value of the individual stages. The ranking shows that some companies such as CDF and Taishin Financial Holding Company Limited (hereinafter referred to as "Taishin Holdings") have similar ranking in the overall and individual stages, which implies the overall efficiency is attributed by two sub-efficiency; companies such as HNFHC, Fubon Financial, Cathay Holdings and Mega Holdings have very different ranking in the overall and individual stages, such cases can help FHCs to know in what stage the operating efficiency or profit efficiency causes company inefficiency.

The right parts of table 4-3 shows the results of cooperative model, which are calculated independently. In terms

of overall efficiency, CDF and Taishin Holdings have reached the optimal efficiency value of 1; in the first stage, companies that have achieved the best efficiency are respectively Cathay Holdings, CDF, E.Sun Financial Holding Company Limited (hereinafter referred to as “ESFHC”), Mega Holdings, Taishin Holdings and CTBC Financial Holding Company Limited (hereinafter referred to as “CTBC Holding”); in the second stage, companies that have achieved the best efficiency are respectively CDF, Taishin Holdings, SKFH and Jih Sun Holding. The estimation results comparing the two models are as follows:

1. Comparison of non-cooperation and cooperation.

The comparison of the mean of efficiency value of non-cooperation and cooperation are shown as table 4-4. Table 4-4 shows in the cooperation model the overall efficiency value rate is 0.638, above 0.509 in non-cooperation model. Additionally, in non-cooperation model, the efficiency value rate of stage 1 is approximately the same as the rate of stage 2 at around 0.7. However, there is a significant difference in the efficiency value rate

between stage 1 and stage 2 in the co-operation model with respective rate of 0.921 and 0.691.

The conclusions show that using the game-theoretic two-stage DEA method of non-cooperative games to estimate efficiency value is more appropriate and not likely to be overestimated compared to such method of cooperative games. In terms of overall efficiency (E_k), five FHCs ranking greater under the non-cooperative model than the cooperative model, and the overall efficiency under the cooperative model is greater than the non-cooperative model; in terms of the efficiency (E_k^2) in the second stage, three FHCs rank greater under the non-cooperative model than the cooperative model, and the efficiency value in the second stage under cooperative model is lower than the average value under non-cooperative model; lastly, for the efficiency (E_k^1) in the first stage, four FHCs rank greater under the non-cooperative model than the cooperative model, and the efficiency value in the first stage under the cooperative model is greater than the non-cooperative model.

Table 4-4 Comparison of non-cooperation and cooperation

	Efficiency	non-cooperation	cooperation
Mean	Overall	0.509	0.638
	Stage 1	0.718	0.921
	Stage 2	0.731	0.691

Grouped by Business Characteristics

According to different characteristics of the main business of FHCs, this study divides FHC subsidiaries into

four groups, namely, subsidiaries based on banking, i.e., HNFHC, Mega Holdings, First Financial Holding Company Limited (hereinafter referred to as “FFHC”), ESFHC, Taishin Holdings,

CTBC Holding and Jih Sun Holding; subsidiaries based on both banking and insurance, i.e., Fubon Financial, Cathay Holdings and SKFH; subsidiaries based on both banking and securities, i.e., CDF and SinoPac Holdings; and subsidiaries based on securities, i.e., Yuanta Financial Holding Company Limited (hereinafter referred to as “Yuanta”), as shown in Table 4-5.

Among these four groups, in the first stage, subsidiaries based on banking and securities have the best market efficiency; in the second stage, subsidiaries based on securities have the

best profit efficiency; subsidiaries based on banking and insurance have the best overall efficiency value. Therefore, in terms of business management, FHCs based on banking and securities have better efficiency performance; in terms of profit, FHCs based on securities have better efficiency performance; overall, the operating model based on both banking and insurance is better. In addition, the FHCs are further divided into public and private categories. With regard to the overall efficiency and the profit efficiency, private FHCs have better performance.

Table 4-5 Grouped by business characteristics

Principal subsidiaries	Public / Private	company	Stage 1	rank	Stage 2	rank	Over-all(L-F)	rank
Bank	Public	Hua Nan	0.928	2	0.400	6	0.371	4
		Mega	1	1	0.380	7	0.380	3
		First	0.290	7	0.810	2	0.235	6
	mean		0.739		0.530		0.329	
	Private	E.SUN	0.525	5	0.799	3	0.419	2
		Taishin	0.530	4	0.609	5	0.323	5
		CTBC	0.293	6	0.770	4	0.226	7
		Jih Sun	0.764	3	1	1	0.764	1
	mean		0.528		0.794		0.433	
		mean		0.634		0.662		0.381
Bank Insurance	Private	Fubon	0.712	3	1	1	0.712	2
		Cathay	1	1	0.414	3	0.414	3
		Shin Kong	0.904	2	1	1	0.904	1
		mean		0.872		0.804		0.677
Bank Securities	Private	China Dev.	1	1	1	1	1	1
		SinoPac	0.773	2	0.393	2	0.304	2
		mean		0.886		0.696		0.652
Securities	Private	Yuanta	0.617	1	0.925	1	0.571	1
		mean		0.617		0.925		0.571
	mean		0.834		0.788		0.651	

Analysis including banking and securities subsidiaries

This part of empirical analysis includes only the FHC subsidiaries based on banking and securities (excluding other subsidiaries), and the results are shown in Table 4-6. Under the non-cooperative model, only one company has achieved the optimal overall efficiency value of 1, i.e., CDF; Fubon Financial ranks second with an overall efficiency value of 0.95544; in the first stage measuring operating efficiency, companies that have achieved the best efficiency are respectively CDF and

ESFHC; in the second stage measuring profit efficiency, companies that have achieved the best efficiency are respectively Fubon Financial, CDF, Yuanta, SKFH, CTBC Holding and Jih Sun Holding. Under the cooperative model, CDF has achieved the optimal overall efficiency value of 1; in the first stage, companies that have achieved the best efficiency are respectively ESFHC, Yuanta, Mega Holdings and CTBC Holding; in the second stage, companies that have achieved the best efficiency are respectively Fubon Financial, SKFH and Jih Sun Holding.

Table 4-6 Efficiency evaluation results and analysis
 (Including banking and securities subsidiaries)

DMU Name	Non-cooperative model						Cooperative model					
	E_k^1	rank	E_k^2	rank	E_k	rank	E_k^1	rank	E_k^2	rank	E_k	rank
Hua Nan	0.919	7	0.532	10	0.490	10	0.919	9	0.532	10	0.490	10
Fubon	0.955	3	1.000	1	0.955	2	0.955	6	1.000	1	0.955	3
Cathay	0.938	5	0.548	9	0.515	8	0.93851	7	0.548	8	0.515	9
China Dev.	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1
E.SUN	1.000	1	0.603	7	0.603	7	1.000	1	0.603	6	0.603	6
Yuanta	0.688	13	1.000	1	0.688	6	1.000	1	0.586	7	0.586	7
Mega	0.900	8	0.552	8	0.498	9	1.000	1	0.532	9	0.532	8
Taishin	0.706	11	0.443	12	0.312	12	0.717	13	0.440	12	0.316	12
Shin Kong	0.937	6	1.000	1	0.937	4	0.937	8	1.000	1	0.937	4
SinoPac	0.802	10	0.360	13	0.289	13	0.802	11	0.360	13	0.289	13
CTBC	0.948	4	1.000	1	0.948	3	1.000	1	0.976	5	0.976	2
First	0.877	9	0.510	11	0.448	11	0.877	10	0.510	11	0.448	11
Jih Sun	0.701	12	1.000	1	0.701	5	0.730	12	1.000	1	0.730	5
mean	0.875		0.734		0.645		0.913		0.699		0.644	
The number of efficiency	2		6		1		5		4		1	

Comparing the results of FHCs including and excluding other subsidiaries respectively (as shown in Table

4-7), we can see from either operating efficiency (0.71851 < 0.87526), profitability (0.73106 < 0.73486) or overall

efficiency (0.50990 < 0.64541), the average value of analysis inclusive of other subsidiaries are lower than non-inclusive of them.

Conclusions

This study employs the two-production-stage data envelopment analysis (DEA) proposed by Liang et al. (2008) and Kao and Hwang (2008) to evaluate the performance of the finance holding companies (FHCs)

in Taiwan. Meanwhile, it constructs a non-cooperative DEA research method based on the concept of game theory. In order to analyze how the performance of subsidiaries affect the overall efficiency of the parent company, a performance evaluation is conducted taking thirteen FHC subsidiaries as the assessment individual and regarding the FHCs (parent companies) as the leaders and their subsidiaries the followers.

Table 4-7 Comparison of efficiency among the company which has other subsidiaries and the company which doesn't have other subsidiaries

2011 DMU Name	banking, securities and other subsidiaries						banking and securities subsidiaries					
	E_k^1	rank	E_k^2	rank	E_k	rank	E_k^1	rank	E_k^2	rank	E_k	rank
Hua Nan	0.928	4	0.400	11	0.371	9	0.919	7	0.532	10	0.490	10
Fubon	0.712	8	1.000	1	0.712	4	0.955	3	1.000	1	0.955	2
Cathay	1.000	1	0.414	10	0.414	7	0.938	5	0.548	9	0.515	8
China Dev.	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1	1.000	1
E.SUN	0.525	11	0.799	7	0.419	6	1.000	1	0.603	7	0.603	7
Yuanta	0.617	9	0.925	5	0.571	5	0.688	13	1.000	1	0.688	6
Mega	1.000	1	0.380	13	0.380	8	0.900	8	0.552	8	0.498	9
Taishin	0.530	10	0.609	9	0.323	10	0.706	11	0.443	12	0.312	12
Shin Kong	0.904	5	1.000	1	0.904	2	0.937	6	1.000	1	0.937	4
SinoPac	0.773	6	0.393	12	0.304	11	0.802	10	0.360	13	0.289	13
CTBC	0.293	12	0.7706	8	0.226	13	0.948	4	1.000	1	0.948	3
First	0.290	13	0.810	6	0.235	12	0.877	9	0.510	11	0.448	11
Jih Sun	0.764	7	1.000	1	0.764	3	0.701	12	1.000	1	0.701	5
Mean	0.718		0.731		0.509		0.875		0.734		0.645	
The number of efficiency	3		4		1		2		6		1	

The empirical results show: the two-stage non-cooperative game model is less likely to overestimate the performance evaluation results of FHCs. Under non-cooperative and cooperative model, comparing the FHCs excluding other subsidiaries, their average efficiency values as a whole and in individual stages are respectively 0.87526, 0.73486 and 0.64541; 0.91395, 0.69949 and 0.64487. As it is displayed above, the performance evaluation results are less likely to be overestimated in the case of including other subsidiaries into the comparison, under the non-cooperative model and the cooperative model. Particularly, in the comparison including other subsidiaries and excluding other subsidiaries, except under the cooperative model, the average efficiency value obtained including other subsidiaries is higher than the average efficiency value of 0.008 obtained excluding other subsidiaries, in other cases they are all lower, indicating the performance evaluation results are more objective and comprehensive if the FHCs are analyzed including other subsidiaries. In addition, according to the empirical results of efficiency evaluation, the majority of the FHCs in Taiwan have poor marketability and comparatively good profitability. In terms of different business subject, the FHCs based on banking and securities have relatively better marketability; the FHCs based on securities have relatively better profitability; the organizational model based on banking and insurance has better overall performance.

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