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Measuring the performance of financial holding companies

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Financial institutions have become larger and engage in a wider array of financial activities due to continuing consolidation. Since the financial holding companies face multiple production functions simultaneously, the traditional data envelopment analysis (DEA) approach is not suitable for investigating their efficiency. This study applies the multi-activity DEA model to explore the relative efficiency of 12 financial holding companies in Taiwan. The results show that the multi-activity DEA model is obviously more capable of identifying sources of inefficiency, thereby potentially yielding greater managerial insights into organisational improvements.

Keywords: data envelopment analysis; multi-activity DEA model; efficiency; financial holding company

Introduction

The ongoing consolidation of financial institutions is one of the most notable contemporary features of the financial landscape both within and across many industrialised countries. As a result of these developments, financial institutions today are larger and engage in a wider array of financial activities than at any time in recent history. In response to the growing international competition, the Taiwan government enacted the *Financial Institutions Merger Law* and the *Financial Holding Company Law* during 2000–2001. The *Financial Institutions Merger Law* provides both tax and non-tax incentives for financial institutions to merge on their own initiative, while the *Financial Holding Company Law* allows financial institutions to undertake a wider range of business activities so as to increase their economy and scope.

The potential benefit of a financial holding company (FHC) is the increase in efficiency due to cost reductions as well as cross-selling synergies. However, when a financial institution undertakes a wider range of business activities, the increased complexity makes it even harder to manage in a way that achieves optimal use of the resources available. For example, system incompatibilities, quality of service inconsistencies, cultural incompatibilities, and mixed corporate messages may cause perceived synergies to fail to materialise. Therefore, it is important for the investors as well as the regulators to find an appropriate measure that represents the overall performance and operational efficiency of the FHCs.

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There are two main approaches to assess firm performance: the financial ratio approach and the frontier approach. For the financial ratio approach, firm performance is measured by earnings-based financial ratios, such as return on assets (ROA) or return on equity (ROE). Given that different financial ratios are designed to evaluate different aspects of the firm's performance, there is no consensus about which financial ratio or what combination of ratios best represents the overall performance of a financial institution (Lin, Hu, & Sung, 2005, pp. 605–611). In addition, Kohers, Huang, and Kohers (2000, pp. 101–120) argue that financial ratios do not reflect economic value-maximising behaviour, and the selection of the weights of financial ratios is subjective.

Due to the shortcomings of the traditional financial ratio approach, most researchers adopt frontier analysis methods to evaluate the efficiency of financial institutions (Berger & Humphrey, 1997, pp. 175–212). In short, the frontier approach measures the efficiency of an institution by how well it performs relative to a 'best-practice' frontier. The two major frontier approaches are the non-parametric and the parametric. The parametric approach includes the stochastic frontier approach, the thick frontier approach, and the distribution-free approach, while the non-parametric approach is the data envelopment analysis (DEA) (Bauer, Berger, Ferrier, & Humphrey, 1998, pp. 85–114). These approaches differ primarily in how much shape is imposed on the frontier, the existence of random error, and the distribution assumptions imposed on the random error and inefficiency. Despite intense research efforts, there is no consensus on the best method for measuring frontier efficiency (Bauer et al., 1998, pp. 85–114). The objective of this study is to measure the performance and efficiency of the FHCs in Taiwan. In this study, the DEA approach has been used because DEA is the preferred methodology in the literature when the sample size is small (Sathye, 2001, pp. 613–630).

Since the FHC is a newly established organisation structure, empirical research on its performance or efficiency is limited. Several studies on the efficiency measurement of bank holding companies take one bank holding company as one decision making unit (DMU) and compare it with other DMUs that utilise the same input and output factors both from a practical organisational standpoint and from a costs research perspective (e.g., Bosworth, Mehdian, & Vogel, 2003, pp. 91–99; Kohers et al., 2000, pp. 101–120). However, since an FHC has various subsidiaries with different degrees of success in various industries, this makes the overall evaluation even more difficult. For example, an FHC may have a bank, a security firm, and an insurance company all in operation. An FHC that is efficient in the banking subsidiary may not be as efficient in the security or insurance subsidiaries. Therefore, the evaluation of the efficiency of an FHC that faces multiple production functions using shared inputs needs to be resolved.

This study applies the multi-activity DEA model developed by Tsai and Mar Molinero (2002, pp. 21–38) to explore the efficiency of FHCs in Taiwan. The multi-activity DEA model is designed to examine the efficiency of individual services within different but highly homogeneous multi-subsidiary companies. The conventional DEA model assumes that DMU is equally efficient in all its activities. However, when a DMU is engaged in several activities simultaneously and thus faces several production functions, the assumption does not hold. The multi-activity DEA approach is developed to estimate relative efficiency for multi-activity DMUs such as the FHCs. From the analysis, we are able to evaluate the overall efficiency of the FHCs as well as the efficiency among different subsidiaries. Based on the analysis of the inefficiency across all subsidiaries of each FHC, one can gain further insights from the estimated results and thus propose strategies for improving operational performance.

Our results suggest that the multi-activity DEA model is more capable of identifying sources of inefficiency and therefore, giving more management insights. The multi-activity DEA model is able to evaluate the relative performance of each subsidiary of an FHC in order to identify the one that might reasonably be taken as the FHC's core business. Such evaluation can aid management decisions on how to improve the overall performance of the FHC group. For example, an FHC may decide to devote its efforts on those subsidiaries with comparative advantages. For those subsidiaries performing at a less than satisfactory level, the group may either decide to improve their performance, or to de-emphasise, or even to abandon those portions of the business.

This paper is structured as follows. Following a review of the FHCs in Taiwan, we describe the multi-activity DEA methodology and inputs and outputs of this study. Then, we analyse and discuss the overall and individual efficiency of each FHC. Finally, the managerial implications and conclusions are drawn.

An overview of the FHCs in Taiwan

Over the past 30 years, the financial system in Taiwan has changed from a controlled system into a liberalised one. The liberalisation of the financial sector has created a more efficient financial market, but has also increased operating risks for financial institutions due to keener competition. Ever since the Southeast Asian financial crisis of July 1997, problems in the banking industry have begun to come to light. Asset bubbles in equity and real estate prices further deteriorated the banks' asset quality, with a non-performing loan ratio of 7.48% in 2001. Other financial ratios, such as ROA and ROE, dropped to all-time lows of −0.49% and −5.11%, respectively, in 2002.

In order to redress a number of weaknesses that were uncovered during the Asian financial crisis, the government introduced a series of financial reforms and encouraged financial institutions to integrate, diversify services, and enlarge economies of scale. As a result, the *Financial Institutions Merger Law* and the *Financial Holding Company Law* went into effect in 2000 and 2001, respectively. Under the mechanism provided by the aforementioned laws, mergers among financial institutions and the emergence of FHCs are allowed. As a result of these developments, a financial institution is able to engage in a wider array of financial activities, having such subsidiaries as banks, insurance companies, and securities firms under the structure of an FHC. Given the potential benefit of cross-selling and sharing the information technology and e-commerce platforms, the holding company structure is expected to lead to significant cost reductions and revenue enhancements.

As of December 2001, 13 FHCs had been approved, which ushered in a new era for the financial industry of Taiwan. Today there are 14 FHCs in Taiwan. Moreover, in response to the growing international competition, a second wave of financial consolidation among different FHCs is about to start.

Table 1 presents certain statistics of Taiwan FHCs as of the end of December 2004. From Table 1, there is a large difference among the size of the FHCs, with equity capital ranging from NT$10 billion (Waterland Financial Holdings) to NT$113 billion (Mega Holdings). The total number of branches ranges from 24 to 484. China Development Financial Holding Corporation (CDFH) has the least number of branches, because its main subsidiary, China Development Industrial Bank, has a small number of branch offices due to the characteristics of the industrial bank. On the other hand, Cathay Financial Holdings has the largest number of branches because both Cathay United Bank and Cathay Life Insurance have a substantial number of branches in

Table 1. Descriptive statistics of the Taiwanese financial holding companies in 2004.

Company name	Equity (in 1000 NT dollars)	Number of branches	Number of employees	ROE (%)	ROA (%)	EPS
First	55,490,750	235	9316	14.06	13.66	1.86
HuaNan	55,796,342	230	9594	14.21	13.25	1.93
ShinKong	29,729,121	57	18,259	12.2	12.2	2.23
Cathay	83,074,891	484	31,879	18.81	16.5	3.7
Fubon	82,541,193	179	10,268	9.9	8.61	2.02
Mega	113,657,296	107	7277	13.57	10.81	2.22
Taishin	44,072,921	160	9969	17.92	13.75	2.8
Fuhwa	30,064,445	130	4825	8.8	7.51	1.23
JihSun	22,532,732	97	5362	3.76	3.6	0.54
SinoPac	39,880,826	94	5333	9.35	8.29	1.24
ESun	29,306,096	99	2838	13.99	12.34	1.94
Chinatrust	57,798,995	115	8653	17.23	12.37	2.6
China Development	112,142,470	24	1934	−4.08	−3.34	−0.54
Waterland	10,140,000	45	1085	13.36	13.04	1.54

Taiwan. Moreover, according to the financial records, the most profitable FHC in 2004 is Cathay Financial Holdings, with ROE and ROA of 18.81% and 16.5%, respectively. The CDFH is the least profitable one, with negative ROE and ROA of −4.08% and −3.34%, respectively. The main reason for the negative ROE and ROA is that a new management team took over CDFH in 2004 and re-evaluated the existing direct investment portfolio, which resulted in a booking of an investment loss provision of NT$10.87 billion.

Table 2 shows the various financial activities undertaken by the FHCs. The financial activities that each FHC undertakes mostly depend on its founding company or conglomerate. Basically, their activities can be categorised as banking, securities, insurance, and ‘others’. ‘Others’ refer to those financial activities that do not belong to the first three categories and are undertaken by some FHCs, such as bills finance companies, venture capital companies, asset management companies, and so forth.

For securities activities, all of the FHCs have security houses. Two out of 14 FHCs do not engage in banking activities: the CDFH and Waterland Financial Holdings. Given that the CDFH was founded by the China Development Industrial Bank, the group focus is on direct investment, corporate banking, and project finance, rather than on the regular banking activities. Waterland Financial Holdings is the only FHC in Taiwan founded by a bills finance company and is also the smallest in terms of equity. Its corporate goal is to create niche businesses related to bills financing and become an investment-banking group. Given the distinct characteristics of these two FHCs, they are excluded from our analysis.

Regarding insurance activities, there are six FHCs with insurance companies (life insurance or non-life insurance companies), while all of the 12 FHCs in our sample have insurance agents and/or insurance brokers. According to the *Insurance Act* of Taiwan, an insurance agent acts as a business agent on behalf of an insurance company, while the insurance broker acts on the insured’s behalf to enter into an insurance contract with an insurance company. Beyond this distinction, however, agents and brokers fill many of the same functions. Each meets with potential clients and advises them on the most appropriate coverage. When claims are made, they have to settle the claim equitably

Table 2. Financial activities of Taiwanese financial holding companies in 2004.

Company name	Banking	Security	Insurance company*	Insurance agent or broker†	Others‡
HuaNan	•	•	•	•	•
ShinKong	•	•	•	•	•
Cathay	•	•	•	•	•
Fubon	•	•	•	•	•
Mega	•	•	•	•	•
Taishin	•	•		•	•
Fuhwa	•	•		•	•
JihSun	•	•		•	•
SinoPac	•	•		•	•
ESun	•	•		•	•
Chinatrust	•	•		•	•
China Development		•			•
Waterland		•			

Note: ‘Bullet’ means the FHC has at least one subsidiary under this category.
*Both life insurance companies and non-life insurance companies belong to this category.
†The insurance agent is an organisation which, on the basis of a contract of agency or a letter of authorisation, collects remuneration from an insurer and acts as a business agent on the insurer’s behalf (Article 8, *Insurance Act*). The insurance broker is an organisation which, on the basis of the interests of the insured, acts on the insured’s behalf to enter into an insurance contract with an insurer, and collects a commission from the insurance enterprise that underwrites the insurance (Article 9, *Insurance Act*).
‡‘Others’ refer to those financial activities that do not belong to the first three categories, such as bills finance companies, venture capital companies, asset management companies, etc.

for both the client and the insurance company. As a result, they are grouped into the same category in this study.

However, when evaluating the relative efficiencies of insurance organisations with various types, the differences between the insurance company and the insurance agent/broker must be taken into account. Insurance agents/brokers work on the commission of the premiums they sell, while the insurance companies issue contingent claims to policyholders and receive insurance premiums to purchase income-generating assets. Given that some FHCs own both insurance companies and insurance agents/brokers while others only have insurance agents/brokers, this study takes into consideration the different features between insurance companies and insurance agents/brokers when evaluating the relative efficiency of the FHCs.

Methodology

The multi-activity DEA model is a novel refinement of the conventional DEA approaches. For the joint determination of efficiencies in the DEA context, the multi-activity DEA model was proposed by Beasley (1995, pp. 441–452), and subsequently revised by Mar Molinero (1996, pp. 1273–1279), Mar Molinero and Tsai (1997, pp. 51–56), and Tsai and Mar Molinero (1998, 2002, pp. 21–38). The conventional DEA model is not able to evaluate the efficiency of firms that carry out various activities while sharing common resources. The multi-activity DEA approach was proposed with the objective of providing a solution to this weakness. In this section, we present the formulations for evaluating both the aggregate performance of each DMU, as well as the performance of the separate activities within a DMU’s operation.

The aggregate performance of the DEA model

The DEA method, introduced in Charnes, Cooper, and Rhodes (1978, pp. 215–223), utilises a sequence of linear programs to construct a piecewise linear production frontier and to compute an efficiency index relative to the frontier based on the observed data without having information on the production function. The main characteristics of DEA are that it can be applied to analyse multiple outputs and multiple inputs without pre-assigned weights.

In the following discussion, we assume that there exist K DMUs to be evaluated. Each DMU consumes a variety of n different inputs to produce m different outputs. Specifically, this approach establishes a relationship between outputs, y, and inputs, x. Given a vector of inputs, x, the production correspondence is defined as $p(x) = \{y/y$ can be produced by $x\}$. DMU k consumes amounts x_{ik} of inputs ($i = 1, \ldots, n$) and produces amounts y_{jk} of outputs ($j = 1, \ldots, m$). The $r \times n$ output matrix for the n DMUs is denoted by Y, and the $m \times n$ input matrix for the n DMUs is denoted by X.

Since an FHC's goal is to maximise profit, the technology used to measure its efficiency has to deal with input excesses and output shortfalls simultaneously. The graph-oriented DEA model is therefore applied to this study. In contrast to input-oriented and output-oriented DEA models, both inputs and outputs are allowed to vary by the same (or different) proportion, but inputs are proportionately decreased while outputs are simultaneously increased by the same (or different) proportion. This yields a hyperbolic path to the frontier of the graph. If we allow the same variation (δ) to the rate of increase of outputs and to the rate of decrease of inputs simultaneously, the graph efficiency measure of a particular DMU o under the assumption of constant-returns-to-scale (CRS) can be obtained from the following non-linear programming:

$$\begin{aligned} \min_{z,\delta} \quad & \delta_o \\ \text{subject to} \quad & \sum_{k=1}^{K} z_k y_{jk} \geq y_{jo}/\delta, \quad j = 1, \ldots, m, \\ & \sum_{k=1}^{K} z_k x_{ik} \leq \delta \cdot x_{io}, \; i = 1, \ldots, n, \\ & z_k \geq 0, \quad k = 1, \ldots, K. \end{aligned} \tag{1}$$

The structure in Equation (1) presumes that one desires to measure the overall operational efficiency of each DMU, without consideration of the performance of the sub-activities that may exist within the DMU. In the problem setting presented herein, a further detailed performance evaluation at the level of these sub-activities can be provided.

The separate performance of each activity within a DMU

In this section we explicitly set up the model used to evaluate multi-activity production inefficiency. This approach is based on the frontier production function, which explicitly recognises that some activities are more efficient than others in production. A revised schematic of the production process for a particular firm is illustrated in Figure 1.

For a DMU k, $y^t_{q,k}(q^t = 1, \ldots, Q^t)$ output, which is solely included in the tth activity ($t = 1, \ldots, T$), $x^t_{r,k}(r^t = 1, \ldots, R^t)$ are inputs dedicated to the tth activity, but $x^S_{p,k}(p = 1, \ldots, P)$ are inputs shared among T activities of the DMU k. For an illustration of the multi-activity performance measurement, we choose to evaluate DMU o relative to the multi-activity technology by means of a hyperbolic path to the frontier. The objective

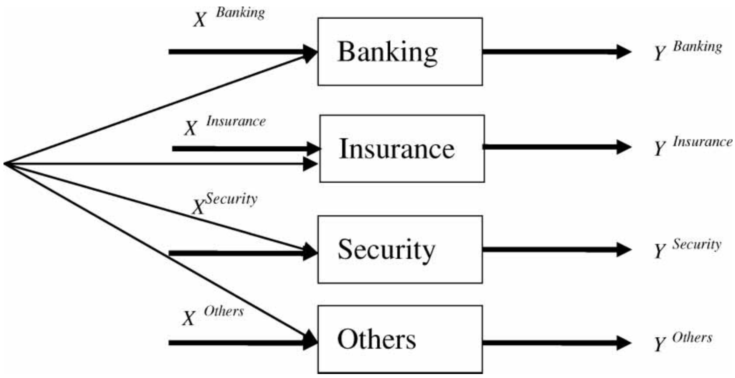

Figure 1. Framework of an FHC multi-activity DEA.

function of the multi-activity model takes the form:

$$\min_{\alpha_k^t, \theta_o^t, \beta_p^t}, \quad \theta_o = \sum_{t=1}^{T} w^t \cdot \theta_0^t \tag{2}$$

The tth activity production process technology, $t = 1, \ldots T$.

$$\sum_{k=1}^{K} \alpha_k^t x_{r,k}^t \leq \theta_o^t x_{r,o}^t, \quad r = 1, \ldots, R^t, \tag{3}$$

$$\sum_{k=1}^{K} \alpha_k^t y_{q,k}^t \geq \frac{y_{q,o}^t}{\theta_o^t}, \quad q = 1, \ldots, Q^t, \tag{4}$$

Shared input constraints of the tth activity production process, $t = 1, \ldots, T$.

$$\sum_{k=1}^{K} \alpha_k^t \beta_p^t x_{p,k}^S \leq \sum_{k=1}^{K} \alpha_k^t \theta_o^t \beta_p^t x_{p,o}^S, \quad p = 1, \ldots, P, \tag{5}$$

$$L_p^t \leq \beta_p^t \leq U_p^t, \quad p = 1, \ldots, P, \tag{6}$$

$$\sum_{t=1}^{T} \beta_p^t = 1, \quad p = 1, \ldots, P. \tag{7}$$

Note that the notation $\beta_p^t x_{p,k}^S$ represents the amounts of shared inputs allocated to activity t by DMU k. The limits L_p^t, U_p^t, on the proportions β_p^t of the various shared inputs p to activity t can be specified by the user. Such limits might generally arise from any information available with the firms regarding standard amounts of shared inputs p per unit of product in activity t. α_k^t represents the intensive variable of the tth activity of DMU k, and is a positive constant associated with the tth activity of DMU k.

The objective function of the multi-activity DEA model in Equation (2) represents that inputs are allowed to proportionately decrease while outputs are simultaneously increased at the same proportion and seeks to estimate the operating efficiencies θ_o^t of firm o.

Specification of inputs and outputs

There has been a longstanding debate among researchers about what constitutes the outputs and inputs of a financial institution. Researchers generally take one of two alternative approaches: the production approach and the intermediation approach (Berger & Humphrey, 1997, pp. 175–212). Under the production approach, a financial institution is defined as a producer of services for account holders. The financial institution performs transactions and processes documents for customers, such as loans, insurance policies, or other payment instruments. According to this approach, outputs are measured by the number and type of transactions processed, while only physical inputs such as number of employees and physical capital are considered as inputs. Under the intermediation approach, a financial institution is an intermediary that converts and transfers financial assets between savers and investors. The financial institution employs labour, physical capital, and borrowed funds to produce earning assets. According to this approach, output is defined as the dollar value of deposits, loans, or insurance in force, while inputs include not only the physical inputs but also the input of funds and their interest costs. Berger and Humphrey (1997, pp. 175–212) suggest that the intermediation approach is more appropriate for evaluating the entire financial institutions while the production approach is better for evaluating the efficiencies of branches of financial institutions.

In this study, the intermediation approach is used, which takes the view that DEA inputs and outputs should be selected according to the services that each individual subsidiary provides. For the banking industry, banks are viewed as financial intermediaries that receive deposits and use deposits as a source of funds to issue loans or make investments. Therefore, following Brown, Chen, and Skully (2005, pp. 229–245) and Sathye (2003, pp. 662–671), the input variable (BTEXP) is the sum of labour expense, interest expense (payment to the depositors), and non-interest expense. The bank outputs are loans (BLAON) and non-interest income (BNIINC).

Regarding the securities industry, a security firm usually engages in three principal activities: brokerage, underwriting, and dealing activities. In return, a security firm receives commissions, underwriting fees, and trading gains. Following Zhang, Zhang, and Luo (2006, pp. 589–594), inputs of a security firm are defined as the sum of labour and capital expense (STEXP) and equity (SEQU). The output item for a security house is the sum of commission and non-commission revenue (STREV, including underwriting fees and trading gains).

Concerning the insurance industry, two types of organisations are considered: insurance companies and insurance agents/brokers. Following Brockett, Cooper, Golden, Rousseau, and Wang (2005, pp. 393–412) and Yang (2006, pp. 910–919), an insurance company can be considered as a financial intermediary that issues contingent claims to policyholders and invests the premiums received to create financial profits. Thus, the inputs and outputs chosen for an insurance company should represent the ability of an insurance company to maximise profits. The input items for an insurance company are therefore the surplus and operating expense (including labour expense). The surplus is the total of owner's equity and various actuarial reserve funds. According to the *Insurance Act*, the surplus represents the available fund resources for an insurance company to make investments or loans (article 146, *Insurance Act*). The outputs used in this study are investment gains and interest income. For the insurance agents/brokers, due to the limited availability of their financial data, this study uses owner's equity and operating expense as inputs and operating revenue as the output. In order to evaluate the relative efficiency of the insurance business as a whole, the input and output items of insurance companies and insurance agents/brokers are aggregated. Therefore, the inputs used in the calculation of relative efficiency are the general surplus (IEQRES) and general expense (ITEXP). IEQRES represents the sum of insurance companies' surplus and the owner's equity of insurance agents/brokers. ITEXP is the sum of operating expenses of both the insurance companies and insurance agents/brokers. The output item used in this study is the general income (ITREV), which is the total of investment gains and interest income of insurance companies and the operating revenue of insurance agents/brokers.

For the 'others' category, it contains other activities undertaken by an FHC that do not belong to the banking, securities, or insurance categories. Since many of these subsidiaries are not listed companies, the financial data are limited. To create input–output items for the 'others' category, this study aggregates the financial data of all the subsidiaries of an FHC under this category. The inputs are aggregate assets (OCAP) and aggregate operating expenses (OOPEXP), while the output item is the aggregate operating revenue (OREV).

As to the shared inputs, the operating expenditure of the holding company is assumed to be shared among all four categories of subsidiaries. Moreover, under the holding company structure, all the subsidiaries of an FHC can enjoy the benefit of multi-channel distribution by joint use of branch offices and branch personnel. Therefore, the shared inputs associated with all the subsidiaries are the operating expense of a holding company (FHCOPEXP), the total number of branches of an FHC group (FHCBRCH), and the total number of employees in an FHC group (FHCTL). Furthermore, the distribution of insurance products by banks, which is the concept of 'bancassurance', has been widely adopted by banks with allied insurance companies or insurance agents/ brokers. Therefore, this study defines the shared inputs between banking and insurance activities by the number of bank branches (BBRABCH) and the non-labour operating expenses of the bank (BOOPEXPSI).

In addition to the multi-activity DEA approach, this study also evaluates the overall operational efficiency of an FHC using the conventional DEA model for comparison purposes. The input items are therefore the total number of branches of an FHC group (FHCBRCH) and the sum of the expense items of all the subsidiaries (i.e., FHCTEXP = BTEXP + ITEXP + STEXP + OOPEXP + BOOPEXPSI). As to the output items, they include bank loans (BLAON) and the sum of revenue items of all the subsidiaries (i.e., FHCTREV = BNIINC + ITREV + STREV + OREV). The inputs and outputs of FHC used in this study are summarised in Table 3. For solution purposes we have restricted each β_p^t to lie in the range 0.1–0.7. This range was deemed reasonable by the management.

The data used in our study are drawn from the 2004 annual reports and the financial statements of the FHCs and their subsidiaries. Two FHCs were eliminated from the sample because they do not engage in banking and insurance activities (see Table 2). The final sample used to estimate efficiency consists of 12 FHCs that have banking, securities, and insurance subsidiaries all in operation. The descriptive statistics of 12 FHCs as of 2004 are reported in Table 4.

Empirical results

In this paper we investigate an FHC's operational efficiency from two perspectives: the conventional DEA approach and the multi-activity DEA approach. In the conventional DEA approach, we make the assumption that the purpose of the FHC is to determine the overall operational efficiency without regarding those subsidiaries' performances. In this situation, we use the traditional two-system DEA model to identify each FHC's

Table 3. Definitions of inputs and outputs.

	Inputs	Outputs
Banking	BTEXP: the sum of labour expense, interest expense, and non-interest expense	BLAON: loans, BNIINC: non-interest income
Insurance	IEQRES: insurance companies' surplus (i.e., owner's equity and various actuarial reserve funds) plus owner's equity of insurance agents/brokers ITEXP: sum of operating expense of both the insurance companies and insurance agents/brokers	ITREV: insurance companies' investment gains and interest income plus the operating revenue of insurance agents/brokers
Security	STEXP: sum of labour and capital expense SEQU: equity	STREV: sum of commission and non-commission revenue, including underwriting fees and trading gains
Others	OCAP: the aggregate assets of all subsidiaries under this category OOPEXP: the aggregate operating expense of all subsidiaries under this category	OREV: aggregate operating revenue of all subsidiaries under this category
Shared inputs (all subsidiaries)	FHCOPEXP: operating expense of the holding company FHCBRCH: total number of branches of an FHC group FHCTL: total number of employees in an FHC group	
Shared inputs (between banking and insurance)	BBRABCH: number of bank branches BOOPEXPSI: non-labour operating expense of the bank	
Overall FHCs (for comparison purposes)	FHCBRCH FHCTEXP = BTEXP + ITEXP + STEXP + OOPEXP + BOOPEXPSI	BLAON FHCTREV = BNIINC + ITREV + STREV + OREV

Table 4. Statistic descriptions of four FHC activities.

		Mean	Max	Min	SD
Specific inputs and outputs of each FHC subsidiary					
Banking					
Inputs	BTEXP*	$19,334,942	$37,856,975	$1,914,863	$12,214,850
Outputs	BLOAN*	$481,412,761	$1,007,962,798	$53,090,684	$317,786,615
	BNIINC*	$10,436,147	$24,594,855	$222,051	$7,364,630
Insurance					
Inputs	IEQRES*	$206,380,716	$1,511,822,217	$63,685	$464,298,909
	ITEXP*	$5,455,722	$36,663,396	$22,863	$10,782,262
Outputs	ITREV*	$12,465,299	$76,724,654	$122,903	$23,923,542
Security					
Inputs	STEXP*	$2,858,406	$6,014,088	$124,416	$2,141,328
	SEQU*	$12,134,353	$31,421,303	$3,190,252	$8,989,422
Outputs	STREV*	$3,911,701	$8,977,335	$60,335	$3,184,222
Others					
Inputs	OCAP*	$169,572,915	$1,102,461,309	$2,499,360	$307,013,531
	OOPEXP*	$8,897,097	$53,407,315	$502,905	$14,691,960
Outputs	OREV*	$12,893,095	$83,506,438	$549,930	$22,884,831
Shared inputs associated with FHC banking and insurance					
Inputs	BBRANCH	96	196	27	55
	BOOPEXPSI*	$4,896,854	$15,853,981	$446,302	$4,149,131
Shared inputs associated with all subsidiaries of FHCs					
Inputs	FHCBRCH	166	484	57	114
	FHCTL	10,298	31,879	2838	7846
	FHCOPEXP*	$246,407	$478,739	$49,663	$131,863
Overall FHC inputs and outputs					
Inputs	FHCBRCH	166	484	57	114
	FHCTEXP*	$41,443,021	$73,188,440	$13,113,566	$20,408,489
Outputs	BLOAN*	$481,412,761	$1,007,962,798	$53,090,684	$317,786,615
	FHCTREV*	$39,706,242	$99,034,861	$9,608,077	$30,095,486

*In 1000 NT dollars.

operational efficiency. The reason for using the two-system DEA model is because of the distinct characteristics between the insurance companies and the insurance agents/brokers. Given that some FHCs own both insurance companies and insurance agents/brokers while others only have insurance agents/brokers, this study divides the sample FHCs into two groups based on the types of their insurance subsidiaries. System A refers to those FHCs with both insurance companies and insurance agents/brokers, while System B refers to those FHCs that only have insurance agents or brokers. For more information about two-system DEA, see Cooper, Seiford, and Tone (2000).

In the multi-activity DEA approach, it is assumed that the FHC engages in several activities simultaneously and thus faces several production functions. In the perspective of subsidiaries' operations, we integrate the two-system DEA concept into a multi-activity DEA model to identify the subsidiary performance of each FHC. From the analysis, we are able to evaluate the overall efficiency of the FHCs as well as the efficiency among different subsidiaries.

All results are obtained using the CRS hyperbolic DEA model. In this paper, the acronyms *subsidiary*-A and *subsidiary*-B are used to refer to the DEA estimates of efficiencies relative to the Systems A and B frontier, respectively. The *subsidiary** is used to refer to the subsidiary operational efficiency of the overall system.

Table 5 shows the operational efficiencies obtained by the traditional DEA model and the two-system DEA model. The results of the traditional DEA model are reported in

Table 5. Traditional DEA and two-system DEA efficiency scores for FHCs.

	FHC-T	FHC*	FHC A	FHC B
System A				
FHC1	0.996	1.000	1.000	1.044
FHC2	0.946	0.971	0.971	1.016
FHC3	1.000	1.000	1.000	1.235
FHC4	0.948	0.968	0.968	1.072
FHC5	0.948	0.963	0.963	1.092
FHC6	1.000	1.000	1.000	1.191
Mean	0.973	0.984	0.984	1.108
Max	1.000	1.000	1.000	1.235
Min	0.946	0.963	0.963	1.016
System B				
FHC7	0.799	0.808	0.808	0.871
FHC8	0.853	0.889	0.889	0.895
FHC9	0.747	0.770	0.770	0.781
FHC10	1.000	1.000	1.257	1.000
FHC11	1.000	1.000	1.057	1.000
FHC12	0.898	0.907	0.907	1.000
Mean	0.883	0.896	0.948	0.925
Max	1.000	1.000	1.257	1.000
Min	0.747	0.770	0.770	0.781
Overall				
Mean	0.928	0.940	0.966	1.016
Max	1.000	1.000	1.257	1.235
Min	0.747	0.770	0.770	0.781

Note: FHC-T represents aggregate performance of FHC using the traditional DEA model and FHC* denotes aggregate performance of FHC using the two-system DEA model.

column FHC-T, while the results of the two-system DEA model are reported in column FHC*. Observing Table 5, the mean overall operational efficiency scores tend to decrease from 0.940 in the two-system DEA model to 0.928 in the traditional DEA model. Additionally, comparing the differences between the overall operational efficiency scores obtained by these two models, 9 out of 12 FHCs have less than 0.02 differences in absolute value. Only one FHC (i.e., FHC8) in the sample whose operational efficiency score produced by the traditional DEA model exceeds that of the two-system DEA model by more than 0.03. This indicates that these two models provide similar results in most cases.

Table 6 presents the efficiency scores of FHCs under the multi-activity DEA model. We find considerably larger differences between the overall operational efficiencies obtained by the two-system multi-activity DEA model and those by the two-system DEA model. Comparing the efficiency scores in column 2 of Table 5 with the figures in column 1 of Table 6, only 2 (FHC5 and FHC10, 16.7% of the sample) out of 12 FHCs whose absolute difference between the efficiency scores is less than 0.03. Most of the efficiency score differences are greater than 0.05. Moreover, note that for those FHCs in System A, their efficiency scores under the two-system multi-activity DEA model are mostly lower than those of the two-system DEA model. But for those FHCs in System B, most of their efficiency scores under the two-system multi-activity DEA model are higher than (or only slightly lower than) those of the two-system DEA model. Since the characteristics of the subsidiaries under the FHCs are different between Systems A and B, this result indicates that the relative efficiency of those subsidiaries will affect the aggregate efficiency measure of the FHCs.

Moreover, according to column 1 of Table 6, the operational efficiencies of System A's FHCs range from 0.812 to 0.970, with an average of 0.871. The efficiency scores of those FHCs in System B range from 0.816 to 0.981, with an average of 0.940. Observing the averages for these two systems, the average operational efficiency of System B's FHCs is larger. This implies that System B's FHCs dominate the other FHC types in overall operational efficiency.

The reason why System B's FHCs obtain higher efficiency scores under the multi-activity DEA model might lie in the characteristics of their subsidiaries. Therefore, Table 6 reports the efficiency scores of the four major financial activities (i.e., banking, insurance, securities, and 'others') under the two-system multi-activity DEA model. The efficiency scores of each subsidiary are reported under Systems A and B, respectively. Following the definition of the two-system DEA model, we obtain the operational efficiency of each subsidiary (i.e., *subsidiary**) by choosing the minimum efficiency score among the scores of Systems A and B.

In the 'Bank A' column, the efficiency frontier is measured based on those banks in System A. For those banks in System B with better performance than those in System A, their efficiency scores will be greater than one (e.g., banks of FHC10, FHC11, and FHC12). Similarly, in the 'Bank B' column, the efficiency frontier is measured based on those banks in System B. Those banks in System A with better performance than those in System B will produce an efficiency score greater than one. According to the 'Bank B' column, all the banks in System A have efficiency scores greater than one. It implies that banks in System A perform better than those in System B. The operational efficiency scores of the banking subsidiaries of overall system are shown in the 'Bank*' column. For example, according to the 'Bank*' column, the efficiency score of the bank in FHC2 is 0.993. It indicates that the bank in FHC2 is about 99.3% efficient when measured relative to the System A frontier. This means that outputs and inputs of

Table 6. Efficiency scores of FHC and its four subsidiaries and comparison of each subsidiary in two systems.

	Overall	Bank A	Bank B	Bank*	Insurance A	Insurance B	Insurance*	Security A	Security B	Security*	Others A	Others B	Others*
System A													
FHC1	0.813	0.959	1.228	0.959	0.595	0.450	0.450	0.961	0.892	0.892	0.949	1.045	0.949
FHC2	0.850	0.993	1.321	0.993	0.692	0.409	0.409	1.000	1.020	1.000	0.998	1.636	0.998
FHC3	0.954	0.995	5.580	0.995	0.889	6.741	0.889	0.930	0.951	0.930	1.000	1.581	1.000
FHC4	0.830	1.000	1.789	1.000	0.774	3.116	0.774	0.557	0.570	0.557	0.987	1.580	0.987
FHC5	0.970	1.000	2.603	1.000	1.000	2.264	1.000	1.000	1.023	1.000	0.878	0.880	0.878
FHC6	0.812	0.997	1.443	0.997	0.592	0.386	0.386	0.863	0.881	0.863	1.000	1.081	1.000
Mean	0.871	0.991	2.327	0.991	0.757	2.228	0.651	0.885	0.890	0.874	0.969	1.301	0.969
Max	0.970	1.000	5.580	1.000	1.000	6.741	1.000	1.000	1.023	1.000	1.000	1.636	1.000
Min	0.812	0.959	1.228	0.959	0.592	0.386	0.386	0.557	0.570	0.557	0.878	0.880	0.878
System B													
FHC7	0.979	0.875	0.920	0.875	3.741	1.000	1.000	1.121	1.000	1.000	1.010	1.000	1.000
FHC8	0.968	0.937	1.000	0.937	5.002	1.000	1.000	1.104	0.984	0.984	0.952	0.969	0.952
FHC9	0.816	0.774	0.958	0.774	3.840	0.768	0.768	0.999	0.957	0.957	0.765	0.791	0.765
FHC10	0.981	1.064	0.997	0.997	3.954	1.000	1.000	0.938	0.958	0.938	0.987	1.000	0.987
FHC11	0.945	1.215	1.000	1.000	2.184	1.000	1.000	0.778	0.795	0.778	1.064	1.000	1.000
FHC12	0.952	1.079	1.000	1.000	2.068	1.000	1.000	0.909	0.930	0.909	0.900	0.936	0.900
Mean	0.940	0.991	0.979	0.931	3.465	0.968	0.968	0.975	0.937	0.928	0.946	0.949	0.934
Max	0.981	1.215	1.000	1.000	5.002	1.000	1.000	1.121	1.000	1.000	1.064	1.000	1.000
Min	0.816	0.774	0.920	0.774	2.068	0.768	0.768	0.778	0.795	0.778	0.765	0.791	0.765
Overall													
Mean	0.906	0.991	1.653	0.961	2.111	1.598	0.810	0.930	0.913	0.901	0.958	1.125	0.951
Max	0.981	1.215	5.580	1.000	5.002	6.741	1.000	1.121	1.023	1.000	1.064	1.636	1.000
Min	0.812	0.774	0.920	0.774	0.592	0.386	0.386	0.557	0.570	0.557	0.765	0.791	0.765

Note: System A includes FHC1–FHC6 and System B includes FHC7–FHC12.

banking of the FHC2 is approximately 99.3% in the rate of increase of outputs and decrease of inputs simultaneously given the production technology available in System A.

Following the same logic, the subsidiary efficiency scores of the overall system for the insurance, securities, and 'others' activities are reported in columns 'Insurance*', 'Security*', and 'Others*', respectively. For the insurance activities, those insurance activities in System A generally obtain lower efficiency scores than those in System B. As mentioned earlier, System A refers to those FHCs with both insurance companies and insurance agents/brokers, while System B refers to those FHCs that only have insurance agents or brokers. The results in Table 6 indicate that those who engage in insurance activities by both insurance companies and insurance agents/brokers are relatively less efficient than those who only have insurance agents or brokers. Insurance agents or brokers with allied banks under the same holding company structure can use the existing bank branches and share certain facilities. The costs of insurance agents/brokers are therefore minimised and thus their efficiency is improved. This finding is consistent with Brockett et al. (2005, pp. 393–412), who evaluated the possible efficiency differences between 'agency' versus 'direct sales' type of marketing distribution systems of insurance companies. In their terminology, the 'agency' type refers to those independent agents. The rest will be regarded as 'direct sales' type (directly represents a single insurer), which includes the salespersons who are employees of the insurer. They found that the agency type is more efficient than the direct sales type, and the result is robust regardless of their organisational structure.

For the security subsidiaries, the average efficiency scores of those security subsidiaries in System A are lower than those in System B. However, the lower average efficiency scores of System A may be due to the lower efficiency score of the security firm of FHC4, with only 0.557. One possible reason is that the security firm of FHC4 was established in May 2004 and it had not fully utilised its resources for that year. We expect that the ranking of its security firm may change in later years when the security firm in FHC4 has had more time to develop business models and allocate resources more efficiently. As to the 'others' category, there is not much difference between Systems A and B in terms of average efficiency scores. The 'others' activity of FHC9 obtained the lowest efficiency score. Because the major activities of FHC9 are security related, it has limited varieties of financial activities compared with other FHCs.

Managerial implications

Using the multi-activity DEA approach, this study evaluates the overall efficiency of the FHCs, as well as the efficiency of the various subsidiaries. Based on the analysis of the level of performance of those subsidiaries of the FHCs, one can gain further insights from the estimated results and thus propose strategies for improving operational performance. For example, the results in Table 6 indicate that those who engage in insurance activities using both insurance companies and insurance agents/brokers are relatively less efficient than those who only have insurance agents or brokers. The results suggest that a combination of banks and insurance agents/brokers may be more efficient for the 'bancassurance' businesses, given that the insurance agents/brokers can utilise the existing bank branches and share certain facilities. The fact is that most FHCs with banks and insurance companies in 2004 had separate distribution channels and different systems. Therefore, in order to improve an FHC's overall performance, it is suggested that the integration of resources between banks and insurance companies should be implemented.

Table 7. Efficiency scores and ranking of FHC and its four subsidiaries.

Overall			Banking			Insurance			Security			Others		
Ranking	Code	Score	Ranking	Code	Score	Ranking	Code	Score	Ranking	Code	Score	Ranking	Code	Score
1	FHC10	0.981	1	FHC12	1	1	FHC7	1	1	FHC7	1	1	FHC11	1
2	FHC7	0.979	1	FHC11	1	1	FHC12	1	1	FHC5	1	1	FHC7	1
3	FHC5	0.970	1	FHC5	1	1	FHC11	1	1	FHC2	1	1	FHC6	1
4	FHC8	0.968	1	FHC4	1	1	FHC10	1	4	FHC8	0.984	1	FHC3	1
5	FHC3	0.954	5	FHC10	0.997	1	FHC8	1	5	FHC9	0.957	5	FHC2	0.998
6	FHC12	0.952	5	FHC6	0.997	1	FHC5	1	6	FHC10	0.938	6	FHC10	0.987
7	FHC11	0.945	7	FHC3	0.995	7	FHC3	0.889	7	FHC3	0.930	7	FHC4	0.987
8	FHC2	0.850	8	FHC2	0.993	8	FHC4	0.774	8	FHC12	0.909	8	FHC8	0.952
9	FHC4	0.830	9	FHC1	0.959	9	FHC9	0.768	9	FHC1	0.892	9	FHC1	0.949
10	FHC9	0.816	10	FHC8	0.937	10	FHC1	0.450	10	FHC6	0.863	10	FHC12	0.900
11	FHC1	0.813	11	FHC7	0.875	11	FHC2	0.409	11	FHC11	0.778	11	FHC5	0.878
12	FHC6	0.812	12	FHC9	0.774	12	FHC6	0.386	12	FHC4	0.557	12	FHC9	0.765

Note: The rankings of FHCs are based on their overall efficiency scores in column 1. The rankings of four subsidiaries are based on the efficiency scores of the overall systems (Bank*, Insurance*, Security*, and Others*).

Moreover, this study does not suggest that the results of the multi-activity DEA approach are more accurate or any better than those of the conventional DEA model. However, our results do show that the multi-activity DEA model can offer more information than the conventional DEA approach. From the multi-activity DEA analysis, the researcher can not only obtain the overall efficiency rankings of the FHCs, but can also identify the relative strengths of each subsidiary under an FHC. A given FHC may choose to devote its efforts to the relatively efficient subsidiaries. For those subsidiaries performing at a less than satisfactory level, the group can either find a way to improve performance, or de-emphasise or even abandon those portions of the business.

For purposes of illustration, the rankings of FHCs and the four subsidiaries are listed in Table 7. FHC10 has the highest overall ranking, with its bank ranked fifth, insurance first, securities activity sixth, and 'others' activity sixth. FHC7 has the second-highest ranking. From multi-activity DEA analysis, the research shows that FHC7 has the most efficient subsidiaries in the insurance, security, and 'others' categories, although its ranking for banking activities is among the lowest. Given that the source of inefficiencies may be due to the bad debts of credit cards and cash cards, it is suggested that credit risk control should be enhanced in the credit card and cash card departments.

On the other hand, FHC6 has the lowest overall ranking, but their banking activity (ranked fifth) and others activity (ranked first) are relatively efficient. The inefficiency of security (ranked third-lowest) and insurance (the lowest-ranking) activities is the reason behind the overall inefficiency. Therefore, FHC6 should make use of its comparative advantages in the banking sector and other financial activities, such as bills financing, asset management, venture capital, etc. On the other hand, FHC6 should improve the performance of its security and insurance activities. Given that the security firm of FHC6 is a merger of three existing security firms in 2003, this new security firm may be still have been in the consolidation stage in 2004 and thus the available resources had not been efficiently allocated. Concerning the insurance activity, according to the rating list of Taiwan Ratings Corporation, the insurance company of FHC6 is among the lowest ranking of all the insurance companies of the FHCs. Taiwan Ratings Corporation is Taiwan's first credit rating services organisation and provides independent and objective assessments of the ability of banks, bills finance companies, and securities firms. The report of Taiwan Ratings Corporation indicates that the integration within the group has been relatively slow and that therefore, group synergies have been limited. As a result, this study suggests that FHC6 should increase its pace of integration and utilise its group resources to support its subsidiaries.

Therefore, the multi-activity DEA model is obviously more capable of identifying sources of inefficiency among the subsidiaries. For specific subsidiaries, the measures can point to those that are doing well, and also those that require attention. Such evaluation can aid the management in identifying the extent to which overall performance can be improved.

Conclusion

This study evaluates the relative efficiency of 12 FHCs in 2004 using the two-system multi-activity DEA approach. All results are obtained using the CRS hyperbolic DEA model. The FHCs under evaluation may perform a variety of functions or may be separated into several subsidiaries. Hence, the multi-activity DEA model provides an efficiency evaluator with activity-based information as part of the aggregate efficiency measure. Our results suggest that the multi-activity DEA model is more capable of identifying sources of inefficiency, thereby potentially yielding greater managerial insights into organisational improvements.

Regarding future research directions, it would be interesting to see the efficiency changes of FHCs in Taiwan over time. In addition, using multi-activity DEA analysis, we can further analyse whether those subsidiaries have marked improvements in performance after joining the new holding company structure. Moreover, given that one major purpose of the holding company structure is 'resource integration and reallocation', further discussion on the benefits of sharing resources and inputs among subsidiaries after they join the holding company is also of interest.

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