

Efficiency, Effectiveness and Risk in Australian Banking Industry

Amir Moradi-Motlagh* , Ali Salman Saleh** , Amir Abdekhodae*** and Mehran Ektesabi****

This paper analyses three aspects of profitability of banking industry in Australia over the period from 2000 to 2010. Using a three-stage Data Envelopment analysis (DEA) technique, we measure sources of profitability, which are risk, efficiency and effectiveness. This study utilizes a DuPont financial ratio analysis method to determine inputs and outputs variables of the DEA model. We break profitability to three main components as follows; risk, efficiency and effectiveness. By doing so, this decomposition enhances our understanding about the sources of the profitability. Results from the DEA model indicate that the effectiveness of the large banks is greater than the small sized banks. On the contrary, the small sized banks are able to achieve higher efficiency scores. In addition, some banks gain their profit due to taking higher risk rather than others which might not be sustainable in the longer term. The results demonstrate as well that the averages of the risk scores of the small sized banks are greater than large banks during the study period.

Field of Research: Banking, Data Envelopment Analysis, Efficiency, Effectiveness, Risk

1. Introduction

There is no doubt that banking industry plays a central role in the economy. For instance, in Australia, in June 2010, the financial sector has had the most market capitalisation among the other sectors with 35 per cent of the whole capital in the market. Due to this key position, measuring banks performance has been an issue of major interest for academics, managers, policy makers and stockholders. Therefore, many studies have recently focused on performance and efficiency of banking industries (See Fethi and Pasiouras 2010 for review of 196 studies in assessing bank performance). Most bank performance studies focus only on different aspect of performance, neglecting the effect of risk in their analyses (eg, Sathy 2001, Luo 2003, Kirkwood and Nahm 2006, Paul and Kourouche 2008). A study of banks performance regarding to the risk is significant due to the effect of risk factors in the long term profit. Raise in the profit can be achieved with a high risk, thus it is interesting to detect the source of profit.

*Amir Moradi-Motlagh, Faculty of Engineering and Industrial Sciences, Swinburne University of Technology, Melbourne, Australia, email: amoradimotlagh@swin.edu.au

**Dr. Ali Salman Saleh, Faculty of Business and Enterprise, Swinburne University of Technology, Melbourne, Australia, email: asaleh@swin.edu.au

***Dr. Amir Abdekhodae, Faculty of Engineering and Industrial Sciences, Swinburne University of Technology, Melbourne, Australia, email: aabdekhodae@swin.edu.au

****Dr. Mehran Ektesabi, Faculty of Engineering and Industrial Sciences, Swinburne University of Technology, Melbourne, Australia, email: mektesabi@swin.edu.au

Moradi-Motlagh, Saleh, Abdekhodae & Ektesabi

Given the above issues, this paper attempts to extend the current performance literature in banking industry by evaluating the trend of Australian banks profitability in term of performance and risk by using Data Envelopment Analysis (DEA) method which is a mathematical programming technique to measure the performance of organizations in compare to frontiers in the sample. This study is unique due to the study period and also, it is the first study in Australian banking industry which measures three factors of the profitability (risk, efficiency and effectiveness) using a nonparametric technique.

Six Australian banks based on the market value in the Australian Stock Exchange (ASX) are considered in this paper. Names and abbreviations have been used in this study are demonstrated in Table 1. To maintain consistency in the sample, we removed Macquarie bank and Suncorp from the list as their non interest incomes are higher than that those of interest incomes.

Table 1: Banks in the sample study

DMU	Name of Bank	Abbreviation	Category
1	Australia and New Zealand Bank	ANZ	Large
2	Commonwealth Bank	CBA	Large
3	National Australian Bank	NAB	Large
4	Westpac	WBC	Large
5	Bank of Queensland	BOQ	Small
6	Bendigo and Adelaide Bank	BEN	Small

The remainder of the paper is organised as follows: Section 2 reviews the use of the DEA in measuring performance of the bank industry. Section 3 provides a brief overview of the DEA methodology and discusses the developed model. Section 4 presents empirical results of measuring performance and risk for the sample banks. Section 5 summarizes and concludes the study.

2. Literature Review

There are many applications of Data Envelopment Analysis in measuring the performance of the bank industry. For example, Fethi and Pasiouras (2010) survey shows that recent DEA studies have examined almost all of the banking sectors around the world. DEA has been used widely to measure profit efficiency, technical efficiency, allocative efficiency, scale efficiency, effectiveness and productivity of banks. Table 2 illustrates a summary of its applications.

There is a considerable amount of discussions regarding the selection of input and output variables for banks. Nevertheless, Berger and Humphrey (1997) argue that neither of approaches is perfect. Moreover, Soteriou and Zenios (1999) emphasise that details on inputs and outputs of each model, can be determined based on the specific questions at hand, and the availability of data. In this section, because of many applications of DEA method in the banking sector, we focus only on studies which measure the performance of Australian banks as well as those which have been implemented by using a multi-stage DEA analysis in various counties.

One of the advantages of DEA is the ability of this nonparametric method to work with small samples and because of limited number of banks in Australia, DEA has become more prevalent technique to measure the performance of banks in this

Moradi-Motlagh, Saleh, Abdekhodae & Ektesabi

country (Avkiran 1999, Avkiran 2000, Kirkwood and Nahm 2006, Neal 2004, Paul and Kourouche 2008). Even though, there are some studies in Australia which focused on measuring performance in banks, none of them have measured performance and risk together as two key factors of profitability.

Avkiran (1999) measures operating efficiencies, employee productivity, profit performance and average relative efficiency using DEA for Australian trading banks from 1986 to 1995. In 2000, he also in the same study period examines the changes in productivity of 10 Australian banks. Avkiran (2000) measures the effect of technological progress in total productivity and concludes it is more than technical efficiency especially for major banks.

Recently, more studies have been conducted on the performance of Australian banks, especially, after 2000. For example, Sathye (2002) similar to Avakiran in 2000 analyses the change in the productivity of Australian banks using DEA technique but in different time period from 1995-1999. This study finds that there was a decline in productivity of banks during the study period. Kirkwood and Nahm (2006) consider different aspects of efficiency as the first study in Australian banking industry which measures the profit efficiency and also compares the result of the model with the stock returns for the study period of 1995 to 2002. They indicate that, the major banks have had some improvements in both banking service and profit efficiency, but regional banks' banking service efficiency remained unchanged while their profit efficiency declined. Paul and Kourouche (2008) examine the technical efficiency of 10 Australian banks during post-Wallis period (1997-2005). The results based on DEA, reveal that medium sized banks have outperformed both the small and large banks in terms of efficiency improvements.

Additionally, there are several studies in the banking sector which have used a multi-stage DEA to measure different aspects of performance. Luo (2003) uses a two-stage DEA to measure the profitability and marketability efficiency of 254 large banks in USA. In this study as a two-stage method, outputs of profitability efficiency are inputs of marketability efficiency as shown in Table 2. He finds large banks acquire relatively a lower level of marketability efficiency.

Ho and Zhu (2004) use an innovative two-stage data envelopment analysis model that separates efficiency and effectiveness to evaluate the performance of 41 listed corporations of the banking industry in Taiwan by using DEA methodology. They conclude that a company with better efficiency dose not always mean that it has a better effectiveness. Their results show as well that there is no apparent correlation between these two indexes. In this paper, we develop Ho and Zhu's model by adding the risk as a new stage which makes it a three stage DEA model. Additionally, we consider an eleven year period instead of just one year which also enable us to study the trends of the efficiency, effectiveness and risk of banks.

3. Methodology

DEA is a nonparametric method in operations research, it is used for the estimation of efficient frontiers and to measure the efficiency of decision making units (DMUs) such as banks. DEA technique calculates a relative score for each DMU (which is bank in this study) based on frontiers in the sample. This methodology, first

Moradi-Motlagh, Saleh, Abdekhodae & Ektesabi

Table 2: A summary of bank performance studies using DEA procedure

Author(s)	Country	Inputs	Outputs	Indexes
Sathye (2001)	Australia	Labour, Capital, Loanable funds	Loans, Demand Deposit	Technical Efficiency/ Allocative Efficiency
Luo (2003)	USA	Stage 1: Employees, Assets, Equity	Revenue, Profit	Profitability Efficiency
		Stage 2: Revenue, Profit	Market Value, Stock price, EPS	Marketability Efficiency
Asmild, Paradi et al. (2004)	Canada	Employees, Book Value of Physical , Assets, Other Non-interest Expense	Deposits, Loans, Securities, Deposits with other banks, Other Non-Interest Income	Productivity
Chien-Ta and Dauw-Song (2004)	Taiwan	Stage 1: Capital Stocks, Assets, Branches, Employees	Sales, Deposits	Efficiency
		Stage 2: Sales, Deposit	Net Income, Interest Income, Non-interest Income	Effectiveness
Angelidis and Lyroudi (2006)	Italy	Total Earning Assets, Loans, Deposits	Personnel Expense, Other Operating Expense, Total Fixed Assets	Productivity
Beccalli, Casu et al (2006)	Europe	Deposits, Labour, Capital	Total Loans and Securities	Efficiency
Kirkwood and Nahm (2006)	Australia	Model A Employees, Property, Plant and Equipment, Interest-bearing liabilities	Interest-bearing assets, Non-interest income	Efficiency
		Model B Employees, Property, Plant and Equipment, Interest-bearing liabilities	Profit before tax	Profit Efficiency
Rezitis (2006)	Greece	Labor, Capital Expense, Deposits	Loans , Investment Assets	Overall Technical Efficiency, Pure Technical Efficiency, Scale Efficiency
Paul and Kourouche (2008)	Australia	Interest Expense, Non-interest Expense	Net Interest Income, Non-interest Income	Technical Efficiency

Moradi-Motlagh, Saleh, Abdekhodae & Ektesabi

explained by Charnes, Cooper et al. (1978) which efficiency is defined as a weighted sum of outputs to a weighted sum of inputs, where the efficiency is calculated by mathematical programming with assumption of constant returns to scale (CRS). Readers interested in details of DEA method are advised to see Cooper, Seiford et al. (2007).

Fethi and Pasiouras (2010) argue that the DEA is by far the most commonly used operations research and artificial intelligence technique in assessing bank performance. Emrouznejad, Parker et al. (2008) believe DEA and its applications will continue to be a primary arena of research going forward. In Australian context, use of DEA to measure the performance of banks seems to be appropriate due to limited number of banks. Kirkwood and Nahm (2006) emphasise that the majority of Australian banking efficiency studies use DEA, largely because of small number of banks; along with, Paul and Kourouche (2008). Capability of combining multi inputs and outputs in a single measure of efficiency has made DEA as a powerful technique to measure performance of organisations.

DuPont financial analysis model defines, return on equity (ROE) as a profitability ratio, multiplying of the return on asset (ROA) and the financial leverage. ROA is used widely as a performance measure in many studies (eg. Berman et al. 1999, Halkos and Salamouris 2004, Ta-Cheng and Yung-Ho 2006). In addition, financial leverage is typically the cause of financial risk (Meric and Meric 2001) as Best (2010) believes that both the Asian crisis and the current one were the product of excessive leverage and poor risk management. In DuPont model, the profit can be gained from both increasing the performance and risk. Therefore, identifying the effect of the performance and risk in earning profit is vital; especially, in the long term. Derived from the importance of risk and return view we define a DEA model to measure the performance and risk in which the selection of inputs and outputs has been carried out based on ROA and financial leverage concept. We also determine the position of each bank in the two dimensions of performance and risk. Figure 1 demonstrates the four places, each bank can stand.

Figure 1: Performance and Risk

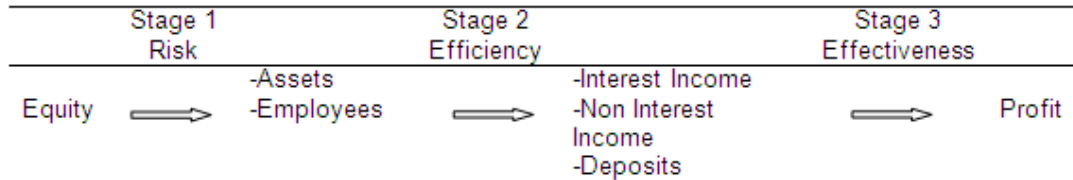
High	High Risk Low Performance ZONE 2	High Risk High Performance ZONE 3
Low	Low Risk Low Performance ZONE 1	Low Risk High Performance ZONE 4
	Low	High

Performance

In some studies return on asset as a performance index has decomposed to asset turnover and profit margin while they have been defined in order, efficiency and effectiveness of DMUs (eg. Ho et al. 2009, Ho and Zhu 2004). We apply the same approach to have a better perception about the Australian banks performance while we add the financial leverage as an important risk factor which has not been considered in previous studies.

In our three-stage DEA model, the first stage addresses the risk, the degree to which a bank is utilizing borrowed money. The second stage measures efficiency, the ability of a bank to generate income from assets and resources and the last stage, effectiveness measures the ability of a bank to generate profit from its incomes. Figure 2 indicates the stages and the input and output variables of each stage.

Figure 2: The inputs and outputs of the stages



The DEA model employed in this study is the CCR model also DEA output-oriented model is chosen in the present study according to Charnes, Cooper et al. (1978) as follows:

$$\text{Max } \Theta$$

$$\sum_{j=1}^J \lambda_j x_{jm} \leq x_{j_0m} \quad ; \quad m=1, 2 \dots M$$

$$\sum_{j=1}^J \lambda_j y_{jn} \geq \Theta y_{j_0n} \quad ; \quad n=1, 2 \dots N$$

$$\lambda_j \geq 0 \quad ; \quad j=1, 2 \dots J$$

Where:

$$\Phi=1/\Theta$$

Φ = the efficiency score bounded between 0 and 1

X_{jm} = the m th input of the j th bank

Y_{jn} = the n th output of the j th bank

λ_j = the j th bank weight value

In this method, the score of each bank is a number between 0 to 1 and the most risky, efficient and effective banks attain a score of 1, while other banks in the sample gain a score less than 1.

4. Empirical Findings and Discussion

Observing a bank's relative efficiency on a selection of variables over a number of years provides an insight into performance of that bank compared to its peer (Avkiran 1999). In this study, we consider eleven years for six Australian banks. In result, there are 66 data observations. Due to limited sample size, we apply a pooling approach and we also assume that there is no technical change during the study period similar to recent studies in Australia which have been conducted by Paul and Kourouche (2008) and Kirkwood and Nahm (2006).

Moradi-Motlagh, Saleh, Abdekhodae & Ektesabi

Derived from the proposed model the indexes of three stages have been measured and presented in this section. In the beginning, the elements of performance, named efficiency and effectiveness in the stages 2 and 3 are discussed. In our case, within six Australian banks, the bank with higher efficiency does not always mean higher in effectiveness which is consistent with the study by Ho and Zhu (2004) in Taiwan's commercial banks. This model not only determines the position of each bank in comparison with its rivals but also demonstrates the opportunities to improve performance. Therefore, banks are able to improve their performance by either increasing the level of their efficiency or effectiveness.

Figure 3 and 4 illustrate the trend of the efficiency and effectiveness for large and small banks during the study time period from 2000 to 2011. The trend of the efficiency is upward for four major Australian banks except 2009 and 2010 and the trend of the effectiveness on the contrary is downward or constant. This means that, Australian major banks preserve or increase their performance by raising the amount of sale in comparison by controlling their cost.

Figure 3: Trend of Australian banks efficiency

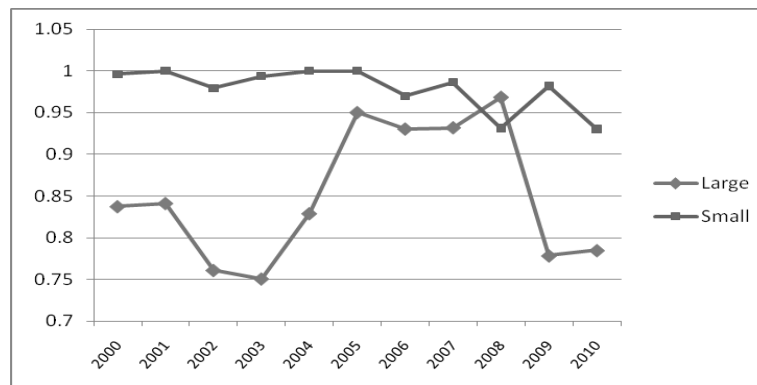
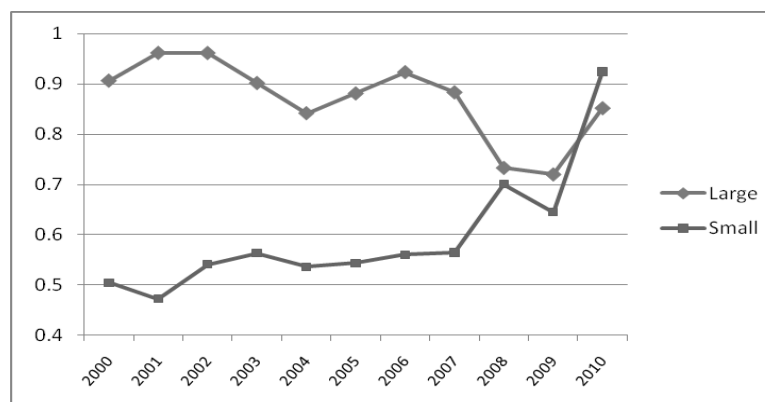


Figure 4: Trend of Australian banks effectiveness



The main contribution of this paper is considering the performance and risk together to analyse the position of banks in comparison with their rivals. Risk is calculated according to variables of stage 1 and performance is achieved by multiplying efficiency and effectiveness (stage 2 and 3). Figure 5 represents the position of Australian banks in terms of performance and risk in 2007. To have a more realistic view, we divided four zones with considering the average of performance and risk scores. As a result the zone areas are not equal. As demonstrated in figure 5, it is

Moradi-Motlagh, Saleh, Abdekhodae & Ektesabi

obvious that among the banks with equal risk, whichever has the higher performance is more profitable than the others. For example in Figure 5, WBC is more profitable than NAB.

Figure 6 shows that the trend of Australian banks' risk between 2000 and 2010. Although the risk score of small banks has been much greater until 2008 but after this year their leverage has been decreased dramatically.

Figure 5: Australian banks performance and risk in 2007

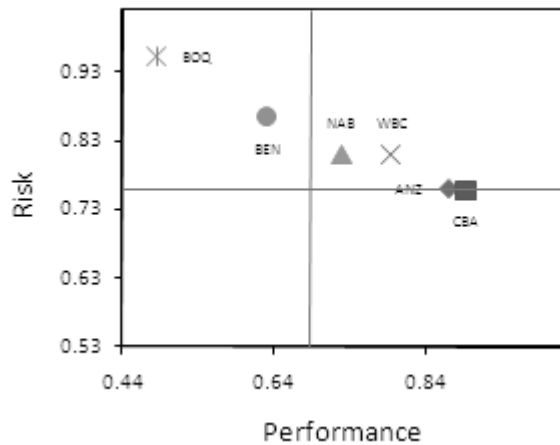


Figure 6: Trend of Australian banks risk

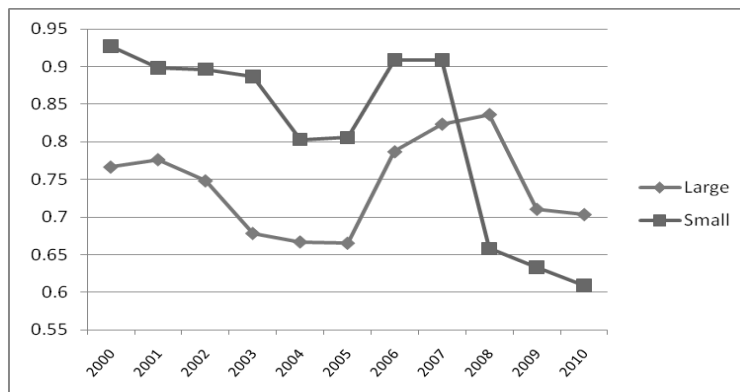
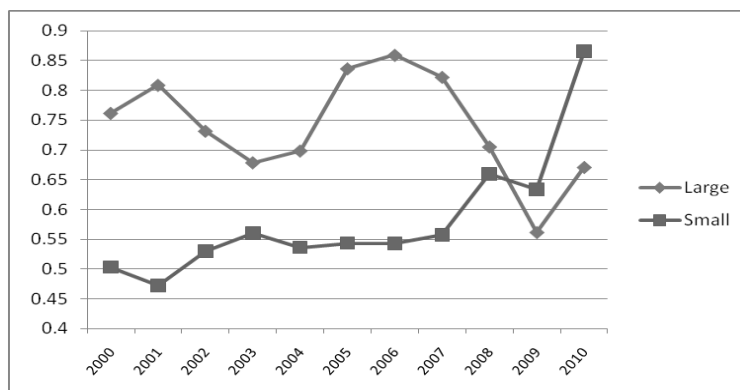


Figure 7: Trend of Australian banks performance



Moradi-Motlagh, Saleh, Abdekhodae & Ektesabi

The trend of the performance indexes of the Australian banks shows an increase in the performance during the study period for small banks which has illustrated in Figure 7. There is no apparent correlation between performance and risk score in this study and it seems that individually each bank has a different policy in terms of performance and risk which has been demonstrated in Figure 8.

Figure 8: Performance and risk of Australian banks

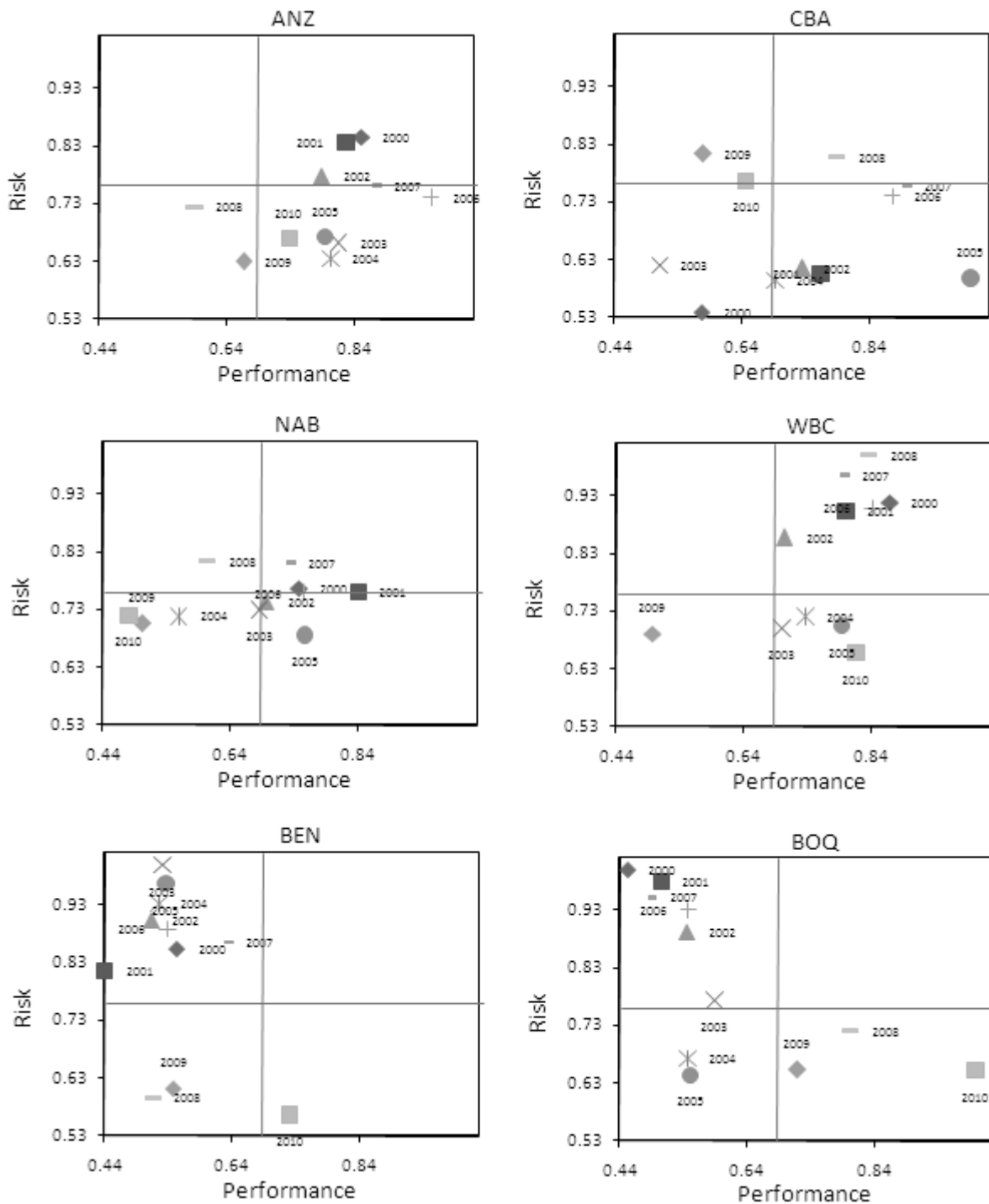


Figure 8 illustrates that the most of the sample observations of the four large banks are in zone 3 and 4 with high performance and changing risk. The results demonstrate that these large banks have different strategies in terms of performance

and risk. While ANZ and WBC data points are in zone 3 and 4 (except 2008 and 2009) which means high performance in all years with changing risk scores, most of CBA observations are in zone 1 and 4 with lower risk. Moreover, NAB has a different approach and it has the lowest variance in its risk score along with data points in boundaries of all four zones. On the other side, most of observations of two small banks are in Zone 1 and 2 which means low performance with changing risk. Although Bank of Queensland have improved its performance in the last three years and changed its position to zone 4 but Bendigo Bank with no obvious shift have stayed in the zone 1 and 2.

5. Summary and Conclusion

This paper introduces a three stage DEA model to examine the performance of Australian banks over the period from 2000 to 2010. This paper extends the current performance literature on banking industry by incorporating not only the performance factors, but also by taking into account the risk factor which earlier studies have ignored. A three stage DEA model has been presented in this research to measure effectiveness, efficiency and risk where effectiveness, efficiency have been considered as two elements of performance. Selection of inputs and outputs of each stage has been accomplished based on the Dupont model concept. Moreover, the proposed model in this paper demonstrates the position of each bank in comparison with its rivals as well as the trend of performance and risk scores which gives more information about the policies and strategies of banks in terms of performance and risk. Results indicate that there is a varying range of performance and risk scores in the Australian banking industry and it proves the importance of considering the risk in performance studies. Therefore, considering the issue of risk factors can be the focus of any future research in this area as it is misleading to ignore this factor and this study strongly recommends this issue to be taken into account in future studies that measure the performance of organizations.

References

- Angelidis, D and Lyroudi, K 2006, 'Efficiency in the Italian banking Industry: Data envelopment analysis and neural networks', *International Research Journal of Finance & Economics*, no. 5, pp. 155-165.
- Asmild, M, Paradi, JC, Aggarwall, V and Schaffnit, C 2004, 'Combining DEA window analysis with the Malmquist index approach in a study of the Canadian banking industry', *Journal of Productivity Analysis*, vol. 21, no. 1, pp. 67-89.
- Avkiran, NK 1999, 'The evidence on efficiency gains: The role of mergers and the benefits to the public', *Journal of Banking and Finance*, vol. 23, no. 7, pp. 991-1013.
- Avkiran, NK 2000, 'Rising productivity of Australian trading banks under deregulation 1986-1995', vol. 24, no. 2, pp. 122-140.
- Beccalli, E, Casu, B and Girardone, C 2006, 'Efficiency and stock performance in European banking', *Journal of business finance and accounting*, vol. 33, no. 1-2, pp. 245-262.
- Berger, AN and Humphrey, DB 1997, 'Efficiency of financial institutions: International survey and directions for future research', *European Journal of Operational Research*, vol. 98, no. 2, pp. 175-212.

Moradi-Motlagh, Saleh, Abdekhodae & Ektesabi

- Berman, SL, Wicks, AC, Kotha, S and Jones, TM 1999, 'Does stakeholder orientation matter? The relationship between stakeholder management models and firm financial performance', *Academy of Management Journal*, vol. 42, no. 5, pp. 488-506.
- Best, J 2010, 'The limits of financial risk management: Or, what we didn't learn from the Asian crisis', *New Political Economy*, vol. 15, no. 1, pp. 29-49.
- Charnes, A, Cooper, WW and Rhodes, E 1978, 'Measuring the efficiency of decision making units', *European Journal of Operational Research*, vol. 2, no. 6, pp. 429-444.
- Chien-Ta, H and Dauw-Song, Z 2004, 'Performance measurement of Taiwan's commercial banks', *International Journal of Productivity & Performance Management*, vol. 53, no. 5, pp. 425-434.
- Cooper, WW, Seiford, LM and Tone, K 2007, *Data Envelopment Analysis: A comprehensive text with models, applications, references and DEA-Solver software*: Second edition. New York: Springer.
- Emrouznejad, A, Parker, BR and Tavares, G 2008, 'Evaluation of research in efficiency and productivity: A survey and analysis of the first 30 years of scholarly literature in DEA', *Socio-Economic Planning Sciences*, vol. 42, no. 3, pp. 151-157.
- Fethi, MD and Pasiouras, F 2010, 'Assessing bank efficiency and performance with operational research and artificial intelligence techniques: A survey', *European Journal of Operational Research*, vol. 204, no. 2, pp. 189-198.
- Halkos, GE and Salamouris, DS 2004, 'Efficiency measurement of the Greek commercial banks with the use of financial ratios: a data envelopment analysis approach', *Management Accounting Research*, vol. 15, no. 2, pp. 201-224.
- Ho, C-TB, Wu, DD and Olson, DL 2009, 'A risk scoring model and application to measuring internet stock performance', *International Journal of Information Technology and Decision Making*, vol. 8, no. 1, pp. 133-149.
- Ho, C and Zhu, D 2004, 'Performance measurement of Taiwan's commercial banks', *International Journal of Productivity and Performance Management*, vol. 53, no. 5, pp. 425-434.
- Kirkwood, J and Nahm, D 2006, 'Australian banking efficiency and its relation to stock returns', *Economic record*, vol. 82, no. 258, pp. 253-267.
- Luo, X 2003, 'Evaluating the profitability and marketability efficiency of large banks: An application of data envelopment analysis', *Journal of Business Research*, vol. 56, no. 8, pp. 627-635.
- Meric, G and Meric, I 2001, 'Risk and return in the world's major stock markets', *Journal of Investing*, vol. 10, no. 1, pp. 62-66.
- Neal, P 2004, 'X-efficiency and productivity change in Australian banking', *Australian Economic Papers*, vol. 43, no. 2, pp. 174-191.
- Paul, S and Kourouche, K 2008, 'Regulatory policy and the efficiency of the banking sector in Australia', *Australian economic review*, vol. 41, no. 3, pp. 260-271.
- Rezitis, AN 2006, 'Productivity growth in the Greek banking industry: a non-parametric approach', *Journal of applied economics*, vol. LX, no. 1, pp. 119-138.
- Sathye, M 2001, 'X-efficiency in Australian banking: An empirical investigation', *Journal of Banking & Finance*, vol. 25, no. 3, pp. 613-630.
- Sathye, M 2002, 'Measuring productivity changes in Australian banking: an application of Malmquist indices', *Managerial Finance*, vol. 28, no. 9, pp. 48-59.

Moradi-Motlagh, Saleh, Abdekhodae & Ektesabi

- Soteriou, A and Zenios, SA 1999, 'Operations, quality, and profitability in the provision of banking services', *Management Science*, vol. 45, no. 9, pp. 1221-1238.
- Ta-Cheng, C and Yung-Ho, C 2006, 'Affecting factors on risk-adjusted efficiency in Taiwan's banking industry', *Contemporary Economic Policy*, vol. 24, no. 4, pp. 634-648.