PERFORMANCE OF FINANCIAL HOLDING COMPANIES IN TAIWAN: AN APPLICATION OF NETWORK DATA ENVELOPMENT ANALYSIS

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ABSTRACT

In this paper, we adopt the network data envelopment analysis model in lieu of the multi-stage data envelopment analysis model to evaluate the operational efficiency of financial holding companies and their subsidiaries; the advantage of the network data envelopment analysis model is that it fully captures the synergies of cross selling undertaken by subsidiaries. In this study, conducted in 2012, we find synergistic effects associated with the merger of four financial holding companies, Hua Nan, Cathay, Shin Kong and First, with operational efficiency significantly better than that of other financial holding companies. We also find that banking and securities companies of financial holding companies have superior operational efficiency to investment trust companies and insurance companies. This paper suggests that investment trust companies, insurance companies and securities companies within financial holding companies should decrease their use of relevant inputs to improve efficiency.

JEL: G2

KEYWORDS: Network Data Envelopment Analysis, Operational Efficiency, Financial Holding Companies, Cross Selling, Synergy

INTRODUCTION

The "Financial Institutions Merger Act" was enacted in Taiwan on December 13, 2000. Subsequently, on June 28, 2001, referring to the American "Glass-Steagall Act (GLS)", the "Financial Holding Company Act" was passed, allowing for the establishment of Financial Holding Companies (FHCs). This act approved cross-sector business within the financial industry, with the goal of improved business integration and increased customer satisfaction through one-stop shopping that achieves economies of scope and synergy. In addition, through a distribution system based on network connections, low cost and multiple products can be enjoyed, facilitating the gradual development of large financial institutions in Taiwan (as "the big ones get bigger") and increasing the global competitiveness of the Taiwanese financial industry. FHCs have enabled increased integration of such industries as banking, insurance, and securities firms, in addition to other financial industries, through mergers and acquisitions (M&A), expanding the scale of these businesses and improving their competitiveness. Moreover, when there is external competition, FHC subsidiaries provide an advantage by satisfying customers' diverse demands through cross selling, thereby boosting the firm's overall effectiveness. In recent years, Taiwan's FHCs, led by banking, securities, and life insurance companies, have engaged in both vertical and horizontal diversification in Taiwan's financial market (Zhao & Luo, 2002). From 2001 to 2013, 16 FHCs have been established: Hua Nan, Fubon, Cathay, China Development, SinoPac, China Trust, First, E. Sun, Fuh Hwa, Mega, Taishin, Shin Kong, JihSun, Waterland, Taiwan Financial and Taiwan Cooperative.

Mergers of FHCs, however, are not easy. Integration following a merger first requires integration of organizational culture and new value creation. Previous studies investigating the operational efficiency of the financial industry have widely employed data envelopment analysis (DEA). In particular, many scholars have applied two-stage DEA to Taiwan's FHCs in studying the effects of industry diversification on profitability and efficiency (Lo & Lu, 2006; Sheu, Lo & Lin (2006). Chao, Yu and Chen (2010), however,

argue that two-stage DEA is not appropriate and instead adopt a multi-activity data envelopment analysis (MDEA) to measure the performance of FHCs. In the above-cited literature, the conventional CCR or BCC model of DEA is utilized to obtain efficiency values for different firms. As such values turn out to be 1 for many decision making units (DMUs), such analyses provide no basis for further differentiation. Yen, Yang, Lin, and Lee (2012) use the super SBM efficiency model to resolve this problem and, employing a two-stage DEA, provide management information during production. Nevertheless, the multi-stage super SBM efficiency model cannot show the synergies of FHCs generated by resource complementarity and supported by banking, securities, life, property and casualty insurance, and investment advisory subsidiaries working together through cross selling. This deficiency of the above-cited literature motivates the present study, which investigates the synergies generated within FHCs and evaluates the overall business performance of FHCs.

We thus employ a network DEA to investigate the business performance of FHCs in Taiwan. The purpose of the study is to examine whether the operational efficiency FHCs improves after an M&A or decreases, due to the diversification of the business or the enlargement of the organization. Next, we examine the cross-selling efficiency of Taiwan's FHCs, evaluating and comparing that of each individual FHC and making suggestions for future efficiency improvements. The paper is organized as follows. Chapter 2 provides a literature review. Chapter 3 presents our research design. Chapter 4 analyzes our empirical findings. Finally, Chapter 5 concludes and offers suggestions.

LITERATURE REVIEW

Studies of the factors behind performance often measure performance from a financial viewpoint, using accounting-based and market-based performance measures. Accounting-based measures emphasize such financial metrics as return on assets (ROA), return on equity (ROE) and return on investment (ROI) to assess a company's past performance (Murphy & Zimmerman, 1993; Denis & Denis, 1995). One disadvantage of this method is that it utilizes calculations based on previous accounting information and is thus subject to a time error in estimating current performance. Another disadvantage is that accounting information is subject to the administering authority and is not objective. Market-based measurements, however, offer timely reflections of the entire market's expectations of a company's future profits as well as the market's judgment of a company's overall value. Nevertheless, these measurements are susceptible to non-company factors, such as price interference. Hence, both methods have merits and demerits. To address these difficulties, some scholars have integrated numerous indexes (including accounting-based and market-based) (Gomez-Mejia, Tosi, Hinkin, 1987). Berger, Hunter, and Timme (1993) observe that the DEA model is a performance measurement index that can handle multiple inputs and outputs, maintain unit invariance and resist the influence of subjective factors on weighting, thus providing an excellent composite index of efficiency.

As the traditional one-stage DEA does not fully reflect management information during production, Seiford and Zhu (1999) first use the two-stage DEA to analyze the profitability and marketability of 55 American banks. Taiwan's financial holding companies have not been long established, and there is little analysis of the operational efficiency of financial holding companies using two-stage DEA. Lo and Lu (2006), using a two-stage DEA, focus on 14 of Taiwan's FHCs in 2003. In the first stage, they use as inputs employees, assets and shareholders' equity and as outputs revenue and profit. In the second stage, marketability is measured, with the outputs of the first stage becoming the inputs (i.e., revenue, profit); the outputs of the second stage are then market value, share price and earnings per share. The research shows that larger FHCs have better operational efficiency than smaller ones. In addition, FHCs based on life insurance show stronger business performance than those based on banks and securities firms. Sheu et al. (2006) adopt the conventional two-stage DEA analysis, finding that FHCs with low diversification have superior profit efficiency to those with high diversification, while financial holding companies with related diversification have greater profit efficiency than those with unrelated diversification. The traditional DEA model was

adopted in most of the above studies. However, when several DMUs have an efficiency value of 1, sequencing is impossible. According to Chao et al. (2010), FHCs are characterized by different production activities, and thus it is improper to use the traditional DEA. Instead, they utilize MDEA to measure the performance of a multidivisional structure within FHCs. However, not all FHCs simultaneously include banks, securities firms, insurance companies, investment trusts and investment advisory subsidiaries, and few FHCs conform to the definition set forth by Chao et al.

Lin, Yen and Yang (2012) use a one-stage DEA to analyze the operational efficiency of all FHCs together with the co-plot method to present the dynamic relationships among FHC variables over time; they classify the leading and lagging groups on a two-dimensional graph. Yen et al. (2012) use the super SBM efficiency model to address the issue of multiple DMUs having an efficiency of 1, using a two-stage DEA that can incorporate management information during production, and observe dynamic changes of FHCs, using a two-dimensional co-plot graph. Yang and Lee (2013) use the three-stage Malmquist index to determine efficiencies in marketing, operations and profit of Taiwanese FHCs and use co-plot analysis to illustrate the strategic group development of Taiwan's FHCs in a two-dimensional graph. Ho and Lin (2012) divide the production activities of Taiwan's FHCs into four categories - marketing efficiency, operational efficiency, profit efficiency and market efficiency - using a four-stage DEA.

The models used in the analysis include tradditional DEA, Andersen and Petersen, and slack-based measures, together with a slack-based measure of super-efficiency. Because too many models were used, no conclusions could be drawn from the empirical results. The above literature was unable to show any network efficiencies that may have resulted from cross-selling among banks, securities firms, life insurance companies, property and casualty insurance companies, and investment advisory subsidiaries of FHCs. In the traditional one-stage DEA model or multi-stage DEA model, the black box hides the processes by which inputs are distributed to the production of various outputs and thus constrains the analyst's ability to measure efficiency. Through use of a network DEA model, this paper makes the black box visible, so that the performance of the entire organization and of all production activities within the organization can be evaluated (Färe & Grosskopf, 2000).

METHODOLOGY

The overall operational performance of FHCs is found to relate significantly to that of several of their subsidiaries. We find that FHCs have four principal subsidiaries: investment trusts, life insurance companies, securities firms and banks. Each subsidiary uses its resources to produce outputs. At the same time, there is a tie-up activity or intermediate product; the essential tie-up activity in all subsidiaries is cross selling. In the conventional DEA model, each activity involves only one input or output; thus, the conventional model cannot handle tie-up activities or intermediate products. The network DEA model, unlike the traditional DEA model, allows for an evaluation of cross-sectional efficiency within an organization; through the network DEA model, a comprehensive measure of efficiency can thus be obtained. The network DEA framework associated with FHCs is shown in Figure 1.

In Taiwan, there are 16 FHCs, shown as Table 1. To capture network efficiencies achieved through cross selling among subsidiaries of FHCs, we selected for our sample companies that simultaneously own an investment trust company, a life insurance company, a securities firm and a bank. The 12 FHCs were excluded. The sampled firms include Hua Nan (HN), Fubon (FB), Cathay (CA), Chinatrust (CT), Shin Kong (SK), Mega (MG), First (FI) and Taiwan Cooperative (CO), and the study was conducted in 2012. Data were gathered from the databases of the Taiwan Economic Journal (TEJ), the Securities Investment Trust & Consulting Association of the R.O.C., the Taiwan Stock Exchange Corporation and the public websites of each FHC.

Figure 1: Network DEA Framework

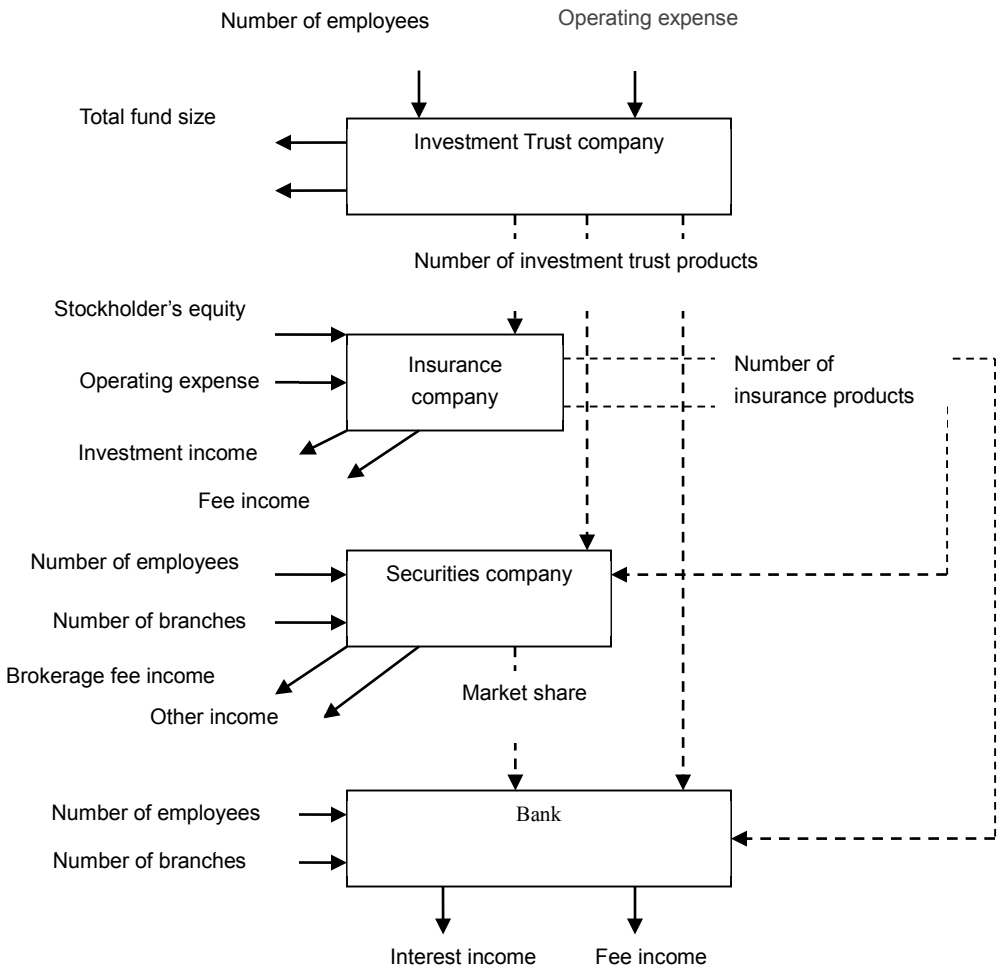

Figure 1 shows FHCs have four principal subsidiaries: investment trusts, life insurance companies, securities firms and banks. Each subsidiary uses its resources to produce outputs.

Selection and Definition of Variables

We define an FHC as an intermediary institution that offers financial services, i.e., as an intermediator that transfers financial resources rather than a producer of goods and services (Isik & Hassan, 2002; Bonin, Hasan & Wachtel, 2005). Inputs and outputs are identified based on a literature review, while intermediate outputs are identified based on expert interviews. All the experts interviewed believe that the cross-selling performance of subsidiaries of financial holding companies can be regarded as a synergy index for the industry. As inputs of an investment trust, the study uses the number of employees and operating expenses; as outputs, it uses fund size and the number of fund beneficiaries (Yen & Yang, 2013). Funds issued by the investment trust company are sold via subsidiaries of an FHC; thus, the number of fund products is the intermediate product, cross sold by the investment trust company, the life insurance company, the securities company and the bank.

For a life insurance company, stockholder's equity and operating expenses are the inputs; investment income and premium income are the outputs (Wang, Peng, & Chang, 2006; Lu, Wang & Lee, 2011). As a distribution channel, aside from the insurance company itself, its products are sold through two channels:

securities companies and banks; therefore, the number of insurance products is the intermediate product cross sold by the life insurance company, the securities company and the bank. The number of employees and the number of branches are the inputs for securities companies, while the brokerage fee revenue and other operating revenue are the outputs (Lee & Wang, 2007; Liao, 2012). As a client opens an account in a securities company and finances one's stock trading, increasing the interest income of the bank, market share is the intermediate product between securities companies and banks.

Table 1: Members of FHCS

FHC	Members	Established
Hua Nan	Hua Nan Bank, Hua Nan Securities, Hua Nan Assets Management, Hua Nan Venture Capital, South China Insurance, Hua Nan Investment Trust, Hua Nan Management and Consulting	2001/11/28
Fubon	Taipei Fubon Bank, Fubon Life Insurance, Fubon Insurance, Fubon Securities, Fubon Securities Investment Services, Fubon Marketing, Fubon Financial Holding Venture Capital, Fubon Venture Capital Management, Fubon Bank (Hong Kong), Fubon Asset management, Luck Color Technology	2001/12/19
China Development	China Development Industrial Bank, Grand Cathay Securities, KGI Securities	2001/12/28
Cathay	Cathay Life Insurance, Cathay United Bank, Cathay Century Insurance, Cathay Securities, Cathay Pacific Venture Capital, Cathay Securities Investment Trust	2001/11/27
Chinatrust	CTBC Bank, CTBC life, CTBC Insurance Brokers, CTBC Securities, CTBC Capital, CTBC AMC, CTBC Security, Taiwan Lottery, CTBC Investment	2002/05/17
SinoPac	Bank SinoPac, SinoPac Securities, SinoPac Leasing, SinoPac Capital Management, SinoPac Venture Capital, SinoPac Secturities Investment Trust, SinoPac Information Services	2001/11/28
E.Sun	E.Sun Bank, E.Sun Securities, E.Sun Venture Capital, E.Sun Insurance Brokers	2002/01/28
Yuanta	Yuanta Bank, Yuanta Securities, Yuanta Securities Finance, Yuanta Investment Consulting, Yuanta Futures, Yuanta Venture Capital, Yuanta Asset Management, Yuanta Financial Consulting	2002/02/04
Taishin	Taishin Bank, Taishin Securities, Taishin Investment Consulting, Taishin Investment Trust, Taishin Venture Capital, Taishin Marketing Consultant, Taishin Asset Management, Chang Hwa Bank, Taishin Securities Investment Trust	2001/12/31
Shin Kong	Shin Kong Bank, Shin Kong Life Insurance, Shin Kong Investment Trust, Shin Kong Insurance Brokers, Shin Kong Venture Capital, Masterlink Securities Corporation	2002/02/19
Mega	Mega Bank, Chung Kuo Insurance, Mega Securities, Mega International Investment Trust, Mega Asset Management, Mega Bills	2001/12/31
First	First Bank, First P&C Insurance Agency, First-Aviva Life Insurance, First Securities, First Venture Capital, First Financial AMC, First Securities Investment Trust, First Consulting	2001/12/31
Jih Sun	Jih Sun Securities, Jih Sun Bank, Jih Sun Futures, Jih Sun Securities Investment Consulting, Jih Sun International Property Insurance Agency, Jih Sun Life Insurance Agency, Jih Sun Technology Management Consulting, Jih Sun Cresvale Financing, Jih Sun Financial Services, Jih Sun International Investment Holdings	2001/12/31
Waterland	Waterland Securities, International Bills, Waterland Venture Capital, Waterland Securities Investment Consulting, Waterland Futures, Paradigm Asset Management	2002/03/26
Taiwan	Bank of Taiwan, Bank Taiwan Life Insurance, Bank Taiwan Securities, Bank Taiwan Insurance Brokers	2007/12/06
Taiwan Cooperative	Taiwan Cooperative bank, Co-operative Asset Management Corp, Taiwan Cooperative Securities, Taiwan Cooperative Bills Finance Corporation, BNP Paribas TCB Life, BNP Paribas TCB Asset Management.	2011/12/01

Table 1 shows the subsidiaries of each FHC and the date of establishment. Hua Nan (HN), Fubon (FB), Cathay (CA), Chinatrust (CT), Shin Kong (SK), Mega (MG), First (FI) and Taiwan Cooperative (CO) simultaneously own an investment trust company, a life insurance company, a securities firm and a bank. Source: arranged in the study from website of each FHCs

The number of employees and the number of branches are the inputs for banks, while interest income and fee income are the outputs (Chen, Chiu & Huang, 2010). The above definitions of inputs and outputs are listed in Table 2.

Network DEA Model

Färe, Grosskopf and Whittaker (2005) argue that a production process is a network constructed out of many subordinate production technologies; such a network is not included in the conventional DEA model. Thus, in the present paper, we propose a network DEA model. The production process is divided into parts, using several sub-production technologies as sub-DMUs; the CCR and BCC models or the non-increasing returns to scale (NIRS) model without weight constraints are adopted to obtain the most suitable solution. The

weighted slack-based measures network DEA, suggested by Tone and Tsutsui (2007), comprehensively tests the performance relationships between divisions of an organization as the basis for network DEA model analysis.

Table 2: Definition of Variables

DMU	Input/ Output	Variable	Description	Unit	Source
Investment trust company	Input	Number of employees	Total number of employees hired in a year	person	TEJ
		Operating expense	Expenses by division of the enterprise, including marketing, management and R&D in a defined period of time	million	TEJ
	Output	Fund size	Total assets of fund issued and managed by investment trust company	million	Securities Investment Trust & Consulting Association of The R.O.C.
		Number of fund beneficiaries	Total beneficiaries of fund issued and managed by investment trust company	person	Securities Investment Trust & Consulting Association of The R.O.C.
Life insurance company	Input	Stockholder's equity	Total assets – liabilities	million	TEJ
		Operating expense	Expenses by division of the enterprise, including marketing, management and R&D in a defined period of time	million	TEJ
	Output	Investment income	Economic benefit gained from investment by the life insurance company	million	TEJ
		Fee income	Income received by the life insurance company from the sale of insurance	million	TEJ
Securities company	Input	Number of employees	Total number of employees hired in a year	person	TEJ
		Number of branches	Total number of branches throughout the country	company	Taiwan Stock Exchange Corporation
	Output	Brokerage fee income	Revenue of brokers commissioned to trade and process short sales and securities lending as well as to trade OTC as an agent	million	TEJ
		Other income	Revenue other than brokerage fee income	million	TEJ
Bank	Input	Number of employees	Total number of employees hired in a year	bank	TEJ
		Number of branches	Total number of branches throughout the country	bank	Bank website
	Output	Interest income	Interest income, including deposit interest, loan interest, debenture interest, interest arrears and so on, gained by bank from lending funds to others	million	TEJ
		Fee income	Fee charged for the sale of financial products	million	TEJ
Intermediate production		Number of fund products	Total number of fund products issued and managed by the investment trust company	production	Securities Investment Trust & Consulting Association of the R.O.C.
		Number of insurance products	Total number of insurance products sold by the life insurance company	production	Company website
		Market share	The ratio of the operating revenue of securities company to the overall operating revenue of the industry	%	Taiwan Stock Exchange Corporation

The Table 2 shows the definitions of inputs, outputs and intermediate production.

The study employs the weighted slack-based measures network DEA in a vertically integrated model proposed by Tone and Tsutsui (2009). Suppose there are K associated companies in an FHC $_{(k=1,\ldots,K)}$, with n decision making units (DMUs) (j=1,…,n). mk and rk represent, respectively, the inputs and outputs of the K companies. The correlation between company k and company h is indicated by (k,h), and L denotes the set of connections. Thus, $\{X_j^k \in R_+^{m_k}\}_{(j=1,\ldots,n;\ k=1,\ldots,K)}$ indicates the inputs of company k to DMU$_j$; $\{Y_j^K \in R_+^{Y_k}\}_{(j=1,\ldots,n;\ k=1,\ldots,K)}$ indicates the outputs of company k to DMU$_j$; $\{Z_j^{(k,h)} \in R_+^{t(k,h)}\}_{(j=1,\ldots,n;\ (k,h)\in 1,\ldots,K)}$ indicates the correlation between company k and company h. t(k,h) indicates the number of terms connecting companies k and h. Accordingly, the set $\{(X^k,Y^k,Z^{(k,h)})\}$ is defined as follows:

$$X^k \geq \sum_{j=1}^{n} X_j^k \lambda_j^k \quad (j=1,\ldots,n;\ k=1,\ldots,K),$$
$$Y^k \leq \sum_{j=1}^{n} Y_j^k \lambda_j^k \quad (j=1,\ldots,n;\ k=1,\ldots,K),$$
$$Z^{(k,h)} = \sum_{j=1}^{n} Z_j^{(k,h)} \lambda_j^k \quad (\forall(k,h)) \text{ , input of company k} \qquad (1)$$
$$Z^{(k,h)} = \sum_{j=1}^{n} Z_j^{(k,h)} \lambda_j^h \quad (\forall(k,h)) \text{ , output of company h}$$
$$\sum_{j=1}^{n} \lambda_j^k = 1_{(\forall k)} \ , \ \lambda_j^k \geq 0_{(\forall j,k)}$$

in which $\lambda^k \in R_+^n$ is the relative vector of company k $(k=1,\ldots,K)$. It should be noted, from the above equation, that the production process is characterized by variable returns to scale (VRS). However, when the final constant $\sum_{j=1}^{n} \lambda_j^k = 1_{(\forall k)}$ is deleted, constant returns to scale (CRS) are obtained. Accordingly, DMU $(O=1,\ldots,n)$ is established and shown in equations (2):

$$X_o^k = X^k \lambda^k + S^{k-} \quad (k=1,\ldots,K) \ ,$$
$$Y_o^k = Y^k \lambda^k - S^{k+} \quad (k=1,\ldots,K) \ ,$$
$$\sum \lambda^k = 1 \quad (k=1,\ldots,K) \ , \qquad (2)$$
$$\lambda^k \geq 0, S^{k-} \geq 0, S^{k+} \geq 0, (\forall k),$$
$$X^k = (X_1^k, \cdots, X_n^k) \in R^{m_k \times n},$$
$$Y^k = (Y_1^k, \cdots, Y_n^k) \in R^{\gamma_k \times n},$$
$S^{k-}(S^{K+})$ is the open vector of inputs (outputs)

Considering a decrease in the input cost as an increase in economic efficiency, the network DEA model in this paper is established as an input-oriented constant returns to scale model.

Expert Interviews and AHP Results

Saaty (1980) developed the Analytic Hierarchy Process (AHP), a method of analyzing complex decisions involving multiple goals and criteria. This method sorts complicated and unstructured issues into component parts, which are ranked, while opinions from experts, scholars and all levels participating in decision making are gathered to simplify the complex system into a precise factor level system. In addition, pair-wise comparisons between factors are made at each level, using a nominal scale, to establish a pairwise comparison matrix and thus obtain the eigenvector of the matrix, which is taken as the priority vector of the level, indicating its priority among all factors.

The relative weights for investment trust companies, insurance companies, securities companies and banks, shown in Table 3, are based on appraisals by experts, who are senior, practiced executives at the management level. An AHP evaluation, using the software Expert Choice, is conducted to obtain the weights for the subsidiaries of financial holding companies. The calculated weights are 0.098 for investment trusts, 0.247 for insurance companies, 0.190 for securities firms and 0.465 for banks.

RESULTS AND DISCUSSIONS

An input-oriented constant returns to scale model, such as the Network-DEA of DEA-Solver Pro 7.1, is used to determine the overall efficiency of FHCs together with their efficiency rankings indicated in Table 4. The returns to scale of the investment trust companies, insurance companies, securities companies and

Table 3: Expert Group

Expert	Service Unit	Number of Brokers Served	Experience In Financial Industry (Years)
Mr. A	Auditor General of a financial broker	2	10
Mr. F	Vice President of a life insurance broker under financial holding	4	5
Ms. J	Wealth Manager of a bank under FHCs	1	10
Mr. C	Senior professional of an investment trust company	1	5
Ms. W	Senior banker of a bank	1	9

Table 3 shows the background of experts.

banks are shown in Tables 5, 6, 7 and 8, respectively. As shown in Table 4, the overall average efficiency of FHCs is 0.960, while that of investment trust companies is 0.867, that of insurance companies is 0.917, that of securities companies is 0.966 and that of banks is 1. Thus, banks are the most efficient subsidiaries of FHCs, while investment trust companies are the least. Among FHCs, it is found that Hua Nan, Cathay, Shin Kong and First have an efficiency value of 1, indicating that these FHCs are relatively efficient in their overall operations. In addition, it is clear that Fubon and Chinatrust should improve the operational efficiency of their investment trust companies; Mega should improve the operational efficiency of its insurance company; and Taiwan Cooperative should improve the operational efficiencies of its investment trusts, insurance companies and securities firms.

Table 4: Overall Efficiency of the FHCS and Their Efficiency Ranking

	Overall		Investment Trust		Life Insurance		Securities		Bank	
DMU	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
HN	1	1	1	1	1	1	1	1	1	1
FB	0.984	5	0.835	6	1	1	1	1	1	1
CA	1	1	1	1	1	1	1	1	1	1
CT	0.957	6	0.557	7	1	1	1	1	1	1
SK	1	1	1	1	1	1	1	1	1	1
MG	0.922	7	1	1	0.684	7	1	1	1	1
FI	1	1	1	1	1	1	1	1	1	1
CO	0.818	8	0.540	8	0.651	8	0.731	8	1	1
Average	0.960		0.867		0.917		0.966		1	
Max	1		1		1		1		1	
Min	0.818		0.540		0.651		0.731		1	
St Dev	0.064		0.205		0.154		0.095		0	

Table 4 shows efficiency score of FHCs, investment trust companies, insurance companies, securities companies and banks.
Note: Hua Nan (HN), Fubon (FB), Cathay (CA), Chinatrust (CT), Shin Kong (SK), Mega (MG), First (FI), Taiwan Cooperative (CO)

As shown in Table 5, the average overall efficiency of investment trust companies is 0.867, lower than that of financial holding companies as a whole, at 0.960. An analysis of investment trust companies reveals that those of Hua Nan, Cathay, Shin Kong, Mega and First have an efficiency value of 1, indicating that these investment trust companies are relatively efficient in their operations. Fubon, Chinatrust and Taiwan Cooperative are all characterized by decreasing returns to scale and hence should decrease their relevant inputs to increase efficiency. Specifically, Fubon Investment Trust should reduce its employees by 4.29% and its operating expenses by 28.65%; Chinatrust's investment trust company should reduce its employees by 49.02% and its operating expenses by 39.57%; and Taiwan Cooperative investment trust company should reduce it employees by 29.41% and its operating expenses by 62.36%.

It is evident in Table 6 that the overall efficiency of insurance companies averages 0.917, less than that of FHCs, at 0.960. The insurance companies of Hua Nan, Fubon, Cathay, Chinatrust, Shin Kong and First all show an efficiency value of 1, indicating that these insurance companies are relatively efficient in their operations. Mega and Taiwan Cooperative are characterized by decreasing returns to scale and thus should decrease their relevant inputs to improve efficiency. Specifically, Chung Kuo Insurance should reduce its stockholder's equity by 51.18% and its operating expenses by 12.05%; and Taiwan Cooperative's insurance company should reduce its stockholder's equity by 50.17% and its operating expenses by 19.56%.

Table 5: Returns to Scale for Investment Trust Companies within FHCS

DMU	Overall	Divisional	(I) Employee		(I) Operating expense		(O) Fund size		(O) Beneficiary	
	Score	Score	Data	Change (%)	Data	Change (%)	Data	Change (%)	Data	Change (%)
HN	1	1	78	0	194,373	0	36,362,344,147	0	11,989	0
FB	0.984	0.835	162	-4.29	512,720	-28.65	65,127,484,347	24.86	49,225	0
CA	1	1	230	0	800,902	0	88,994,897,957	0	119,440	0
CT	0.957	0.557	72	-49.02	151,373	-39.57	2,135,137,799	701.43	4,174	35.17
SK	1	1	104	0	185,360	0	24,028,435,147	0	29,057	0
MG	0.922	1	88	0	213,817	0	74,856,881,444	0	25,331	0
FI	1	1	153	0	358,341	0	81,399,437,126	0	51,837	0
CO	0.818	0.540	39	-29.41	183,575	-62.63	6,042,966,612	112.38	31	13549.72
Ave.	0.960	0.867	115.8	-10.34	325,058	-16.356	47,368,448,072	104.834	36,386	1698.111
Max	1	1	230	0	800,902	0	88,994,897,957	701.43	119,440	13549.72
Min	0.818	0.5340	39	-49.02	151,373	-62.63	2,135,137,799	0	31	0
St Dev	0.064	0.205	61.78	18.6356	227,378	24.4041	34,603,065,900	244.169	38,604	4788.789

Table 5 shosw the efficiency score of investment trust companies within FHCs Note: Hua Nan (HN), Fubon (FB), Cathay (CA), Chinatrust (CT), Shin Kong (SK), Mega (MG), First (FI), Taiwan Cooperative (CO)

Table 7 shows that the overall efficiency of securities companies averages 0.966, above that of the average of FHCs as a whole. The securities companies of Hua Nan, Fubon, Cathay, Chinatrust, Shin Kong, Mega and First show an efficiency value of 1, indicating that these securities companies are relatively efficient in their operations.

Table 6: Returns to Scale for Insurance Companies within FHCS

Dmu	Overall	Divisional	(I) Stockholder's Equity		(I) Operating Expense		(O) Investment Income		(O) Fee Income	
	Score	Score	Data	Change (%)	Data	Change (%)	Data	Change (%)	Data	Change (%)
HN	1	1	3,135,691	0	1,061,918	0	69,277	0	4,219,464	0
FB	0.984	1	165,649,065	0	13,157,079	0	32,330,974	0	392,295,243	0
CA	1	1	135,273,284	0	16,134,194	0	40,020,777	0	443,353,808	0
CT	0.957	1	15,516,158	0	1,240,318	0	1,557,411	0	40,864,740	0
SK	1	1	51,002,553	0	12,851,151	0	23,757,540	0	161,265,382	0
MG	0.922	0.684	4,895,188	-51.18	900,640	-12.05	75,872	3.86	3,428,047	0
FI	1	1	1,181,294	0	364,400	0	112,132	0	2,459,741	0
CO	0.818	0.651	5,922,597	-50.17	414,092	-19.56	427,644	25.71	8,454,908	0
Ave.	0.960	0.917	47,821,979	-12.6688	5,765,474	-3.9512	12,293,953	3.6962	132,042,667	0
Max	1	1	165,649,065	0	16,134,194	0	40,020,777	25.71	443,353,808	0
Min	0.818	0.651	1,181,294	-51.18	364,400	-19.56	69,277	0	2,459,741	0
St Dev	0.064	0.154	65,851,804	23.4595	6,932,624	7.5866	16,923,679	8.9969	184,684,895	0

Table 6 shows the efficiency score of insurance companies within FHCs. Note: Hua Nan (HN), Fubon (FB), Cathay (CA), Chinatrust (CT), Shin Kong (SK), Mega (MG), First (FI), Taiwan Cooperative (CO)

The only securities company showing decreasing returns to scale is Taiwan Cooperative Securities, which should thus decrease the relevant inputs to increase efficiency. Specifically, it should reduce its branches by 49.42% and its operating expenses by 4.45%. According to Table 8, the overall efficiency of banks averages 1, higher than that of FHCs as a whole (0.960). All banks show an efficiency value of 1, indicating that they are relatively efficient in their operations.

CONCLUSION

Prior literature has sought to analyze the efficiency of FHCs through two methods: multi-stage DEA, used to evaluate the overall performance of financial holding companies (Lo & Lu, 2006; Sheu et al., 2006; Yen et al., 2012; Ho & Lin, 2012); and multi-activity data envelopment analysis, used to measure the performance of FHCs individually (Chao et al, 2012). However, these tools cannot show synergies within FHCs generated by resource complementarity and by support from banking, securities, life insurance, property and casualty insurance, and investment advisory subsidiaries together with cross selling. In

addition, the DEA model has a black box that obscures how inputs are distributed to the production of various outputs. Ignoring interior production processes constrains the analyst's ability to measure efficiency. Unlike the traditional DEA model, the network DEA allows for an evaluation of cross-sectional efficiency within an organization; a comprehensive measure of efficiency can thus be obtained. Moreover, through use of a network DEA model, this paper illuminates the DEA's black box, enabling an evaluation of the performance of all subsidiaries within FHCs (Färe & Grosskopf, 2000). According to our results, Hua Nan, Cathay, Shin Kong and First are highly efficient (achieving an efficiency score of 1), indicating strong synergies among these firms following their merger. It is evident that banks and securities companies are more efficient in their operations than investment trust companies and insurance companies. In addition to measuring the overall efficiency of financial holding companies and their subsidiaries, the present study suggests that investment trust companies, insurance companies, and securities companies should decrease their relevant inputs to increase efficiency.

Table 7: Returns to Scale for Securities Companies within FHCS

Dmu	Overall	Divisional	(I) Branch		(I) Employee		(O) Brokerage Fee Income		(O) Other Income	
	Score	Score	Data	Change (%)	Data	Change (%)	Data	Change (%)	Data	Change (%)
HN	1	1	55	0	1,538	0	1,231,360	0	559,709	0
FB	0.984	1	61	0	2,211	0	2,433,417	0	900,387	0
CA	1	1	10	0	460	0	312,123	0	112,033	0
CT	0.957	1	9	0	349	0	199,469	0	84,438	0
SK	1	1	50	0	1,932	0	1,576,717	0	1,054,124	0
MG	0.922	1	46	0	1,522	0	1,180,719	0	821,218	0
FI	1	1	27	0	949	0	712,198	0	302,407	0
CO	0.818	0.731	12	-49.42	243	-4.45	187,108	15.19	79,892	1.18
Ave.	0.960	0.966	33.75	-6.1775	1,151	-0.5562	979,139	1.8988	489,276	0.1475
Max	1	1	61	0	2,211	0	2,433,417	15.19	1,054,124	1.18
Min	0.818	0.731	9	-49.42	243	-4.45	187,108	0	79,892	0
St Dev	0.064	0.095	21.7239	17.4726	757	1.5733	786,279	5.3705	398,557	0.4172

Table 7 shows the efficiency score of securities companies within FHCs. Note: Hua Nan (HN), Fubon (FB), Cathay (CA), Chinatrust (CT), Shin Kong (SK), Mega (MG), First (FI), Taiwan Cooperative (CO)

Table 8: Returns to Scale for Banks within FHCS

Dmu	Overall	Divisional	(I) Bank Branch		(I) Employee		(O)Fee Income		(O) Interest Income	
	Score	Score	Data	Change (%)	Data	Change (%)	Data	Change (%)	Data	Change (%)
HN	1	1	187	0	7,054	0	4,097,139	0	29,517,269	0
FB	0.984	1	99	0	6,631	0	7,371,771	0	23,866,767	0
CA	1	1	167	0	6,782	0	6,089,556	0	25,126,708	0
CT	0.957	1	117	0	9,824	0	17,566,381	0	31,948,652	0
SK	1	1	106	0	3,470	0	1,867,900	0	11,791,143	0
MG	0.922	1	108	0	5,308	0	6,618,410	0	36,258,347	0
FI	1	1	192	0	7,185	0	4,586,386	0	31,207,682	0
CO	0.818	1	321	0	8,533	0	3,426,050	0	45,667,799	0
Ave.	0.960	1	162.125	0	6,848	0	6,452,949	0	29,423,046	0
Max	1	1	321	0	9,824	0	17,566,381	0	45,667,799	0
Min	0.818	1	99	0	3,470	0	1,867,900	0	11,791,143	0
St Dev	0.064	0	74.5241	0	1,916	0	4,836,332	0	9,859,010	0

Table 8 shows the efficiency score of banks within FHCs. Note: Hua Nan (HN), Fubon (FB), Cathay (CA), Chinatrust (CT), Shin Kong (SK), Mega (MG), First (FI), Taiwan Cooperative (CO)

Limitations of the Study and Future Study

As not all FHCs have subsidiaries that include investment trusts, insurance companies, securities firms and banks, this study focuses on only eight FHCs: Hua Nan, Fubon, Cathay, Chinatrust, Shin Kong, Mega, First and Taiwan Cooperative. To obtain a more precise analysis of the entire financial holding industry, data from all FHCs should be investigated. In addition, according to the Network DEA model used in this study, the efficiency of many FHCs is very high, achieving a score of 1, which makes sequencing impossible. More precise and thorough analysis, without the above limitations, is left to future studies.

REFERENCES

Berger, A. N., C. Hunter and S. G. Timme (1993) "The efficiency of financial institutions: a review and preview of research past, present, and future," *Journal of Banking and Finance*, vol.17(2/3), p. 221-249.

Bonin, J. P., I. Hasan and P. Wachtel (2005) "Bank performance, efficiency and ownership in transition countries," *Journal of Banking and Finance*, vol. 29, p. 31-51.

Chao, C. M., M. M. Yu and M. C. Chen (2010) "Measuring the performance of financial holding companies in Taiwan with multi-activity DEA approach," *The Service Industries Journal*, vol. 30(6), p. 811 - 829.

Chen, Y. C., Y. H. Chiu and C.W. Huang (2010) "Measuring super-efficiency of financial and non-financial holding in Taiwan: an application of DEA models," *African Journal of Business Management*, vol. 4(13), p. 3122-3133.

Denis, D. J.and D. K. Denis (1995) "Performance changes following top management dismissals," *The Journal of Finance*, vol. 50(4), p. 1029-1057.

Färe, R. and S. Grosskopf (2000) "Theory and application of directional distance functions," *Journal of Productivity Analysis,* vol. 13(2), p. 93-103.

Färe, R., S. Grosskopf and G. Whittaker (2005) *Network DEA*, discussing paper: chapter 9.

Gomez-Mejia, L. R., R. Tosi and T. Hinkin (1987) *Organizational determinants of chief executive compensation*, working paper, University of Florida.

Ho, E. and C. Y. Lin (2012) "Applying multi-stage DEA to evaluate the efficiency of financial holding company after financial tsunami," *Business Review*, vol. 17(1), p. 43-64.

Isik, I. And M. K. Hassan (2002) "Technical, scale and allocative efficiencies of Turkish banking industry," *Journal of Banking and Finance*, vol. 26, p. 719-766.

Lee, Y. H. and T. C. Wang (2007) "The study of operating efficiency of the branches for a securities firm-using DEA approach," *Operating Management Reviews*, vol. 3(1), p. 63-80.

Liao, C. S. (2012) "A study on market structure, efficiency and organizational structure for securities firms in Taiwan," *Journal of Commercial Modernization*, vol. 6(3), p. 255-272.

Lin, W. H., G. F. Yen and Y. H.Yang (2012) "Based on two stages malmquist index of efficiency analysis of Taiwan's financial holding company's operations," *Asia – Pacific Economic Review*, vol. 5, p. 138-143.

Lo, S. F. and W. M. Lu (2006) "Does size matter ? Finding the profitability and marketability benchmark of financial holding companies," *Asia Pacific Journal of Operational Research*, vol. 23(2), pp. 229-246.

Lu, Y. H., C. H. Wang and C. H. Lee (2011) "The differences in technology efficiency of Taiwan's life insurance companies – the application of the metafrontier DEA model," *Journal of Economics and Management*, vol. 7(1), p. 73-100.

Murphy, K. J. and J. L. Zimmerman (1993) "Financial performance surrounding CEO turnover," *Journal of Accounting and Economics*, vol. 16(1), p. 273-315.

Saaty, T. L. (1980) *The analytic hierarchy process.* New York, NY: McGraw-Hill.

Seiford L. M. and J. Zhu (1999) "Profitability and marketability of the Top 55 U. S. commercial banks," *Management Science*, vol. 45(9), p. 1270-1288.

Sheu, H. J., S. F. Lo and H. H. Lin (2006) "Linking diversification strategy to performance: A case for financial holding companies in Taiwan," *Journal of Transnational Management*, vol. 11(3), p. 61-79.

Tone, K. and M. Tsutsui (2007) *Application of network DEA model to vertically integrated electric utilities*, GRIPS discussion papers, National graduate institute for Policy Studies, 7-3.

Tone, K. and M. Tsutsui (2009) "Network DEA: a slacks-based measure approach," *European Journal of Operational Research*, vol. 197, p. 243–252.

Wang, J. L., J. L. Peng and Y. H. Chang (2006) "The impact of bancassurance on the efficiency performance of life insurance companies in Taiwan," *TMR*, vol. 17(1), p. 59-90.

Yang, Y. H. and Y. C. Lee (2013) "Strategic grouping of Financial holding companies: a two-dimensional graphical analysis with application of the three-stage malmquist index and co-plot methods," *The International Journal of Organizational Innovation*, vol. 5(3), p. 158-170.

Yen, G. F. and Y. H. Yang (2013) "Measuring managerial efficiency of securities investment trust firms under Taiwanese financial holding companies: an application of two-stage DEA approach," *The International Journal of Organizational Innovation*, vol. 6(1), p. 72-81.

Yen, G. H., Y. H. Yang, Y. H. Lin and A. K. Lee (2012) "Operating performance analysis of Taiwan's financial holding companies – using super SBM efficiency model and Co-plot analysis," *The International Journal of Organizational Innovation*, vol. 5(2), p. 141-136.

Zhao, H. and Y. Luo (2002) "Product diversification, ownership structure, and subsidiary performance in China's dynamic market," *Management International Review*, vol. 42(1), p. 27−48.

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