

Technical Efficiency in Indonesian Conventional Bank

Winny Perwithosuci

Universitas Sebelas Maret

Tri Mulyaningsih

Universitas Sebelas Maret

ABSTRACT

This study aims to estimates technical efficiency of large, medium-sized and small banks in Indonesia between from 2005 to 2014. This study employ Data Envelopment Analysis (DEA) technique to measure banks' efficiency with intermediation approach to define input and output variables. The results show that large banks are the most efficient group in terms of technical, allocative, and cost efficiency compared to banks with smaller sizes. This indicates that economies of scale has substantial role in improving banks efficiency.

I. Introduction

The Indonesian financial system is a bank based economy as shown by a significant contribution of banking industry in the financial sector. According to Widiarti et al(2015)the contribution of asset of banking industry in financial sector are 78.79% in 2012, 79.56% in 2013 and 79.04% in 2014. Thus, banks' performance drives up the performance of overall financial industry in Indonesia.

Indonesian banking efficiency from 1993 to 2000 was inefficient based on the previous study by Margono et al (2009). But the efficiency score across group by size show that medium-sized bank is more efficient than larger and smaller group. Medium-sized banks are more efficient because they can exploit the economies of scale. On the other hand, a study by Hadad et al (2008) find that the efficiency score of

large banks in Indonesia are the most efficient compared to smaller banks. Moreover, medium and smaller-sized banks perform slightly below the industry average.

The examination of banks' efficiency is substantial because Indonesian banking is under consolidation policy in the past 15 years. The consolidation aims to create strong, stable and efficient banking industry by increasing banks' capital level, strengthening banking supervision and improving banks conduct. Further, bank supervisory encourages banks to increase capital by self-injecting from existing shareholders, inviting external investors or merging with other banks. Therefore by 2020, the number of banks in local market will be reduced into half.

The current consolidation policy assumes that larger banks have higher efficiency level compared to smaller banks.

However, a study by Margono, Sharma and Melvin (2010) suggests that between 1993 and 2000, large and small banks were least cost efficient than the medium-sized banks in Indonesia. Therefore, the examination of banks efficiency during consolidation period is substantial to predict whether current consolidation policy has benefit to improve financial sector performance.

II. Literature Review

Firms efficiency is important aspect in the economics research. In the past 40 years, there were extensive studies discussing the efficiency and its measurement. Various articles measure firm's efficiency and compare it with those with different sizes, ownership structure, location and market segment. In term of size, some studies divide bank into large, medium-sized, and small group. Moreover, several papers concern with the relationship between efficiency and banks' size.

The size of bank is measured by banks' asset. Mesa et al (2013), Tan and Floros (2013), Barros and Wanke (2014), Stewart et al (2016), and Xiaogang et al (2005) find positive relationship between efficiency and asset. Large bank achieved higher efficiency score because they have a good quality of inputs and are able to

minimize input using its economies of scale.

A study by Hauner (2005) also find similar results that large bank are more efficient. Large banks have higher cost efficiency score because they are able to minimize the input cost. Furthermore, large banks gain cost efficiency from specialized workforce because capable to work more productive as banks conduct research and risk management. Moreover, large bank offer various service that enable them to boost revenue which lead to higher efficiency score. Meanwhile, a study by Margono et al (2009) they found that medium size bank was the most cost efficient compare to large and small bank. This because large and small banks couldn't able to exploit economies of scale.

Akeem and Moses (2014) measure allocative efficiency in Nigerian banks from 2002 to 2011. The results showed that there is inefficiency in Nigerian banks. During observation period, the efficiency score is below 1. It means that in average, Nigerian banks weren't optimally allocating the resources to produce given output at the prevailing price. This happen might be due to competitive environment in the banking sector which leads to inefficiency.

In Indonesia, there are several articles discussed about efficiency and its

relation to bank size. Margono et al (2009) estimate cost efficiency in Indonesian banking from 1993 to 2000. The result show that medium sized bank is the most efficient. It is because medium sized bank are more capable to exploit its economies of scale than others. On the other hand, Widiarti et al (2015) estimated efficiency score using DEA and find that there is a positive relationship between size and efficiency. Bank with larger size can boost their efficiency because they have more sufficient resources, number of branch offices, and ability to explout new technology to support their activities. Therefore large banks could reduce their cost. Another study by Hadad et al (2008) find that large bank are more efficient than the smaller banks. Thus, the results support

government policies to force consolidation in the Indonesian banking Industry. The findings also confirmed by the study by Santoso (2010).It stated that large bank in Indonesia caused by merger could make better financial structure in their management. It can boost their efficiency score. Large bank are more robust if there is a financial crisis hit the industry.

III. Efficiency Concept

Firms are defined as efficient if they produce the highest possible output by using the combination of inputs. In addition, firms are efficient if particular level of outputs are produced using the minimum cost (Greene, 1997). Therefore, banks can reach its efficient level either by minimising input or maximizing output.

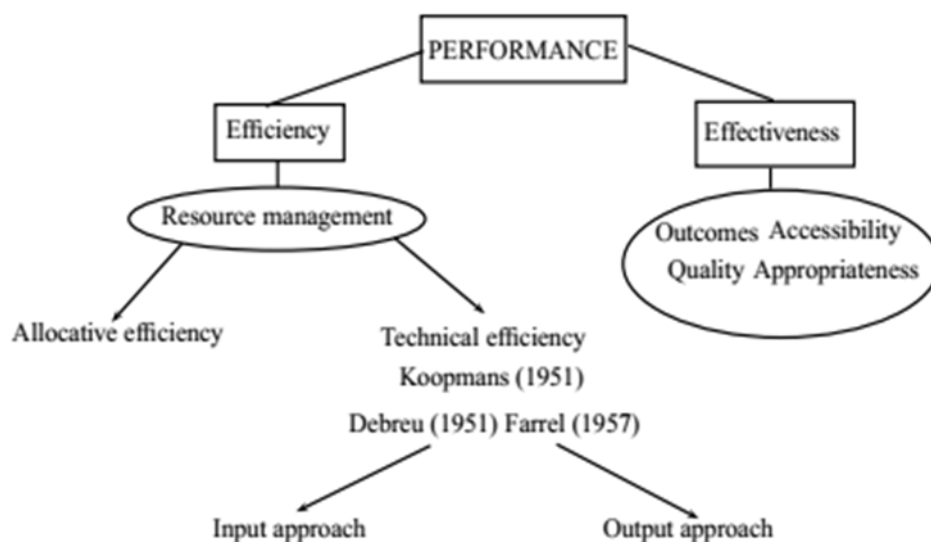


Figure 1.1 Performance Aassessment (Porcelli, 2009)

Above figure shows that efficiency is related to firms' resource management. In managing its resource, firms must conduct the production process efficiently both in terms of technical and allocative.

The technical efficiency reflects the ability of a firm to obtain maximal output from a given set of inputs (output approach). Or the ability of a firm to minimize inputs to produce given outputs (input approach).

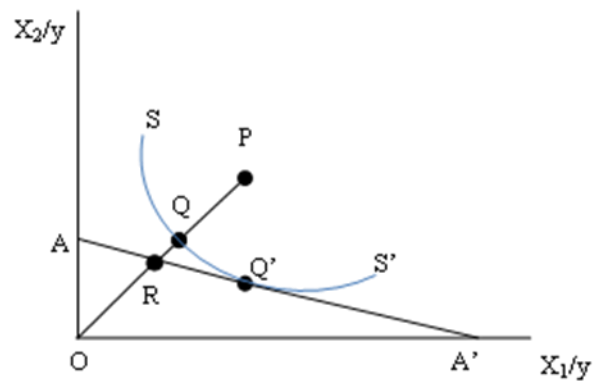


Figure 1.2 Efficiency Concept (Farrel, 1957)

From the figure above, firm is technically efficient if it is located at Q . This is efficient technically because Q lies on isoquant line (SS'). The figure also shows the allocative efficiency concept.

IV. Data Envelopment Analysis (DEA) Methodology

Efficiency estimation often vary across studies according to the data source as well as the efficiency concepts and measurement method that used in the studies (Berger & Mester, 1997). Thus, there is no concensus on how measuring efficiency. One of the efficiency measurement is using frontier function. In the past 40 years, there are two major

frontier approaches; parametric approach and non-parametric approach..

Parametric approach also known as econometric approach. One of the parametric approach methods that frequently used is Stochastic Frontier Analysis (SFA). This approach specifies a function form of production, cost, and revenue frontiers. Also, the assumption that SFA needed is to distinguish the inefficiencies from random components in the error terms. Further, the random error is splitted into two which are inefficiency and stochastic random error. They are separated by assuming that inefficiencies are drawn from asymmetric half-normal distribution, and that random errors are

drawn from a symmetric normal distribution.

The non-parametric approach does not use any functional form to estimate efficiency. Data Envelopment Analysis (DEA) is one of popular technique under the non-parametric approach. It is a linear programming technique invented by Charnes et al (1978) and further developed by Banker et al (1984). DEA has been employed extensively to estimate measure of efficiency across industries. There are 1,817 articles published between 2005 and 2009 using DEA application to estimate efficiency across industries (Liu et al, 2013). Particularly, there are 323 papers adopted DEA technique in measuring banking efficiency. DEA has some advantages for example it requires fewer assumptions and accommodates both multiple inputs and multiple outputs

There are two basic models under DEA namely Constant Return to Scale (CRS) and Variable Return to Scale (VRS). CRS is employed if firms produce under proportionate increase in inputs results in the same proportionate increase in output, meanings that (doubling all inputs results in exactly twice as much output). VRS is preferable measuring the real efficiency score is the intention of the study. Furthermore, there are two frameworks in working on VRS model whether input-orientation or output orientation. Input

orientation is when firm can minimize its inputs to produce given output. Meanwhile output orientation is when firm can maximize its output using given input.

This study utilizes non-parametric approach of Data Envelopment Analysis (DEA) to measure technical, allocative, and cost efficiency of banks across sizes in Indonesian between 2005 to 2014. Further, this study employs VRS model of input-orientation framework. In this study, researcher used input orientation.

V. Data and Variables

This study observes 101 Indonesian conventional banks between 2005 and 2014. In order to compare the degree of efficiency of banks across sizes, this study categorizes banks into three groups, namely large; medium-sized and small banks. Referring Bikker and Haaf (2002), large banks are the biggest ten per cent banks in the industry, followed by medium-sized banks and small banks. Meanwhile, small banks are those in the bottom ten per cent in terms of scale. The remaining 40 per cent banks are categorized as medium-sized banks.

The crucial stage in efficiency measurement is determining output and input and selecting proxies to representing input and output of banking industry. Literatures suggest two approaches namely

production and intermediation in assisting the input and output selection process. The balanced sheet and income statement of Indonesian conventional banks are generated from Indonesian Financial Service Authority (OJK).

Production approach treats banks as firms that produce services using a set of inputs. Regarding to production approach, inputs are labor and capital, and output are deposits and loans. Meanwhile, the intermediary approach treat banks as intermediary firm that employ third parties funds of deposits from borrowers as input

to produce loans to disburse to lenders. Therefore, intermediary approach treat third-parties fund of deposit, capital and and labor as inputs. Outputs are loans disbursement and others revenue revenue generating from other services. This paper refers intermediation approach in determining a set of inputs and outputs. Furthermore, information of price of input is required to measure banks allocative efficiency. The inputs, and output and input pricea specsification aren as follows.

Table 1.1. Input and Output Specification

Input and output specification		Measurements
Set of input	Labor	Values of labor expenditure
	Third-parties funds	Total deposits
	Capital	Values of capital
Set of output	Loans disbursement	Values of loans disbursement
	Securities	Values of securities

VI. ResultsAnalysis and Discussion

Efficiency measurement computation was performed using DEAP v 2.1. The efficiency is measured year by year during observation period using common frontier. The results show that the average value of the technical efficiency of large banks during observation period is 0.943; medium-sized banks is 0.704; and

small banks is 0.724. The average value of allocative efficiency of large banks is 0.875; medium-sized banks is 0.505; and allocative efficiency of small banks is 0.341. The average value of large banks cost efficiency is 0.826; medium-sized banks is 0.485; and the efficiency of small banks is 0.358.

Banks' Technical efficiency

Technical efficiency reflects the ability of a firm to obtain maximal output

from a given set of input; or minimize input of a given set of output.

Table 1.1 Average Value of Technical Efficiency Large, Medium, and Small Banks in Indonesia 2005-2014

Year	Technical Efficiency		
	Large Banks	Medium Bank	Small Bank
2005	0,878	0,710	0,705
2006	0,933	0,670	0,564
2007	0,958	0,695	0,600
2008	0,948	0,714	0,808
2009	0,961	0,764	0,846
2010	0,953	0,737	0,814
2011	0,966	0,708	0,761
2012	0,975	0,683	0,743
2013	0,941	0,609	0,693
2014	0,917	0,651	0,703
Average	0,943	0,704	0,724

Source : Estimation result, 2019

Large bank have the highest average score of technical efficiency compare to medium and small banks during observation period. The average value of technical efficiency of large bank is 0,943 which means large bank has to minimize its input 6% to achieved 100% technical efficiency.

From the previous study by Widiarti et al (2015) large banks are more efficient because they have good infrastructure and system that supported banks operational

activities for example technology, management, and organizational structure. Large bank utilise latest technology to support their activities. Moreover, large banks operation are supported by extensive branches that increasing access of customers to banks compared to smaller banks with less branches. Moreover, large banks enjoy economies of scale that enable banks to manage their operational activities at the cost minimum scale

VII. Conclusion and Future Research

This study aims to measure technical, allocative, and cost efficiency across group size of bank in Indonesia in 2005-2014. The efficiency scores data reveal that large banks are the most efficient in both technical, allocative, and cost compared to smaller banks. In addition, the efficiency score of banking in Indonesia show that large, medium, and small banks are still experiencing problems to allocate resources efficiently as shown by the low score of allocative efficiency.

Large banks are efficient in technical, allocative, and cost than their smaller banks. It providing support for Bank Indonesia's consolidation policies. Thus, to boost performance, bank can improve its efficiency by enlarge its asset. Large asset lead to efficiency through economies of scale. Hire spesialized workforce can be done too because they have ability to do research such as risk management. Large asset and spesialized workforce is a good combination to exploit the asset either to produce various outputs to boost revenue or minimize input cost. Bank also can utilise newest technology to support its operational activities.

The finding states that large bank are the most efficient both technically, allocatively, and cost. This support government's policy to consolidate Indonesian banks to create strong, healthy

and efficient banking structure. Government increase banks' capital and asset. Bigger capital and asset will make banks maintain their business and exploit new technology to support their business activities.

References

- Abidin, Z., & Endri, E. (2010). Kinerja Efisiensi Teknis Bank Pembangunan Daerah: Pendekatan Data Envelopment Analysis (DEA). *Jurnal Akuntansi dan Keuangan*, 11(1), pp-21.
- Akeem, U. O., & Moses, F. (2014). An Empirical Analysis of Allocative Efficiency of Nigerian Commercial Banks: A DEA Approach. *International Journal of Economics and Financial Issues*, 4(3), 465.
- Akin, A., Kiliç, M., & Zadm, S. (2009). Determinants of Bank Efficiency in Turkey: A Two Stage Data Envelopment Analysis. In 1. *International Symposium on Suistainable Development*.
- Aly, H. Y., Grabowski, R., Pasurka, C., & Rangan, N. (1990). Technical, scale, and allocative efficiencies in US banking: An empirical investigation. *The Review of Economics and Statistics*, 211-218.
- Banda, C. M. (2010). The determinants of banking sector interest rate spreads in Zambia. *Unpublished Masters Thesis*). University of Zambia.
- Barros, C. P., & Wanke, P. (2014). Banking efficiency in Brazil. *Journal of International Financial Markets, Institutions and Money*, 28, 54-65.

- Bassett, B & Brady, T 2002, 'What Drives the Persistent Competitiveness of Small Banks?', *The Federal Reserve Board, Finance and Economics Discussion Series*.
- Baye, M. R., & Beil, R. O. (2006). *Managerial economics and business strategy* (Vol. 5). New York, NY: McGraw-Hill.
- Berger, A. N., & Humphrey, D. B. (1991). The dominance of inefficiencies over scale and product mix economies in banking. *Journal of Monetary Economics*, 28(1), 117-148.
- Berger, A. N., & Mester, L. J. (1997). Inside the black box: What explains differences in the efficiencies of financial institutions?. *Journal of banking & finance*, 21(7), 895-947.
- Bikker, J. A., & Haaf, K. (2002). Competition, concentration and their relationship: An empirical analysis of the banking industry. *Journal of Banking & Finance*, 26(11), 2191-2214.
- Boahene, Samuel Hymore, Dasah, Julius dan Agyei, Samuel Kwaku. (2012). Credit Risk and Profitability of Selected Banks in Ghana. *Research Journal of Finance and Accounting*, 3(7), hal.6-14.
- Brissimis, S. N., Delis, M. D., & Tsionas, E. G. (2010). Technical and allocative efficiency in European banking. *European Journal of Operational Research*, 204(1), 153-163.
- Casu, B. and Girardone, C. (2008). Does Competition Lead to Efficiency? The Case of EU Commercial Banks. papers.ssrn.com/sol3/papers.cfm?abstract_id=1200362
- Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European journal of operational research*, 2(6), 429-444.
- Coelli, T. (Ed.). (2003). *A primer on efficiency measurement for utilities and transport regulators* (Vol. 953). World Bank Publications.
- Coelli, T. J., Rao, D. S. P., O'Donnell, C. J., & Battese, G. E. (2005). *An introduction to efficiency and productivity analysis*. Springer Science & Business Media.
- Cooper, W. W., Seiford, L. M., & Zhu, J. (2004). Data envelopment analysis. In *Handbook on data envelopment analysis* (pp. 1-39). Springer US.
- Dabla-Norris, E., & Floerkemeier, H. (2007). Bank efficiency and market structure: what determines banking spreads in Armenia?. *IMF Working Papers*, 1-28.
- Debreu, G. (1951). The coefficient of resource utilization. *Econometrica: Journal of the Econometric Society*, 273-292.
- DeYoung, R. (1993). *Determinants of cost efficiencies in bank mergers* (pp. 93-1). Comptroller of the Currency.
- DeYoung, R. (1997). Measuring bank cost efficiency: don't count on accounting ratios. *Financial Practice and Education*, 7(1), 20-31.
- De Young, R., Hasan, I. and Kirchhoff, B. (1998). The Impact of Out-of-State Entry on the Cost Efficiency of Local Commercial Banks. *Journal of Economics and Business*, 50(2), 191-203.

- Elyasiani, E., &Mehdian, S. (1990). Efficiency in the commercial banking industry, a production frontier approach. *Applied Economics*, 22(4), 539-551.
- Elyasiani, E., &Mehdian, S. M. (1990). A nonparametric approach to measurement of efficiency and technological change: The case of large US commercial banks. *Journal of Financial Services Research*, 4(2), 157-168.
- Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society. Series A (General)*, 120(3), 253-290.
- Ferrier, G. D., & Lovell, C. K. (1990). Measuring cost efficiency in banking: econometric and linear programming evidence. *Journal of econometrics*, 46(1), 229-245.
- Fiordelisi, F., Marques-Ibanez, D., &Molyneux, P. (2011). Efficiency and risk in European banking. *Journal of Banking & Finance*, 35(5), 1315-1326.
- Grabowski, R., Rangan, N., &Rezvanian, R. (1994). The effect of deregulation on the efficiency of US banking firms. *Journal of Economics and Business*, 46(1), 39-54.
- Greene, W. H. (1997). Frontier production functions. *Handbook of applied econometrics*, 2, 81-166.
- Grigorian, D., &Manole, V. (2002). Determinants of commercial bank performance in transition: An application of data envelopment analysis. *World Bank Policy Research Working Paper*, (2850).
- Hadad, M. D., Hall, M., Santoso, W., Satria, R., Kenjegalieva, K., & Simper, R. (2008). *Efficiency in Indonesian Banking: Recent Evidence*. Department of Economics, Loughborough University.
- Hadad, M. D., Santoso, W., Ilyas, D., &Mardanugraha, E. (2003). AnalisisEfisiensiIndustriPerbankan Indonesia: PenggunaanMetodeNonparametrik Data Envelopment Analysis (DEA). *Research Paper*, 7(5).
- Hauner, D. (2005). Explaining efficiency differences among large German and Austrian banks. *Applied Economics*, 37(9), 969-980.
- Iliyasu, A., Mohamed, Z. A., Terano, R., & Malaysia, S. M. (2015). Data envelopment analysis models and software packages for academic purposes. *Health care*, 271(14.9), 107.
- Isik, I., & Hassan, M. K. (2002). Technical, scale and allocative efficiencies of Turkish banking industry. *Journal of Banking & Finance*, 26(4), 719-766.
- Jemric, I., &Vujcic, B. (2002). Efficiency of banks in Croatia: A DEA approach. *Comparative Economic Studies*, 44(2-3), 169-193.
- Karray, S. C., &eddineChichti, J. (2013). Bank size and efficiency in developing countries: intermediation approach versus value added approach and impact of non-traditional activities. *Asian Economic and Financial Review*, 3(5), 593.
- Kasmir, S. E. M. M. (2002). Bank dan LembagaKeuanganLainnya. Jakarta: Raja Grafindo Persada.
- Koopmans, T. C. (1951). Efficient allocation of resources. *Econometrica*:

- Journal of the Econometric Society*, 455-465.
- Kumbhakar, S. C., & Lovell, C. K. (2003). *Stochastic frontier analysis*. Cambridge University Press.
- Kumbhakar, S.C., Lozano-Vivas, A., Lovell, C.A.K. and Hasan, I. (2001). The Effects of Deregulation on the Performance of Financial Institutions: the Case of Spanish Savings Banks. *Journal of Money, Credit and Banking*, 33(1), 101-120.
- Lang, G., & Welzel, P. (1996). Efficiency and technical progress in banking Empirical results for a panel of German cooperative banks. *Journal of Banking & Finance*, 20(6), 1003-1023.
- Liu, J. S., Lu, L. Y., Lu, W. M., & Lin, B. J. (2013). A survey of DEA applications. *Omega*, 41(5), 893-902.
- Margono, H., Sharma, S. C., & Melvin, P. D. (2010). Cost efficiency, economies of scale, technological progress and productivity in Indonesian banks. *Journal of Asian Economics*, 21(1), 53-65.
- McLeod, R. H. (1999). Control and competition: Banking deregulation and re-regulation in Indonesia. *Journal of the Asia Pacific Economy*, 4(2), 258-297.
- Mesa, R. B., Sánchez, H. M., & Sobrino, J. N. R. (2014). Main determinants of efficiency and implications on banking concentration in the European Union. *Revista de Contabilidad*, 17(1), 78-87.
- Muljawan, Dadang. Hafidz, Januar. Astuti, Rieska Indah. Oktapiani, Rini. 2014. "Faktor-faktor Penentu Efisiensi Perbankan Indonesia serta Dampaknya Terhadap Perhitungan Suku Bunga Kredit". *Working paper Bank Indonesia* wp/2/2014. Bank Indonesia
- MULYANINGSIH, T. BANKING COMPETITION AND ITS RELATIONSHIP WITH BANKING STABILITY: EVIDENCE FROM INDONESIA.
- Porcelli, F. (2009). Measurement of Technical Efficiency. A brief survey on parametric and non-parametric techniques. *University of Warwick*, 11.
- Putra, I. P. (2012). ANALISIS TINGKAT EFISIENSI PERBANKAN BUMN DAN BANK ASING DI INDONESIA. *Jurnal Ilmiah Mahasiswa FEB*, 1(2).
- Řepková, I. (2015). Banking Efficiency Determinants in the Czech Banking Sector. *Procedia Economics and Finance*, 23, 191-196.
- Shahooth, K., & Battall, A. H. (2006). Using data envelopment analysis to measure cost efficiency with an application on Islamic banks. *Scientific Journal of Administrative Development*, 4, 134-156.
- San, O. T., Theng, L. Y., & Heng, T. B. (2011). A comparison on efficiency of domestic and foreign banks in Malaysia: A DEA approach. *Business Management Dynamics*, 1(4), 33-49.
- Santoso, R. T. (2010). Pengaruh Merger dan Akuisisi Terhadap Efisiensi Perbankan di Indonesia (Tahun 1998-2009). *Jurnal akuntansi dan keuangan*, 12(2), pp-102.

- Sanusi, L.A. (2012) *“Banking reform and its impact on the Nigerian”* A presentation at the University of Warwick’s Economic Summit, Warwick, 17 February 2012.
- Sastroswito, S., & Suzuki, Y. (2012). The Impact of Competition on Bank Efficiency; The Evidence from Indonesia. *Business and Management Review*, 2(6), 1-9.
- Schaeck, K. and Cihak, M. (2008). How Does Competition Affect Efficiency and Soundness in Banking: New Empirical Evidence. *European Central Bank Working Paper Series*, 932.
- Seiford, L. M., & Thrall, R. M. (1990). Recent developments in DEA: the mathematical programming approach to frontier analysis. *Journal of econometrics*, 46(1), 7-38.
- Shahooth, K., & Battall, A. H. (2006). Using data envelopment analysis to measure cost efficiency with an application on Islamic banks. *Scientific Journal of Administrative Development*, 4, 134-156.
- Sofia, G. N., & Triani, N. N. A. (2016). Analisis Faktor Penentu Tingkat Efisiensi Perbankan di Indonesia pada tahun 2012-2014 dengan Menggunakan Pendekatan Two Stage Data Envelopment Analysis. *Jurnal Ilmu Manajemen (JIM)*, 4(1).
- Stewart, C., Matousek, R., & Nguyen, T. N. (2016). Efficiency in the Vietnamese banking system: A DEA double bootstrap approach. *Research in International Business and Finance*, 36, 96-111.
- Sugiarto, A. (2003). Arsitektur Perbankan Indonesia: Suatu Kebutuhan Dan Tantangan Perbankan Ke Depan, Kompas Newspaper (5 Juni 2003), viewed 24 March 2006.
- Sukirno, S. (2005). *Mikro Ekonomi Teori Pengantar*. Jakarta: PT Raja Grafindo Persada.
- Sutawijaya, A., & Lestari, E. P. (2009). Efisiensi teknik Perbankan Indonesia pascakrisis ekonomi: Sebuah studi empiris penerapan model DEA. *Jurnal Ekonomi Pembangunan: Kajian Masalah Ekonomi dan Pembangunan*, 10(1), 49-67.
- Tahir, I. M., & Bakar, N. M. A. (2009). Evaluating efficiency of Malaysian banks using data envelopment analysis. *International Journal of Business and Management*, 4(8), 96.
- Tan, Y., & Floros, C. (2013). Risk, capital and efficiency in Chinese banking. *Journal of International Financial Markets, Institutions and Money*, 26, 378-393.
- Tasman, A. (2008). Ekonomi Produksi, Analisis Efisiensi dan Produktivitas. *Chandra Pratama*.
- Vu, H., & Nahm, D. (2013). The determinants of profit efficiency of banks in Vietnam. *Journal of the Asia Pacific Economy*, 18(4), 615-631.
- Wanniarachchige, M.K. and Suzuki, Y. (2010). Bank Competition and Efficiency: The Case of Sri Lanka. *Asia Pacific World*, 1(1), 117-131.
- Weill, L. (2003). On the Relationship between Competition and Efficiency in the EU Banking Sectors. <http://www.diw.de/sixcms/detail.php/42156>
- Widiarti, A. W., Siregar, H., & Andati, T. (2015). The Determinants of

Bank's Efficiency in
Indonesia. *BuletinEkonomiMonet
er dan Perbankan*, 18(2), 129-
156.

Worthington, A. C. and Dollery, B.
(2000). An empirical survey of
frontier
efficiency measurement techniques
in local government. *Local
Government Studies*, 26(2):23-
52

Xiaogang, C., Skully, M., & Brown, K.
(2005). Banking efficiency in
China: Application of DEA to
pre-and post-deregulation eras:
1993–2000. *China Economic
Review*, 16(3), 229-245.