European Journal of Operational Research 235 (2014) 755–764

Contents lists available at ScienceDirect

European Journal of Operational Research

journal homepage: www.elsevier.com/locate/ejor

Innovative Applications of O.R.

Measuring performance improvement of Taiwanese commercial banks under uncertainty

Chiang Kao [a,*], Shiang-Tai Liu [b]

[a] Department of Industrial and Information Management, National Cheng Kung University, Tainan, Taiwan, ROC
[b] Graduate School of Business and Management, Vanung University, Chung-Li, Taiwan, ROC

ARTICLE INFO

Article history:
Received 18 February 2013
Accepted 7 November 2013
Available online 16 November 2013

Keywords:
Data envelopment analysis
Malmquist productivity index
Probability
Uncertainty

ABSTRACT

In order to enable domestic commercial banks to be more competitive globally, the Taiwanese government has twice attempted to financially restructure them, in 2001 and 2004. Different from other studies which use deterministic analyses to measure changes in performance between two periods, this paper adopts probabilistic analysis to take the uncertainty related to certain factors into account. Data from six years, from 2005 to 2010, are divided into two periods, 2005–2007 and 2008–2010, to calculate the global Malmquist productivity index (MPI) as a measure of the change in performance. By assuming beta distributions for the data, a Monte Carlo simulation is conducted to find the distribution of the MPI. The results show that, in general, the performance of the commercial banks has indeed improved. While conventional deterministic analyses may mislead top managers and make them overconfident about results that are actually uncertain, probabilistic analysis can produce more reliable information that can thus lead to better decisions.

1. Introduction

After the recent global financial crisis, the financial condition of banks has attracted increased government attention. In addition, due to the globalization of financial markets, financial institutions face an increasingly competitive environment. This is particularly true in Taiwan, as it is a small island where foreign trade accounts for a large portion of its economic activities. Banks in Taiwan, as well as other countries, must thus work to operate more efficiently to face these challenges.

Ways to measure the efficiency of banks have been widely discussed in the literature, with Berger and Humphrey (1997) and Fethi and Pasiouras (2010) providing extensive surveys of the related works. At each period of time the relative efficiency of a bank can be measured by different methods. However, since most methods measure the efficiency in a relative manner, the values calculated for different periods are not comparable. It is thus possible that a bank has a greater efficiency score in a later period, although its performance has actually declined. It is also possible that a bank has a lower score in a later period, while its performance has actually improved. Caves, Christensen, and Diewert (1982) thus proposed the Malmquist productivity index (MPI), which is the ratio of the efficiencies of two periods calculated from the production technology of the former period, in order to make the relative efficiency measures of two periods comparable, and can be used to measure changes in efficiency.

The MPI has been widely applied to measure changes in performance of financial institutions, especially due to a specific act or policy. For example, it has been used to examine the effects of the deregulation of financial markets on Turkish banks (Isik & Hassan, 2003), mergers and acquisitions among Greek banks (Rezitis, 2008) and the US property–liability insurance companies (Cummins & Xie, 2008), the impacts of the Sarbanes-Oxley Act on US accounting firms (Chang, Choy, Cooper, & Ruefli, 2009), and the Single Market Project of the European Commission on German insurance companies (Mahlberg & Url, 2010). The MPI produces a deterministic value, indicating with 100% certainty that the performance of a bank has either improved or worsened. However, since the real world is full of uncertainty, and the operation of banking institutions involves high externalities which lead to uncertain results, the data collected at specific time points are just instances of a probabilistic phenomenon. Consequently, the associated MPI is also probabilistic.

Even if the environment is certain, the values of the data in many cases are not precise for other reasons. For example, if data is missing, then its value must be estimated; if a situation has not occurred yet, then a value must be predicted; or if the value cannot be measured precisely, such as the volume of a tree (due to its irregular shape), then the most likely value is used. As a result, the calculated MPI is a most likely value, rather than a deterministic one, and if the estimated value is not a correct

* Corresponding author. Tel.: +886 6 2753396.
E-mail addresses: ckao@mail.ncku.edu.tw (C. Kao), stliu@vnu.edu.tw (S.-T. Liu).

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http://dx.doi.org/10.1016/j.ejor.2013.11.006

representation of the true situation, then the resulting MPI will not be correct, either. Consequently, the simulation analysis of Giraleas, Emrouznejad, and Thanassoulis (2012) shows that a significantly large measurement error will lead to estimates of MPIs that are unreliable for policy purposes.

In addition to the data itself, different ways of calculating the MPI may also lead to different values. For example, the MPI proposed by Caves et al. (1982) uses the earlier period as the base one for calculation, although the later period can also be used for this. Färe, Grosskopf, Norris, and Zhang (1994) used the geometric mean of the two MPIs calculated from different base periods as the final MPI. Pastor and Lovell (2005) proposed a global MPI by using the overall production technology constructed from the observations of all periods for calculation. The MPIs calculated from different base periods not only may be different, but sometimes they may even be inconsistent; that is, one MPI may show an improvement, while the other indicates a decline (see Kao (2010) for an example of this), which implies that it is inappropriate to represent the MPI with a single value. Therefore, a probabilistic analysis which shows the probability that a DMU has improved, or declined, between two periods, is desirable.

There are several studies that calculate the MPI by employing stochastic frontier analysis (Abdul-Majid, Saal, & Battisti, 2011; Feng & Zhang, 2012; Fuentes, Grifell-Tatje, & Perelman, 2001), although the results of this are deterministic. While Chambers (2008) defined productivity measures for stochastic cases and derived superlative approximations to these stochastic measures, these are still precise values. Eslami, Khodabakhshi, Jahanshahloo, Hosseinzadeh, and Khoveyni (2012) discussed a case of fuzzy constraints and stochastic data, where the uncertain condition is converted to a certain one; the calculated MPI is also deterministic.

In this paper we will use a probabilistic analysis to find the distribution of the MPI, the results of which are more informative and so can be used to make better decisions. For example, a probability of performance improvement greater than 0.5 may still be associated with a performance that has in fact declined. While deterministic analysis may misleadingly indicate a definite improvement, probabilistic analysis can alert decision makers to the uncertainties underlying such results, and thus highlight the need for a more careful inspection of the variations of the inputs and outputs in order to derive better policies.

Simar and Wilson (1998, 2000, 2007) proposed a bootstrap strategy to analyze the sensitivity of efficiency scores relative to the sampling variations of the estimated frontier. The potential biases when using conventional efficiency measures to estimate the true efficiency scores can be calculated, and the related confidence intervals can then be constructed. The bootstrapping of MPIs has also been reported (Simar & Wilson, 1999), and the major difference between this approach and the one proposed in this paper is the underlying assumption of the related distribution functions. The approach presented in this work requires several observations to estimate the corresponding distributions, whereas the bootstrap approach does not. However, the proposed method is easier to carry out, as the number of linear programs that need to be solved is only half that required with bootstrapping.

Taiwan is a newly industrialized country, and its rapid economic development since the 1990s has won it the title of one of "The Four Dragons in Asia." As of December 2012, its foreign reserves of 403.17 billion US dollars were ranked sixth in the world. In order to handle the growth of financial-related businesses and consolidate the concept of free competition, the government opened the market for new banks in 1991. This resulted in many small banks suffering from poor financial conditions, especially with regard to non-performing loans. To solve this problem, the government launched a process of regulatory banking reforms in 2001, officially called the "First Financial Restructuring", with the aims of decreasing the non-performing loan ratio of these financial institutions to below 5%, and increasing the capital adequacy ratio to above 8% within two years.

To expedite the effects of these reforms, the government launched the "Second Financial Restructuring" in 2004 with four major aims. The first was to have at least three financial holding companies whose market shares were greater than 10% in 2005. The second was to reduce the number of government-owned financial institutions from twelve to six in 2005. The third was to cut the number of financial holding companies by half, down to seven, in 2005. The last was to bring in foreign investors to at least one holding company. The overall aim of the government was to provide a sound financial environment for companies to manufacture products and provide services, so that Taiwan's economy could continue growing steadily. Hsiao, Chang, Cianci, and Huang (2010) found improvements in the performance of commercial banks in the post-reform period (2004–2005), as compared to period during which the reforms were being implemented (2002–2003). After the second financial restructuring in 2005, 23 commercial banks remained. The government is obviously eager to know whether the performance of these banks has continued to improve since 2005. This paper thus measures the changes in their performance for the period 2005–2010. The results of this work will not only be helpful for the Taiwanese government, but also for other countries that are considering similar policies.

The next section reviews several studies related to evaluating the performance of Taiwanese banks. Section 3 then explains the global MPI used in this paper in some detail. The two approaches, analytical and numerical, for obtaining the distribution of the probabilistic MPI are explained in Section 4. After that, the performance changes of the commercial banks in Taiwan after the second financial restructuring are investigated in Section 5, where the results are also analyzed. Finally, in Section 6, some conclusions are drawn based on the results of this work.

2. Literature review

The literature contains a number of studies related to evaluating the performance of Taiwanese banks. Huang (2000) used a multi-product translog normalized shadow profit function to examine *X*-efficiency in the Taiwanese banking industry with a panel data from 22 banks, spanning the period 1981–1995. The results indicated that larger banks tend to be more technically efficient than smaller ones. The data also showed strong technical progress during the sample period, although the model without *X*-inefficiency did not find this.

Kao and Liu (2004) predicted the performance of 24 commercial banks in Taiwan based on their financial forecasts using a data envelopment analysis (DEA) approach. They found that all the efficiency scores calculated from the data contained in the subsequent financial statements published fell within the predicted ranges. Their results also showed that the poor performances of the two banks that were taken over by the Financial Restructuring Fund could actually be predicted using their approach.

Lin, Hsu, and Hsiao (2007) adopted DEA and the Malmquist index to measure the relative efficiency of management and variations in this, respectively, among 37 Taiwanese banks for the period 2002–2003. Six banks obtained a perfect efficiency score of 1, and 20 banks had a Malmquist index greater than 1. Based on these two measures the 37 banks were classified into eight categories, and the reasons for this were also discussed.

Chiu, Jan, Shen, and Wang (2008) employed the DEA technique to examine whether a bank's technical efficiency changed significantly when capital adequacy was specified for 46 Taiwanese banks over the period 2000–2002. The major findings were that