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Performance measurement of Taiwan financial holding companies: An additive efficiency decomposition approach

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ABSTRACT

Financial holding companies in Taiwan play an important role in the process of economic development. Facing the financial globalization and market liberalization, competition between financial holding companies is growing. In data envelopment analysis (DEA) studies, the efficiency measurement can have a two-stage structure. A common approach to the two-stage problem is to apply a standard DEA model separately in each stage; such approaches treat the stages in a two-stage process as operating independently of one another. Different from previous studies, this paper takes the series relationship of the two individual stages into account in measuring the profitability and marketability efficiencies of the Taiwan financial holding companies. It is found that the overall efficiencies of all financial holding companies are inefficient and the low efficiency score of the whole process is mainly due to the low efficiency score of the marketability process. Decomposing the overall efficiency into the component efficiencies helps a company identify the stage that causes inefficiency.

1. Introduction

In Taiwan, the Financial Holding Company Act was signed into law. The Act permits banks, insurance companies, securities firms, and other financial institutions to affiliate under common ownership and offer their customers a complete range of financial services. Since the fences across among securities, insurance, and banking sectors have been removed, the operation modes and structures of the banking industry have changed. Facing the financial globalization and market liberalization, competition between financial holding companies is growing. Most bank efficiency studies employ only profitability efficiency (profit generating) evaluation, ignoring the market efficiency (market value increasing) in banking industry. While profitability efficiency is important for a financial institution, marketability efficiency is also critical given the fact that the real value of a financial institution should be ultimately defined by the current stock market (Luo, 2003; Seiford & Zhu, 1999). This paper analyzes the profitability and marketability efficiencies of Taiwan financial holding companies. The efficiency index is useful for evaluating the impact of performance on financial holding companies and detecting the weak areas so that appropriate efforts can be devoted to improve performance.

Data envelopment analysis (DEA), developed by Charnes, Cooper, and Rhodes (1978), is a well established nonparametric approach used to evaluate the relative efficiency of a set of comparable entities called decision making units (DMUs) with multiple inputs and outputs. Numerous DEA theoretical and application studies have been reported, such as Färe, Grosskopf, and Lovell (1994), Seiford (1996), Cooper, Seiford, and Tone (2000). The efficiency performance of the financial industry has been a critical research stream that draws considerable attention from both academicians and policy makers (Aly, Grabowski, Pasurka, & Rangan, 1990; Bauer, Berger, Ferrier, & Humphrey, 1998; Berger & DeYoung, 1997; Berger & Humphrey, 1997; Bhattacharyya, Lovell, & Sahay, 1997; Bonin, Hasan, & Wachtel, 2005; Chiu & Chen, 2009; Elyasiani & Mehdian, 1990; Giokas, 2008; Havrylchyk, 2006; Kao & Liu, 2004; Kao & Liu, 2009; Liu, 2009; Luo, 2003; Miller & Noulas, 1996; Rezitis, 2008; Rezvanian & Mehdian, 2002; Seiford & Zhu, 1999; Sherman & Ladino, 1995; Valverde, Humphrey, & Paso, 2007; Worthington, 2004; Yeh, 1996; Yue, 1992).

One type of DEA studies measures the efficiency via a two-stage structure where the first stage uses inputs to generate outputs that then become the inputs to the second stage. The second stage employs these outputs of the first stage as the inputs to produce its own outputs. For examples, Luo, 2003 and Seiford and Zhu (1999) measure the profitability and marketability efficiencies of US commercial banks via a two-stage DEA process, respectively. Their methods measure the profitability in the first stage using employee, assets and shareholders' equity as inputs, and the outputs are revenues and profits. In the second stage for marketability, the revenues and profits are then utilized as inputs, while market value, total return on investments, and earnings per share are used as outputs. The efficiencies of the first stage, second stage, and the

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whole production process are calculated via three independent DEA models. Although they provide good ideas of performance evaluation for the financial institutions, they do not consider the relationship between the stages and the whole system. Different from previous studies, this paper adopts the method of Chen, Cook, Li, and Zhu (2009) to take the series relationship of the two individual stages into account in measuring the profitability and marketability efficiencies of Taiwan financial holding companies. Using the relational DEA approach to calculate the efficiencies are more meaningful. This study might help the financial holding companies utilize their resources effectively and improve their operating efficiency.

The rest of this paper is organized as follows. We first introduce the approach of additive efficiency decomposition proposed by Chen et al. (2009).Then we have a brief description of Taiwan financial holding companies. Next, we calculate and analyze the efficiencies of the 14 financial holding companies in Taiwan, and finally, the results are discussed and some conclusions drawn from the discussion.

2. Two-stage DEA model

Since the pioneer work of Charnes et al. (1978), DEA has been widely applied to measuring the relative efficiencies of a set of DMUs utilizing the same inputs to produce the same outputs. One form of their model for measuring the efficiency of DMU k is:

$$E_k = \max \quad \sum_{r=1}^{s} u_r Y_{rk} \Big/ \sum_{i=1}^{m} v_i X_{ik} \tag{1}$$
$$\text{s.t.} \quad \sum_{r=1}^{s} u_r Y_{rj} \Big/ \sum_{i=1}^{m} v_i X_{ij} \leqslant 1, \quad j = 1, \ldots, n,$$
$$u_r, v_j \geqslant \varepsilon, \quad r = 1, \ldots, s, \quad i = 1, \ldots, m,$$

where X_{ij} is the amount of ith input ($i = 1,\ldots,m$) of the jth DMU, Y_{rj} is the amount of the rth output ($r = 1,\ldots,s$) of the jth DMU, u_r is the multiplier (weight) given to the rth output, v_j is the multiplier (weight) given to the jth input, there are n DMUs, and ε is a small non-Archimedean number (Charnes & Cooper, 1984). Note that Model (1) is a linear fractional program that is transformable into a linear program:

$$E_k = \max \sum_{r=1}^{s} u_r Y_{rk} \tag{2}$$
$$\text{s.t.} \quad \sum_{i=1}^{m} v_i X_{ik} = 1,$$
$$\sum_{r=1}^{s} u_r Y_{rk} - \sum_{i=1}^{m} v_i X_{ik} \leqslant 0, \quad j = 1, \ldots, n,$$
$$u_r, v_j \geqslant \varepsilon, \quad r = 1, \ldots, s, \quad i = 1, \ldots, m.$$

Therefore, one can apply the conventional linear programming method to solve E_k.

Consider a two-stage process shown in Fig. 1. The whole process uses m inputs X_{ik}, $i = 1,\ldots,m$ to produce s outputs Y_{rk}, $r = 1,\ldots,s$.

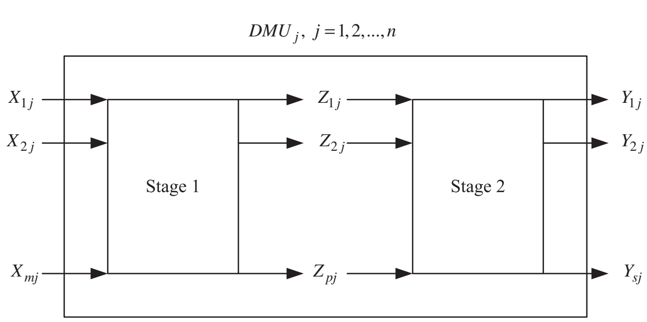

Fig. 1. DEA with two-stage process.

Different from the conventional one-stage production process, the production process is composed of two sub-processes with q intermediate measures Z_{pk}, $p = 1,\ldots,q$. Moreover, the intermediate measures Z_{pk} are the outputs of stage 1 as well as the inputs of stage 2. The conventional two-stage DEA study is to use Model (1) to measure the overall efficiency and the following Models (3) and (4) to measure the efficiencies of stage 1, E_k^1, and stage 2, E_k^2, respectively:

$$E_k^1 = \max \sum_{r=1}^{s} w_p Z_{pk} \Big/ \sum_{i=1}^{m} v_i X_{ik} \tag{3}$$
$$\text{s.t.} \sum_{p=1}^{q} w_p Z_{pj} \Big/ \sum_{i=1}^{m} v_i X_{ij} \leqslant 1, \quad j = 1, \ldots, n,$$
$$w_p, v_i \geqslant \varepsilon, \quad p = 1, \ldots, q, \quad i = 1, \ldots, m,$$

$$E_k^2 = \max \sum_{r=1}^{s} u_r Y_{rk} \Big/ \sum_{p=1}^{q} w_p Z_{pk} \tag{4}$$
$$\text{s.t.} \sum_{r=1}^{s} u_r Y_{rj} \Big/ \sum_{p=1}^{q} w_p Z_{pj} \leqslant 1, \quad j = 1, \ldots, n,$$
$$u_r, w_p \geqslant \varepsilon, \quad r = 1, \ldots, s, \quad p = 1, \ldots, q.$$

These two models are essentially the same as Model (1). The efficiencies of the whole process and the two sub-processes (stages) are calculated independently.

To link the two sub-processes with the whole processes, Chen et al. (2009) assume that overall efficiency of the two sub-processes is a weighted sum of efficiencies of the two individual stages. They propose deriving the overall efficiency of the process by solving the following problem:

$$E_k = \max \left[w_1 \sum_{r=1}^{s} w_p Z_{pk} \Big/ \sum_{i=1}^{m} v_i X_{ik} + w_2 \sum_{r=1}^{s} u_r Y_{rk} \Big/ \sum_{p=1}^{q} w_p Z_{pk} \right] \tag{5}$$
$$\text{s.t.} \sum_{p=1}^{q} w_p Z_{pj} \Big/ \sum_{i=1}^{m} v_i X_{ij} \leqslant 1, \quad j = 1, \ldots, n,$$
$$\sum_{r=1}^{s} u_r Y_{rj} \Big/ \sum_{p=1}^{q} w_p Z_{pj} \leqslant 1, \quad j = 1, \ldots, n,$$
$$u_r, v_i, w_p \geqslant \varepsilon, \quad r = 1, \ldots, s, \quad i = 1, \ldots, m, \quad p = 1, \ldots, q.$$

Since w_1 and w_2 are intended to represent the relative importance or contribution of the performances of stages 1 and 2 to the overall performance of the DMU, respectively, Chen et al. (2009) utilize the portion of total resources devoted to each stage to reflect its importance. Letting $\sum_{i=1}^{m} v_i X_{ik} + \sum_{p=1}^{q} w_p Z_{pk}$ represent the total size of the two-stage process, and $\sum_{i=1}^{m} v_i X_{ik}$ and $\sum_{p=1}^{q} w_p Z_{pk}$, the size of stages 1 and 2, respectively, the values of w_1 and w_2 are defined as

$$w_1 = \sum_{i=1}^{m} v_i X_{ik} \Big/ \left(\sum_{i=1}^{m} v_i X_{ik} + \sum_{p=1}^{q} w_p Z_{pk} \right), \tag{6a}$$

$$w_2 = \sum_{r=1}^{s} w_p Z_{pk} \Big/ \left(\sum_{i=1}^{m} v_i X_{ik} + \sum_{p=1}^{q} w_p Z_{pk} \right). \tag{6b}$$

Putting the values w_2 and w_2, which are derived from (6a) and (6b), we have the following mathematical form:

$$E_k = \max \left(\sum_{r=1}^{s} w_p Z_{pk} + \sum_{r=1}^{s} u_r Y_{rk} \right) \Big/ \left(\sum_{i=1}^{m} v_i X_{ik} + \sum_{r=1}^{s} w_p Z_{pk} \right) \tag{7}$$
$$\text{s.t.} \sum_{p=1}^{q} w_p Z_{pj} \Big/ \sum_{i=1}^{m} v_i X_{ij} \leqslant 1, \quad j = 1, \ldots, n,$$
$$\sum_{r=1}^{s} u_r Y_{rj} \Big/ \sum_{p=1}^{q} w_p Z_{pj} \leqslant 1, \quad j = 1, \ldots, n,$$
$$u_r, v_i, w_p \geqslant \varepsilon, \quad r = 1, \ldots, s, \quad i = 1, \ldots, m, \quad p = 1, \ldots, q.$$