EUROPEAN ACADEMIC RESEARCH
Vol. II, Issue 12/ March 2015

Impact Factor: 3.1 (UIF)
DRJI Value: 5.9 (B+)

ISSN 2286-4822
www.euacademic.org

Performance Analysis of Universal and Commercial Banks in the Philippines from 2004 to 2012: DEA and SFA Approach

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Abstract:

This study examines the overall technical efficiency and productivity level of 12 Universal and 3 Commercial banks in the Philippines. The selected banks' technical efficiency and productivity level were measured by (Stochastic Frontier Analysis - SFA) and (Data Envelopment Analysis -DEA). This paper analyzes the technical efficiency and productivity of each bank for a period of 9 years (2004 to 2012). Cross-sectional and serial analyses showed that efficiency change (effch) or cost efficiency and technical change (techch) caused the improvement in productivity of selected banks from 2004 to 2012. Scale efficiency change (sech) or advantageous conditions in the operation of the banks and pure efficiency change (pech) or managerial efficiency caused the banks to be cost efficient (effch). A 100% increase in inputs usage (operating expense, total deposit and interest expense) affect total loans by 7.8%, 55.5% and 16.5%, respectively. The combine effects of the inputs (79.8%) implied decreasing returns to scale (drs) operation. Older and larger asset size banks were more efficient in their operation than younger and smaller asset size banks. Publicly

(government) owned and commercial banks are technically efficient in their operations than private and universal banks.

Key words: technical efficiency, productivity, bank performance, Stochastic Frontier Analysis (SFA), Data Envelopment Analysis (DEA)

1. Introduction

The Philippine banking system is composed of four types of banks: commercial banks (further subdivided into universal and regular commercial banks), thrift banks, rural banks, and cooperative banks. As of 1st quarter of 2014, the Philippine banking system is composed (by classification), banks (head offices) consisted of 20 universal banks, 16 commercial banks, 71 thrift banks (TBs), and 566 rural banks (RBs). This shows that the number of banking institutions (head offices) fell to 683 as of end of June 2013 from quarter-end year ago levels of 687 and 712, respectively. The market size of the banking industry changes mainly because of bank consolidations and exit of weaker players in the industry.

On the other hand, the operating network (including branches) of the Philippine Banking System increased to 9,543 in 2nd quarter of 2013 from 9,477 in 1st quarter of 2013 and 9,207 during the same period last year, mainly because of the increase in branches of universal and commercial banks and thrift banks. The overall resources of the banking industry mainly increase due to growth in loans, securities and other shares and non-financial assets, representing the public's continued trust in the Philippine Banking System. Universal and commercial banks contribute nearly 90% of the total resources of the Philippine Banking System.

Behind the stable growth in banking industry, some problems may arise along the way. A tension in capital raising, interest rates will continue to be low, and the market will

continue to be liquid, thus more competition and there are lot of changes in regulatory or not that will have an impact on the performance of key players in banking industry.

One of the big banks in the industry, Banco De Oro (BDO) completed its capital-raising scheme for the Basel III requirement. BDO is the country's largest bank with over P 1 trillion in assets. Base III introduced a complex package of reforms designed to develop the ability of the bank capital at absorb losses, extend the coverage of financial risks and have stronger firewalls against periods of stress. Bangko Sentral ng Pilipinas (BSP), decided to adopt the capital adequacy standards in full by January 2014, without resource to staggered implementation or a gradual phase-out ineligible capital instruments. The earlier implementation of Base III put the Philippines alongside such jurisdictions as China, Australia, Hong Kong SAR, and Singapore. By adopting the capital adequacy standards in 2014 BSP effectively accelerates its implementation of the Basel III accord for universal and commercial banks, including their subsidiary banks and overseas banks. Some banks have already raised funds at present to comply ahead with the prescribed Basel III limit by the BSP. But some have yet to decide on when and how to finance the capital requirement. A merger and consolidation might happen with the big banks to be able to compete with other key players. On the other hand, small banks experience pressure with the impending effect of the 2015 ASEAN where there will be more foreign financial institutions coming in the local banking front.

Because of these challenges, a need to assess and measure the productivity and technical efficiency of the banks arises. A deep understanding on performance is necessary to be able to survive the competition. Small or big banks will be able to position itself on the industry by assessing key competencies and weaknesses.

The efficiency of banks will result to improve profit, additional funds to be intermediated, extra quality of service for customers, stability, and contribution to the growth of economy. By determining the efficiency and level of inefficiency will help the government to improves its weaknesses and develop its strengths. The performances of banks affect the wealth of the Philippine economy. Identifying this will let them decide on the best move to make to improve the Philippine banking system. Furthermore, the efficiency and productivity is very much useful to policy makers in assessing the effect of policy initiatives.

A performance measure that illustrates how satisfying a bank in utilizing its resources and in generating products and services is defined as efficiency. It entails growth in profitability, exceptional prices and service quality for customers, and considerable amounts of funds to be intermediated (Berger & Humphrey, 1997). It is essential to determine the level of banks efficiency so that the management will be able to determine sources and areas that are efficient and inefficient to compare with its competitors. After determining the efficiency and inefficiency level and its sources the banks management will be able to improve its performance and increase its market share and also improve its market position. Estimating efficiency also apprehend the effects of deregulation and any disruption in finance, failure in institution, loan problems, the quality of the management, concentration of market, including the mergers and acquisitions. Therefore the efficiency of banks contributes to a wealthier and healthier economy, because economic growth and banking output are highly associated with each other.

Objectives of the Study

The study aims to determine the productivity and technical efficiency performance of Universal and Commercial banks using deterministic and stochastic approaches.

Thus, four objectives were formulated as follows:

1. To measure the level of productivity of universal and commercial banks in terms of:
    - 1.a total loans
    - 1.b interest income
    - 1.c non-interest income
2. To determine the factors affecting the total factor productivity and technical efficiency of universal and commercial banks in terms of:
    - 2.a operating cost
    - 2.b total deposit
    - 2.c interest expense
3. To determine the factors affecting total loans, interest income, and non- interest income
4. To determine the least and best performers in output and input slacks between universal and commercial banks to technical inefficiency
5. To find out the effect of size in terms of total assets, age of the banks, type of ownership, and classification of the banks

Significance of the study

The paper intends is to fill in the gap to provide the latest empirical evidence on universal and commercial banks performance efficiency for the test period of 2004-2012. The study concentrates on measuring the total factor productivity and technical efficiency of universal and commercial banks in the Philippines by identifying the source of efficiency and inefficiency, including productivity; while considering the external factors that affects its performance. The impact of

external factors such as size in terms or total assets or resources, age of the bank, and type of ownership, and classification of bank is determined in measuring technical efficiency. This study will practically help the government decision-making bodies and Banko Sentral ng Pilipinas to provide possible solution and strategies to help the least efficient banks that could be found out in this study. Furthermore, the investors will be guided in which bank to invest their funds.

Scopes and Limitation of the Study

A sample of 15 banks, universal banks (Security Bank Corporation, Union Bank of the Philippines, United Coconut Planters Bank, Development Bank of the Philippines, Philtrust Bank, Land Bank of the Philippines, Metropolitan Bank & Trust Company, Banco De Oro, Eastwest Bank, China Bank Corporation, Bank of the Philippine Island, Philippine National Bank and commercial banks (Asia United Bank Corporation, Robinsons Bank Corporation, and Maybank Philippines Inc.) over the time span of 2004 to 2012 has been selected. DEA will be employed to evaluate or examine the technical efficiency and SFA to determine the factors affecting the technical efficiency of the banks, and furthermore to measure the productivity Malmquist Productivity Index will be used. 14 universal and commercial banks that are branches of foreign banks are not included in the study.

2. Literature Review

Study on Bank Efficiency using DEA

Staub, Souza, and Tabak (2010) examined the Evolution of Bank Efficiency of Brazil during the period of 2000 to 2007. They employed Data Envelopment Analysis (DEA) and intermediation approach to measure 127 banks, using interest

expense, operating expenses net of personnel expenses and labor expenses as inputs, and total loans net provision of loans and deposits, investments as output. They also included covariates of interest the NPL, MS, equity, bank activity, bank size, and ownership if it will affect the efficiency of the Brazilian banks. They found that the managers of Brazilian banks were good to select appropriate input mix given prices, but all factor inputs were not able to utilize, this was the reason why there was a higher technical inefficiency. The cost inefficiency found in Brazilian banks was minimally attributed by underutilization of its inputs. As to the size of the banks and their efficiency, the highest inefficiency of micro banks recommended that the niche is a conceivable expectation, which helped explain the merger and acquisition wave; while the size is determined as not so essential cause for economic efficiency despite the fact that descriptive statistics suggested that small banks attribute higher efficiency with in the time period of their analysis. Moreover, public owned banks were found to be most efficient that showed the relative inefficiency and less cost inefficiency of foreign banks. Furthermore, state-owned banks are evaluated to have higher efficiency level compare to private banks.

Assaf, Barros, and Matousek (2011) examined the technical efficiency in Saudi banks during the period of 1999-2007. They employed boothstrap DEA approach, output oriented assumption with VRS assumption to evaluate 9 banks. They used intermediation approach for the selection of variables: inputs are total employees, fixed assets and total deposits, for the outputs are total customer loans, securities and interbank loans. They found out that the technical efficiency boost with an asset, which signifies that banks with larger size bring higher technical efficiency. Although Saudi banks are efficient, they also suggested that there was a need to provide largely in technologies, development of product, human capital, and networking of branches. Furthermore, Saudi banks

constantly develop its efficiency since 2004. However banks technical efficiency was needed to improve with banks that were foreign capitalized; this was in contradictory to the generic concept that foreign capital delivers managerial skills.

Abu-Alkheil, Burghof, and Khan (2012) examined the Islamic Commercial Banking in Europe efficiency performance during the period of 2005 to 2008. They employed two-stage DEA Model in output oriented-intermediation approach while using the OLS (Ordinary Least Squares Regression) to measure 40 banks. The selected inputs for the study were total deposits, total expenses and total staff cost, while total loans and total revenues as outputs. They found out that IBB (Islamic Bank of Britain) was technically inefficient and with relative poor financial performance. The inefficiency of the banks originates from scale (size) inefficiency and issues on management. Additionally, the results suggested that greater profitability and loan intensity, less acquired debt and on normal have a small market share attributes a technically more efficient larger bank. Finally, they proposed that the banks with exceptional efficiency levels were bigger in size (total assets).

Chhikara and Rani (2012) examined the technical efficiency, pure technical efficiency, and scale efficiency of public sector banks in India during the period of 2010 to 2011. They employed Data Envelopment Analysis with Variable Returns to Scale assumptions to measure 26 Public Sector Banks. The results from DEA with variable returns to scale Pure Technical Efficiency (PTE) out of 26 PSBs, 8 banks were found to be inefficient. All the banks mean score of p is 0.992, while based from scale efficiency 8 banks were also found to be inefficient with mean score of .971 of entire banks covered by study. The overall efficiency, 10 banks were inefficient even though the mean score for the banks was 0.987. The study suggested that the banks that are inefficient because they are incapable to achieve acceptable outputs of non-interest income, and loans and advances, which they require to increase.

Furthermore, this inefficient bank did not use the inputs properly; they need to minimize the input.

Chiu and Yu-Chuan (2009) examined the Taiwanese bank efficiency including both external environmental and internal risk during the period of 2002 to 2004. They employed Stochastic Frontier Analysis and super-slacks based measure (SBM) to measure 29 banks, using count of employees, total deposits, fixed assets as input and total amount of loans, total investments and non-interest revenue for outputs, furthermore the government shareholding proportion of the bank, the number of years that the bank has been operating (age), the loans of capital ratio (loans), and the size of the bank are considered as SFA variables. They found that size has significantly coefficient in all input slack equations also the deposit risk. Additionally, external environmental variables do affect the efficiency of the domestic banks.

Barros, Managi, and Matousek (2012) examined the technical efficiency of the Japanese banks with undesirable output during the period 2000 to 2007. They employed Data Envelopment Analysis, CRS and VRS assumptions to measure 133 banks in Japan. Using the intermediation approach, the following inputs were used, number of employees, deposits and premises/physical capital; while outputs were securities, loans and bad loans. They found that the efficiency level remains exceptionally high with regard to number of employees and consumption of bank premises.

Zreika and Elkanj (2011) examined the banking efficiency in Lebanon during the 2 sub periods, 2002- 2006 and 2006 to 2009. They employed Data Envelopment Analysis to measure 40 banks in Lebanon. Labor and capital were input variables while total deposits and total loans as output. DEA results displayed that the intensity of technical efficiency differs beyond the banks. Technical efficiency was the preeminent in large banks and slightest in small banks.

Study on Bank Productivity using Malmquist Total Productivity Index

Liu (2010) examined the technical efficiency and productivity change of commercial banks in Taiwan during the period of 1997 to 2001. He employed Malmquist Productivity Index approach to measure 25 commercial banks. The selected input variables are labor (physical capital), purchased fund (time and savings deposit), and number of employees; while demand deposits (checking, passbook and temporary deposits), short-term loans, and medium term loans for output. He found that the technical efficiencies of the 15 banks have been developing, while the technical efficiency of the 10 banks has been declining. In 1998, 1999, 2000, and 2001 the technical efficiency of banking industry in Taiwan has declined, but the results showed an upward change of technology, thus banks still gain its productivity after the crisis. After all the commercial banks are very comparable in Taiwan, a bank must actualize the product differentiation and explore for financial modernization capacity to go for robust aggressiveness in the market and avoid from crisis with minor sources.

Nasieku, Kosimbei, and Obwogi (2013) examined the intermediation efficiency and productivity of commercial banks in Kenya during the period of 1999 to 2007. They employed Data Envelopment Analysis and Malmquist Productivity Index (MPI) to measure Kenyan banking sector. Total costs (interest expense and non-interest expense, personnel expenses), total deposits (total customers and short term funding) as inputs, while total loans, and other earning assets as outputs. They found out that Kenyan banking sector has outstandingly grown not only in size but also in there trading activities as shown by the increase in bank outputs (loans and investment) and inputs (deposit and total cost) during the 2001-2010 period analysis. DEA results 80% overall efficiency scores. The productivity growths were largely the result of technical change. The

analysis showed that all large banks reported positive TFP change, meaning there was progress unlike the medium and small banks that reported mixed reactions. Looking at the large banks technological change, they all developed in terms of technology with none reporting a negative sign. The performance of large banks showed increase in technological innovations by the largest percentage as compared to medium and small banks. Large local banks have the highest productivity index though not the best in the industry. The findings suggested that the heightened performance of banks in Kenya during the sample period was primarily due to technological change and not from other efficiencies (such as exceptional management or organization). There was indication that some banks reacted more productively and positively to the convenience suggested by modern technology, than other banks, as asserted to a greater degree of dispersion in bank performance, as to the initial DEA results over time.

Guzman and Reverte (2008) examined the performance in productivity, efficiency change and shareholder value of Spanish banking sector during the period of 2000 to 2004. They employed Malmquist non-parametric technique to measure 14 banks using total deposits, interest expenses and commissions paid and personnel and administrative expenses as inputs and total loans, interest income and commissions as outputs. They found that banks are distinguished by higher efficiency and productivity were the ones with a higher shareholder value. Furthermore, the results also revealed that there is a high efficiency scores present in the banks for the study period where in the process of merger and acquisition occurred, therefore this occurrence helped with the improvement of banks efficiency. While on the productivity, the growth is 2.2% and was almost entirely associated to technological change 2.1% despite the increase in productivity of the best practice banks; the small banks only needed to perform a small catching up effect.

Study on Bank Efficiency using SFA

Dond, Hamilton, and Tippett (2014) examined the efficiency of Chinese banks divided into 5 bank types: Big Four, Policy Banks, JSCBs, CCBs and Foreign banks in China during the period of 1994 to 2007. The employed Stochastic Frontiers Analysis and Data Envelopment Analysis to measure 41 banks using total physical capital, total borrowed funds and labour as input variables, and total loans, other earning assets and non-interest income as output. They also considered use of control variables including total equity, non-performing loans and time trend variables (bank size, market structure indicators as well as dummy variables of bank ownership). They found that medium size banks in Chinese banking sector were more scale efficient, than any of the two, a really large or really small bank. They suggested that the employment of multiple frontier techniques for efficiency determination was highly suggested and that this scholarly crosschecking investigation will bring about in more strong and convincing assessments of performance in the banks.

Hasan, Kamil, Mustafa, and Baten (2012) examined the technical efficiency of Domestic Bank in Malaysia during the period of 2005 to 2010, they employed Stochastic Frontier Analysis an output oriented measure of technical efficiency using total earning assets as dependent variable and total deposits, total overhead expenses as inputs. They found that banks, which utilize higher deposits, were further productive, while banks, which utilize fewer expenses for overhead, were also further productive.

Kristo (2011) examined the efficiency of Albanian banking system during the period of 2002 to 2011. He employed the Stochastic Frontier Analysis to examine the efficiency of 17 banks, using net interest margin, cost-income ratio, overhead cost to total assets, operating expenses to operating revenues and return on assets as input and output variables. He

suggested that, it is not clear with the association between ROA or banks sizes with its cost efficiency, because there were small banks with negative ROA but showed efficiency compare to larger banks with positive ROA.

3. Methodology

This study involved a utilization of inferential statistics known as quantitative research to obtain the results of the study. A descriptive statistics has also been used. The audited annual financial statement of each bank and annual reports from the Securities and Exchange Commission will be analyzed. Different books and journals published by different international publishers helped a lot for understanding the research.

Three inputs and outputs were employed this study to perform the fundamental examination of productivity and efficiency analysis. Furthermore, it included other exogenous variables such as size of the bank in terms of total assets, type of ownership, age of the bank-years in the industry, and classification of the bank that affect their technical efficiencies. Performance Analysis of universal and commercial banks were evaluated during the time period of 2004 to 2012.

To be able to examine the productivity and technical efficiency, a non-parametric approach (DEA) Data Envelopment Analysis and a parametric approach, Stochastic Frontier Analysis (SFA), were used in this study. By using these two quantitative approaches the banks performance will be able to measure for the given period of time, and the effect of size in terms of total assets, age of bank and the type of ownership and classification of the bank.

DEA (Data Envelopment Analysis)

This paper compared universal and commercial banks using DEA approach. The DEA-model is estimated under the

assumption of VRS approach, because the sample varies on its sizes, also known as BCC model as suggested by Banker, Charnes, and Cooper (1978) and Cooper, Seiford, and Toke (2007). DEA can measure the efficiency of banks under Constant Returns-to-Scale (CRS) and Variable-Returns-to-Scale (VRS). CRS assumption is more acceptable when all Decision Making Units (DMUs) are operating at optimal scale.

The DEA approach permits the interpretation of an efficient production frontier, which provides as a benchmark for the examination of efficiency in the sense of Farell (1957).

CCR-Model

DEA was initially introduced by Charnes, Cooper, and Rhodes (1978) with the assumption of constant return to scale (CRS) in effort to suggest a model that generalizes the single-input, single output measure of a DMU to a multiple inputs, multiple outputs setting. CCR Model is introduced by Charnes, Cooper, and Rhodes, 1978. This model examines the efficiency of each DMU, which achieved as a maximum of a ratio of total sum of weighted outputs to total sum of weighted inputs. Using DEA approach in examining efficiency may be based on either an input-oriented model or an output-oriented model. In output-oriented model, the technical inefficiency can be measured as a proportional increase in output production. Choosing any of the orientation will not robustly affect the efficiency estimations, because both approaches will show the same frontier, still the most excellent performers will be identified. The competition in banking industry especially in universal and commercial banks is very tough, merger and acquisitions are happening recently (i.e., PNB and Allied Bank). Since universal and commercial banks almost offer the same products and their operations are same, and serves as both intermediary in converting deposits to loans, input-oriented BCC model will be used in the study, defined as the maximum attainable proportional devaluation in input with output held constant.

The DEA efficiency score in the presence of multiple input and output factors is defined as:

$$\text{Efficiency} = \frac{\text{weighted sum of outputs}}{\text{weighted sum of inputs}}$$

A DMU can be said to be comparatively efficient to another if it can produce same amount of output with fewer inputs or can produce higher output with equal or smaller amount of inputs. The efficiency score lies between 0 to 1 and the DMU with maximum efficiency score of 1 is known as an efficient DMU.

CCR models are called as fixed efficiency respect to scale that is outputs change proportional to input changes (Fakuyama, 2000).

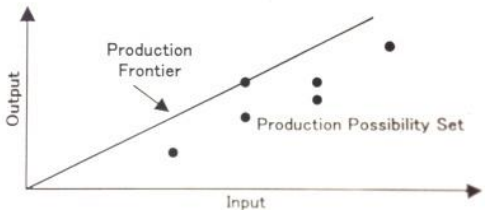

Figure 1.5 Production Frontier of CCR Model Cooper, Seiford, & Tone, A Comprehensive Text with Models, Applications, References and DEA-Solver Software (1998)

BCC Model

BCC Model (Banker-Charnes-Cooper) model has its production frontiers stretch over by the convex hull of the actual DMUs. The frontier have piecewise linear and concave components, leads to variable returns-to-scale characterizations with (a) increasing returns to scale appearing in the first solid line segment followed by (b) decreasing returns-to-scale in the second segment and (c) constant returns-to-scale appearing at the point where development from the first to second segment is made.

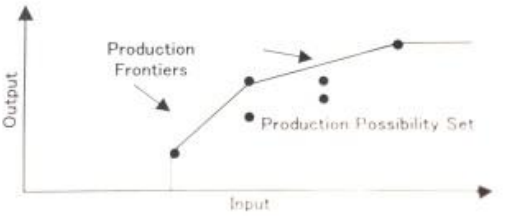

Figure 1.6 Production Frontiers of BCC Model Cooper, Seiford, & Tone, A Comprehensive Text with Models, Applications, References and DEA-Solver Software (1998)

CCR-type models, under uncertain efficiency, examine the radial (proportional) efficiency θ* but do not take account of the input excesses and output deficiencies. This is a disadvantage whereas θ* does not involve the nonzero slacks. Even though the additive model accord with the input exuberance and output shortfalls directly and can single out efficient and inefficient DMUs, it has no method to benchmark the extent of inefficiency by a scalar measure related to the θ* in the CCR-type models.

Slack Based DEA Models

The input-oriented DEA models contemplate the attainable (proportional) input reductions while maintaining the prevailing level of outputs. The output-oriented DEA models contemplate the attainable (proportional) output enhancements while maintaining the prevailing level of inputs. Charnes, Cooper, Golany, Seiford, and Stutz (1985) established an additive DEA model that examines desirable input decreases as well as output increases concurrently. The additive model is based upon input and output slacks.

$$\max \sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+$$

subject to :

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = x_{io} \qquad i = 1,2,\ldots,m;$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{ro} \qquad r = 1,2,\ldots,s;$$

$$\lambda_j, s_i^-, s_r^+ \geq 0 \qquad (1.14)$$

$$\max \sum_{i=1}^{m} w_i^- s_i^- + \sum_{r=1}^{s} w_r^+ s_r^+$$
subject to
$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = x_{io} \qquad i = 1,2,...,m;$$
$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{ro} \qquad r = 1,2,...,s;$$
$$\lambda_j, s_i^-, s_r^+ \geq 0 \qquad (1.15)$$

Where w^-_i and w_r^+ are user-specified weights achieved through value judgment. The DMU_o under assessment will be termed efficient if and only if the optional value to (1.9) is equal to zero. On the other hand, non-zero optimal s_i^{-*} classify an exuberance usage of the *i*th input, and the non-zero optimal s_r^{+*} identifies a loss in the *r*th output. Thus, the solution of (1.15) allows the information on potential improvement to single outputs and inputs of each DMU. Apparently, model (1.15) is appropriate for setting targets for inefficient DMUs with a *priori* information on the improvements of outputs and inputs.

It should be regarded that model (1.15) does not automatically yield results that are contrasting from those attained from the model (1.14). Specifically, it will not turn the disposition from efficient to inefficient (or vise versa) for any DMU.

Model. (1.15) identifies a CRS frontier, and therefore is called CRS slack-based model. The table summarizes the slack-based models in terms of the frontier types.

Frontier type	Slack-based DEA Model
CRS	$\max \sum_{i=1}^{m} w_i^- s_i^- + \sum_{r=1}^{s} w_r^+ s_r^+$ subject to $\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = x_{io} \quad i = 1,2,...,m;$ $\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{ro} \quad r = 1,2,...,s;$ $\lambda_j, s_i^-, s_r^+ \geq 0$
VRS	Add $\sum_{j=1}^{n} \lambda_j = 1$
NIRS	Add $\sum_{j=1}^{n} \lambda_j \leq 1$
NDRS	Add $\sum_{j=1}^{n} \lambda_j \geq 1$

Figure 1.7: Slack-based Models Cook & Zhu (2005).

Malmquist Productivity Index

This study employed Malmquist Total Factor Productivity (TFP) index to analyze productivity change and to breakdown this productivity change into technical change and technological change. The Malmquist Productivity Index (MPI) employs a distance function approach to determine productivity improvements. Following DEA, if inefficiency does occur, the development of any given bank over time will depend on both its position proportionate to the corresponding frontier (technical efficiency) and the position of the frontier itself (technical change). These allow us to differentiate between changes arising from the bank's catch up to the frontier and that arising from the frontier changing up over time. (Nasieku, Kosimbei, and Obwogi, 2013).

The Malmquist index in bases on the output distance function, according to Shepard (1970) and Fare, Shawna Grosskopf, Mary Norris, and Zhang (1994) is defined as:

$$D_t^0(x_t, y_t) = \inf\{\theta : (x_t, y_t/\theta) \in T_t\} \qquad (1)$$

where xt, and yt denote a vector of inputs and outputs, respectively and Tt represents the production technology for each reference period. The distance function is the reciprocal of Farrell's (1957) measure of output technical efficiency, that measures the distance of observation from the technology frontier.

Following Fare, Shawna Grosskopf, Mary Norris, and Zhang (1994), there will be an assumption that ouput oriented constant return to scale, the Malmquist TFP index between period t (the base period) and period t is given by:

$$M_O(\mathbf{x}^{t+1}, \mathbf{y}^{t+1}, \mathbf{x}^t, \mathbf{y}^t) = \left[\left(\frac{D_O^t(\mathbf{x}^{t+1}, \mathbf{y}^{t+1})}{D_O^t(\mathbf{x}^t, \mathbf{y}^t)}\right)\left(\frac{D_O^{t+1}(\mathbf{x}^{t+1}, \mathbf{y}^{t+1})}{D_O^{t+1}(\mathbf{x}^t, \mathbf{y}^t)}\right)\right]^{\frac{1}{2}} \qquad (2)$$

where the $\hat{D}_o^t\left(x^t, y^t\right)$ is the distance from period t observation to period s efficiency frontier. A productivity growth from period t

to to period t is indicated if a value of Mo is greater than one, while decline in productivity if less than.

There are two components of the Malmquist index formulation of productivity growth, the following:

$$M_O(\mathbf{x}^{t+1},\mathbf{y}^{t+1},\mathbf{x}^{t},\mathbf{y}^{t}) = \left[\left(\frac{D_O^t(\mathbf{x}^{t+1},\mathbf{y}^{t+1})}{D_O^t(\mathbf{x}^{t},\mathbf{y}^{t})}\right)\left(\frac{D_O^{t+1}(\mathbf{x}^{t+1},\mathbf{y}^{t+1})}{D_O^{t+1}(\mathbf{x}^{t},\mathbf{y}^{t})}\right)\right]^{\frac{1}{2}} \quad (3)$$

According to Fare, Shawna Grosskopf, Mary Norris, and Zhang (1994) using DEA-like linear programming techniques Charnes, Cooper, & Rhodes (1978), we can calculate the distance from equation 3 for the Malmquist TFP index, under the assumption of CRS, DEA model is expressed as:

$$\begin{aligned} &[d_o^{t+1}(x_{t+1},y_{t+1})]^{-1} = \max_{\theta,\lambda}\theta \\ &st \\ &-\theta y_{i,t+1} + Y_{t+1}\lambda \geq 0 \\ &x_{i,t+1} - X_{t+1}\lambda \geq 0 \\ &\lambda \geq 0 \end{aligned} \quad (4)$$

Where Yt and Xi represent the outputs and inputs, respectively and () represent the weight of each unit within the reference or "perr group" to which is correlated any distinct examination to be able to resolve the distance to the efficiency frontier.

Stochastic Frontier Analysis

Aigner, Lovell, and Schmidt (1977) and Meeusen and van den Broeck (1977) independently proposed the stochastic frontier production model of the form

$$\text{In } q_i = X_i^1\beta + v_i - u_i \quad (9.2)$$

Stochastic Frontier Production Function the output values are bordered from above by the stochastic (i.e., random) variable exp ($X_i^1\beta+v_i$). The random error v_i can be positive or negative and so the stochastic frontier outputs differ about the deterministic part of the model, exp($X_i^1\beta$).

In SFA, the aberration from a firm's observed cost, the frontier, may be interpreted by an error term, which can be divided into components, one attributing to random noise and the other one to technical or allocative efficiency.

Battese and Coelli (1995), proposed model to assimilate the possibility that the mean of the inefficiency levels can be elucidated by a set of environmental variables, i.e. the random disturbance terms, $u_{it,}$ catching the effects of cost inefficiency are modeled in terms of a set of environmental variables $E_{it,}$ as follows:

$$u_{it} = \delta E_{it} + w_{it}$$

The random error term, $w_{it,}$ taking the effect of the 'unobserved' factors and is explained by a truncated normal distribution with zero mean and constant variance and δ is a vector of estimated parameters. The inefficiency term u_{it} is individually but not identically distributed and takes the form $u_{it} \sim (\delta E_{it}, \sigma_u)$ where the truncation point is $- \delta E_{it}$ (Coelli, Prasada Rao, O' Donell, & Battese 2005).

Kruskal-Wallis test

It is a non-parametric test used to compare three or more samples, it is a logical extension of the Wilcoxon-Mann-Whitney Test, it is used to test the null hypothesis that all populations have identical distribution functions against the alternative hypothesis that at least two of the samples differ only with respect to location (median) if it all.

4. Input and Output Variables

According to Eken and Kale (2011), there are 3 types on measuring bank branch performance approach namely "production approach", "intermediation approach", and " profitability approach". The production approach perceive banks as institutions employing labor and capital for branch performance evaluation (Freixas & Rochet, 1997). The second approach, banks provides as intermediary for converting deposits into money to lent to borrowers. The third and newest approach, being started to use in the industry, a more profit oriented and uses variables like interest income and non interest income, the profit oriented approach.

Using the DEA model both input and output oriented is possible to use to determine the efficiency level and bank productivity. Input oriented model, we minimized the inputs or the use of given resources, while output oriented model we maximize output using lesser or the given amount of input.

The intermediation approach view deposits as input. Berger & Humphrey (1997) suggested that intermediaion approach is more applicable in analyzing bank performance, while the production approach is best for examining branch performance and efficiency. This is the reason why intermediaton approach will be used in analyzing the efficiency and universal and commercial banks.

DEA Variables

This study used three inputs and three outputs to examine the banks performance in terms of efficiency and productivity. The inputs were (a) operating expenses (b) total deposit (c) interest expense, while the output of the study (a) total loans (c) interest income (d) non-interest income. All the input and output variables covered the test period of 2004-2012 of the Universal and Commercial banks.

SFA Variables

In addition to input output variables, the utilized exogenous variables in the SFA model, these variables are size in terms of total assets, age of the bank, and ownership and classification of the bank. These variables determine its effect on the performance efficiency and productivity of each universal and commercial banks.

Data Gathering procedure and Source of Data

This research mainly uses secondary data. All the data of this study will be based on audited annual financial statement and annual report extracted from the website of each universal and commercial banks. The financial statement will come from

Securities and Exchange Commission. Banks with negative values are not possible to include because of limitation of using DEA. Furthermore, banks with missing annual report and banks that cannot be found on SEC database are not included in the study. Universal and commercial foreign bank branches, thrift banks, savings banks and rural banks are not included in the sample.

5. Results and Discussion

1. Examine the productivity of 15 banks over the test period (2004 – 2012).

Across the banks, the top three (3) highest performers in productivity (tfpch) are BDO Unibank (1.117), Metropolitan Bank & Trust Co. (1.114), and PNB (1.096). The 4^{th} – 10^{th} banks with productivity above 1.000 are LBP (1.095), BPI (1.090), China Banking Corporation (1.059), Security Bank Corporation (1.044), East-West Banking Corporation (1.041), Union Bank of Philippines (1.040), and Asia United Bank Corporation (1.022). Rest of the banks perform below the 1.000 mark, namely: DBP (0.985), Philtrust Bank (Philippine Trust Co., 0.977), MayBank Philippines, Incorporated (0.945), Robinsons Bank/ABN Amro Bank, Inc. (0.844) and United Coconut Planters Bank (0.810).

Table 1 shows the productivity of the banks (2004 – 2012). There are ten (10) banks above the (tfpch > 1.000) mark indicating improvement in productivity. Improvement in productivity is caused by either overall efficiency (effch) or technological change (techch). Banks that show improvement in productivity because of overall efficiency (effch) or cost efficiency (Cooper et. al, 2006) are the following: LBP (effch = 1.060), Security Bank Corporation (effch = 1.039), and East-West Banking Corporation (effch = 1.030). Banks with improved productivity because of technological progress (techch) are as follows: BDO Unibank (techch = 1.069), Metropolitan Bank & Trust Company (techch = 1.104), PNB

(techch = 1.104), BPI (techch = 1.066), China Banking Corporation (techch = 1.040), Union Bank of the Philippines (techch = 1.040) and Asia United Bank Corporation (techch = 1.022).

There are five (5) banks below the 1.000 mark signifying regress in productivity. Banks that failed to achieve improvement in productivity (tfpch < 1.000) because of technological obsolescence (techch) rather than overall (cost) inefficiency (effch) are the following: DBP (techch = 0.985), Philtrust Bank (Philippine Trust Co., techch = 0.959), May Bank Philippines, Incorporated (techch = 0.941), Robinsons Bank/ ABN Amro Bank, Inc. (techch = 0.915), and United Coconut Planters Bank (techch = 0.825). On the average, the cross-sectional analysis reveals that banks are productive (tfpch = 1.018) because of overall (cost) efficiency (effch = 1.012) rather than technological growth (techch = 1.005).

Table 1. Productivity of Philippine Banks.

MALMQUIST INDEX SUMMARY OF FIRM MEANS FOR PRODUCTIVITY		tfpch	effch	techch	tfpch	effch	techch	# times
firm	BANKS	tfpch	effch	techch	rank	rank	rank	top 3
1	SECURITY BANK CORPORATION	1.044	1.039	1.005	7	3	10	1
2	UNIONBANK OF THE PHILIPPINES	1.040	1.000	1.040	9	10	5.5	0
3	UNITED COCONUT PLANTERS BANK	0.810	0.982	0.825	15	14	15	0
4	DBP	0.985	1.000	0.985	11	11	11	0
5	LBP	1.095	1.060	1.033	4	1	7	1
6	BDO UNIBANK	1.117	1.045	1.069	1	2	3	3
7	CHINA BANKING CORPORATION	1.059	1.019	1.040	6	6	5.5	0
8	EAST WEST BANKING CORPORATION	1.041	1.030	1.010	8	4	9	0
9	METROPOLITAN BANK & TRUST CO.	1.114	1.009	1.104	2	8	1.5	2
10	PNB	1.096	0.993	1.104	3	13	1.5	2
11	PHILTRUST BANK (PHIL. TRUST CO.)	0.977	1.019	0.959	12	7	12	0
12	BPI	1.090	1.023	1.066	5	5	4	0
13	ASIA UNITED BANK CORPORATION	1.022	1.000	1.022	10	12	8	0
14	MAY BANK PHILIPPINES, INC.	0.945	1.005	0.941	13	9	13	0
15	ROBINSONS BANK/ABN AMRO BANK, INC	0.884	0.966	0.915	14	15	14	0
	mean	1.018	1.012	1.005	$\chi^2_{(df=16,\ 0.005)} = 44 > 34.27$			

The level of productivity (tfpch), overall (cost) efficiency (effch) and technological change (techch) differs from the 15 banks. However, five (5) banks were detected in the top three (3) ranking in productivity, overall (cost) efficiency, and technological change within 2004 – 2012, namely: BDO

Unibank (3 times), Metropolitan Bank & Trust Co and PNB (2 times each), and LBP and Security Bank Corporation (1 time each). The rest of the banks occupied 4th rank to 15th ranks in the productivity, overall (cost) efficiency, and technological progress indicators.

A Kruskal – Wallis test was conducted to determine if the banks really exhibit differences in performance ranking. If the chi-square (χ^2) computed is lesser than the critical value of chi-square, then the rankings in the three (3) indicators (productivity, overall (cost) efficiency and technological change) are the same and no differences in performance exist. The Kruskal-Wallis shows that the chi-square computed ($\chi^2_{(DF=16, 0.005)} = 44$) is greater than the critical value of the chi-square ($\chi^2 = 34.27$) at 0.05 % level of significance. This means that the variation in ranking is true and the banks differ in performance during the 9-year test period.

The above cross-section implied that majority of banks achieved improvement or growth in productivity due to overall (cost) efficiency (effch) rather than technological progress (techch). Noor & Ahmad (2012) The Islamic banks have been managerially efficient in utilizing their entire resources. They have a high Pure Technical Efficiency, and PTE is the main reason for determining world Islamic bank total technical efficiency. They suggested those more efficient banks likely to become more profitable, a positive relationship between TE levels and bank profitability. Moreover technically, more efficient banks are those that have fewer market share and high non-performing loans. Loans intensity, market capitalization is negatively correlated with technical efficiency, but size is positively related to TE.

Other banks achieved productivity because of technological progress (techch) rather than overall (cost) efficiency. Nasieku, Kosimbei, and Obwogi (2013) suggested that the added performance of banks in Kenya during the sample period was primarily attributed to technological change

and not other efficiencies (such as superior management or organization). There is confirmation that some banks behave more positively and productively to the favorable circumstances provided by new technology than other banks, as expressed in the higher dispersion in bank performance in the initial DEA results over time. Liu (2010) purported that the technical efficiencies of the 15 banks have been developing, while the technical efficiency of the 10 banks has been declining. In 1998, 1999, 2000 and 2001 the Taiwan banking industry decrease its technical efficiency, but after the crisis banks still increase its productivity attributed by upward shifts of technology. Similar result with Sufian (2010) suggested that the Malaysian Islamic Banking sector show productivity progress, this is because of technological change rather than efficiency change. Some banks failed to achieve productivity because of technological obsolescence (techch). Assaf, Barros, and Matousek (2011), said that although Saudi banks are efficient they also suggested that it is necessary to prepare substantially in technologies, product development, human capital and branch networking.

Table 2 shows the comparison of yearly productivity, overall (cost) efficiency, and technological improvement (techch). The 15 banks show no improvements in productivity (tfpch < 1.000) in 2004 – 2005, 2005 – 2006, and 2010 - 2011 because of obsolete bank technology (techch < 1.000) but maintain cost efficiency (effch > 1.000). Banks achieve productivity improvements (tfpch >1.000) from 2006 – 2007, 2007 – 2008, 2008 – 2009, 2009 – 2010, and 2011 – 2012 because of cost efficiency or technological progress. Particularly, productivity improvements (tfpch > 1.000) in 2006 – 2007 and 2008 -2009 are caused by overall (cost) efficiency (effch > 1.000) rather than technological progress (techch < 1.000), respectively. While, productivity improvements in 2007 – 2008, 2009 – 2010 and 2011 – 2012 are influenced by technological progress (techch > 1.000) rather than cost efficiency (effch < 1.000), respectively.

Table 2. Productivity of Philippine Banks (2004 – 2012).

total factor productivity vs effch and techch								
MALMQUIST INDEX SUMMARY OF ANNUAL MEANS					tfpch	effch	techch	Total
year	year	tfpch	effch	Techch	above avg	above avg	above avg	above avg
2	2004 - 2005	0.870	1.017	0.855	0	1	0	1
3	2005 - 2006	0.965	1.019	0.947	0	1	0	1
4	2006 - 2007	1.013	1.045	0.969	0	1	0	1
5	2007 - 2008	1.110	0.948	1.170	0	0	1	1
6	2008 - 2009	1.012	1.071	0.945	0	1	0	1
7	2009 - 2010	1.139	0.919	1.239	1	0	1	2
8	2010 - 2011	0.981	1.098	0.894	0	1	0	1
9	2011 - 2012	1.077	0.994	1.084	0	0	1	1
	mean	1.018	1.012	1.005	1	5	3	9
					$\chi^2_{(df=1,\ 0.005)} = 23 > 7.88$			

The annual index of productivity (tfpch), overall (cost) efficiency (effch) and technological growth (techch) were benchmarked to their mean indices to detect if their annual performance was above the mean. The comparisons showed that banks perform better in productivity during 2009 - 2010. Banks were cost efficient (above the group mean, effch = 1.012) during 2004 – 2005, 2005 - 2006, 2006 - 2007, 2008 - 2009, and 2010 – 2011, respectively. Technological growth was above average during 2007 – 2008, 2009 – 2010, and 2011 – 2012, respectively.

The results of annual performance comparison on productivity (tfpch), overall (cost) efficiency (effch) and technological change (techch) to their means implied that banks enjoyed exceptional productivity during 2009 – 2010, high cost efficiency during 2004 - 2007 than the years 2008 – 2012, and technologically competitive during 2009 - 2012 than the years 2004 – 2008. On the average, the results revealed that banks' cost efficiency have greater influenced in attaining productivity than technological progress. Also, banks' showed below the average productivity improvement with higher tendency to cost efficiency and less of technical progress before 2007 – 2008. But, as improvement in productivity reached above average performance from 2008 to 2012, cost efficiency and technological progress tends to exhibit equal improvements. In contrast with Chhikara & Rani (2012) in their study, out of 26

PSBs, 8 banks were found to be inefficient. The study suggested that the banks that are inefficient because they are incapable to produce adequate outputs of other income, and loans and advances, which they must increase. Furthermore this inefficient banks have not been used the inputs properly, they need to minimize the input.

Kruskal – Wallis tested if the banks experience low (0) and high (1) indices to the group means. If the chi-square (χ^2) computed is lesser than the critical value of chi-square, then there's no difference between low and high annual performance in the three (3) indicators (productivity, overall (cost) efficiency and technological change). The Kruskal-Wallis shows that the chi-square computed ($\chi^2_{(df=1,\ 0.005)}$ = 23) is greater than the critical value of the chi-square (χ^2 = 7.88) at 0.05 % level of significance. This means that the incidence of low annual productivity (more zeroes), high annual cost efficiency (more 1), and low annual technological growth (more zeroes) is true and the banks differ in annual performance during the 9-year test period.

2. The sources of overall (cost) efficiency or technical efficiency of 15 banks in 2004 - 2012.

Previously, banks' cost efficiency significantly contributed to average productive years. Overall (cost) efficiency is affected by pure efficiency change (pech) and scale efficiency change (sech). Cooper et. al (2006, p. 140 - 141) decompose the cost efficiency (effch) into pure technical efficiency (pech) and scale efficiency (sech). This decomposition reflects the sources of cost efficiency of selected Philippine banks. Table 3 and 4 show crosswise and annual efficiency and ranking of selected Philippine Banks.

Across the banks and the test periods, scale efficiency change (sech) or advantageous conditions in the operation of the banks and pure efficiency change (pech) or managerial efficiency caused the banks to be cost efficient (effch). Kruskall-Wallis test for ranks showed that five (5) banks were consistent

in occupying top 3 spots in their cost efficiency performance at 5% level of significance. LBP, BDO-UNIBANK & Security Bank Corporation, and East West Banking Corporation occupy the first, second and third spots, respectively. This indicates that the top five (3) banks performed better in cost efficiency as driven by advantageous condition (sech) and managerial efficiency (pech) in handling their inputs.

Table 3. Efficency vs pech and sech.

MALMQUIST INDEX SUMMARY OF FIRM MEANS FOR EFFICIENCY					effch	pech	sech	# time
firm	BANKS	effch	pech	sech	rank	rank	rank	top 3
1	SECURITY BANK CORPORATION	1.039	1.018	1.020	3	3	4	2
2	UNIONBANK OF THE PHILIPPINES	1.000	1.000	1.000	11	9	12	0
3	UNITED COCONUT PLANTERS BANK	0.982	0.983	0.999	14	14	14	0
4	DBP	1.000	1.000	1.000	11	9	12	0
5	LBP	1.060	1.024	1.035	1	1	2	3
6	BDO UNIBANK	1.045	1.008	1.036	2	4	1	2
7	CHINA BANKING CORPORATION	1.019	1.000	1.019	6	9	5.5	0
8	EAST WEST BANKING CORPORATION	1.030	1.021	1.009	4	2	8.5	1
9	METROPOLITAN BANK & TRUST CO.	1.009	1.000	1.009	8	9	8.5	0
10	PNB	0.993	0.981	1.013	13	15	7	0
11	PHILTRUST BANK (PHIL. TRUST CO.)	1.019	1.000	1.019	7	9	5.5	0
12	BPI	1.023	1.000	1.023	5	9	3	1
13	ASIA UNITED BANK CORPORATION	1.000	1.000	1.000	11	9	12	0
14	MAY BANK PHILIPPINES, INC.	1.005	1.000	1.005	9	9	10	0
15	ROBINSONS BANK/ABN AMRO BANK, INC	0.966	1.000	0.966	15	9	15	0
	mean	1.012	1.002	1.010	$\chi^2_{0.05,15,0.005} = 43.92 > 34.27$			

Serial performance on cost efficiency (effch) was improved by advantageous conditions (sech) during 2005 – 2006, 2006 – 2007, and 2010 – 2011, respectively. Managerial efficiency (pech) improves cost efficiency (effch) during 2008 – 2009. Overall perspective of the improvement on annual cost efficiency (effch) is caused by advantageous conditions (sech) and managerial efficiency (pech) of the selected banks.

Table 4. Annual efficiency change vs pech and sech 2004 – 2012.

efficiency change vs pech and sech								
MALMQUIST INDEX SUMMARY OF ANNUAL MEANS					effch	pech	sech	Total
year	year	effch	pech	Sech	above avg	above avg	above avg	above avg
2	2004 - 2005	1.017	0.963	1.056	1	0	1	2
3	2005 - 2006	1.019	1.006	1.013	1	1	1	3
4	2006 - 2007	1.045	1.020	1.024	1	1	1	3
5	2007 - 2008	0.948	0.958	0.990	0	0	0	0
6	2008 - 2009	1.071	1.056	1.014	1	1	1	3
7	2009 - 2010	0.919	0.992	0.926	0	0	0	0
8	2010 - 2011	1.098	1.038	1.058	1	1	1	3
9	2011 - 2012	0.994	0.990	1.004	0	0	0	0
	mean	1.012	1.002	1.010	5	4	5	14
					$\chi_{(df=1,\ 0.005)} = 23 > 7.88$			

3. The best and least performers among the 15 banks.

The Best and Least Output Performers.

The most productive scale size (MPSS) describes best performance. It is a condition where banks achieved 100% performance in cost efficiency (crste), managerial efficiency (vrste) and advantageous condition (sech) in their operation. Hence, a good performing bank is in their constant returns to scale (crs or noted by a dash in the results). There are 5 best performing banks that reached their most productive scale size. They have no shortage in their output targets and no excess usage of inputs. The 10 least performers are operating at decreasing or increasing returns to scale and didn't achieve the most productive scale size condition.

Data Envelopment Analysis (DEA) computes and reveals the return to scale (rts) of each respective banks. Selecting the slack-based model of DEA, the outputs and inputs best and least performers is detected using the standards of the most productive scale size. Overall, a bank should passed 100% in cost efficiency (crste), managerial efficiency (vrste) and advantageous conditions (sech) criterions to be included in the best performers. Thus, their operations should be in the constant return to scale (crts) to be the best performer.

Table 5 shows the best and least output performers. The best output performers are Union Bank of the Philippines, United Coconut Planters Bank, DBP, Asia United Bank

Corporation and Robinsons Bank/ABN Amro Bank, Inc. They don't have any output shortage in total loans, interest income, and other income. These best output performers are operating at constant returns to scale (crs, indicated by a dash). This indicates that doubling the inputs (operating expense, total deposits and interest expense) doubles the outputs (length total loans, interest income and other income) of the selected banks (Salvatore 1993).

The above results implied that top five (5) banks converted their inputs efficiently because they economically manage their operation and enjoyed advantageous condition indicated by their scale efficiency. Banks operated at constant returns to scale (crs) because skilled labors and equipment effectively produced the outputs needed with minimum use of time and resources. On a study by Kumar & Gulati (2008) 7 efficient banks are operating at most productive scale size and experiencing constant returns to scale, so they suggested that the policy implication in this findings is that these has a space and capability to improve OTE by increasing their size. The least 10 performing banks are not in their most productive scales size and not operating at constant returns to scale. Four (4) banks incur slacks or shortage in output achievement, namely: BDO Unibank (P54,073.15 million in total loans), Security Bank Corporation (P433.64 million in other income), LBP (P11.01 million in interest income and P398,58 million in other income), and East West Banking Corporation (P439.43 million in interest income and P274.65 million in other income), respectively.

Table 5. The best and least output performers.

			TOTAL LOANS	*INTEREST INCOME*	*NON-INTEREST INCOME*
			Pmillion	Pmillion	Pmillion
Best (Most productive scale size)		Rts	y1	y2	y3
1	UNIONBANK OF THE PHILIPPINES	-	0	0	0
2	UNITED COCONUT PLANTERS BANK	-	0	0	0
3	DBP	-	0	0	0
4	ASIA UNITED BANK CORPORATION	-	0	0	0
5	ROBINSONS BANK/ABN AMRO BANK, INC	-	0	0	0
Least Performers (not in their most productive scale size)					
6	CHINA BANKING CORPORATION	drs	0	0	0
7	METROPOLITAN BANK & TRUST CO.	drs	0	0	0
8	PNB	drs	0	0	0
9	PHILTRUST BANK (PHILIPPINE TRUST CO.)	drs	0	0	0
10	BPI	drs	0	0	0
11	MAY BANK PHILIPPINES, INCORPORATED	Irs	0	0	0
12	BDO UNIBANK	drs	54073.15	0	0
13	SECURITY BANK CORPORATION	drs	0	0	433.64
14	LBP	drs	0	11.01	398.58
15	EAST WEST BANKING CORPORATION	drs	0	439.43	274.65
	mean		3604.88	30.03	73.79

Banks operating at higher scale sizes are operating at decreasing returns to scale (drs) denoting positive but decreasing annual output(s). Decreasing annual output implies that banks operation cannot be sustained in the future. Kumar & Gulati (2008) in their study on 27 Indian public sector banks in the year 2004/2005, 52% banks operate in the zone of decreasing returns to scale and suggested that they need to down size their operations to observe efficiency gains. Banks operating at lower scales sizes are operating at increasing returns to scale (irs) because they can achieve greater economies of scale if they increase their volume of operation (Ramanathan, 2003). At the drs and irs, the selected banks are not 100% efficient in cost, administration (management of inputs) and scale conditions implying a condition of "not in the most productive scale sizes". Related results with Kumar & Gulati (2008) based on their study with 6 banks found to be operating below their optimal scale size and therefore in its IRS, these banks are suggested to develop OTE through increasing their size.

The Best and least Input performers.

Following the standards set above, Table 6 shows that the best input performers are Union Bank of the Philippines, United Coconut Planters Bank, DBP, Asia United Bank Corporation and Robinsons Bank/ABN Amro Bank, Inc. They are the same set of best output performers and don't have any input excesses

in operating expense, total deposits and interest expense. These best input performers are operating at constant returns to scale (crs, indicated by a dash) indicating that doubling the inputs (operating expense, total deposits and interest expense) doubles the outputs (length total loans, interest income and other income) of the selected banks (Salvatore, 1993).

Above results implied that the top five (5) banks reached their most productive scale size (mpss) because they converted their inputs efficiently, economically manage their operation and enjoyed advantageous condition indicated by their scale efficiency. They were operating at constant returns to scale (crs) because inputs effectively produced the outputs needed with minimum use of time and resources. The least 10 performing banks are not in their most productive scales size and not operating at constant returns to scale. Two (2) banks incur slacks or excesses in inputs usage, namely: BDO Unibank (P52,938.53 million in total deposits) and LBP (P10.29 million in operating expense and P458.11 million in interest expense), respectively.

Table 6. The best and least performers in input usage.

INPUT EXCESS USAGE			*OPERATING EXPENSE*	*TOTAL DEPOSIT*	*INTEREST EXPENSE*
			Pmillion	Pmillion	Pmillion
Best (Most productive scale size)		rts	x1	x2	x3
1	UNIONBANK OF THE PHILIPPINES	-	0	0	0
2	UNITED COCONUT PLANTERS BANK	-	0	0	0
3	DBP	-	0	0	0
4	ASIA UNITED BANK CORPORATION	-	0	0	0
5	ROBINSONS BANK/ABN AMRO BANK, INC	-	0	0	0
Least Performers (not in their most productive scale size)					
6	SECURITY BANK CORPORATION	drs	0	0	0
7	CHINA BANKING CORPORATION	drs	0	0	0
8	EAST WEST BANKING CORPORATION	drs	0	0	0
9	METROPOLITAN BANK & TRUST CO.	drs	0	0	0
10	PNB	drs	0	0	0
11	PHILTRUST BANK (PHILIPPINE TRUST CO.)	drs	0	0	0
12	BPI	drs	0	0	0
13	MAY BANK PHILIPPINES, INCORPORATED	irs	0	0	0
14	BDO UNIBANK	drs	0	52938.53	0
15	LBP	drs	1029.20	0	456.11
	mean		68.61	3529.24	30.41

Seven (7) banks operate at higher scale sizes indicating decreasing returns to scale (drs) and positive but decreasing annual output(s). Banks at decreasing annual output is in danger of closing their operation in the future. Kumar & Gulati

(2008) in their study on 27 Indian public sector banks in the year 2004/2005, 52% banks operate in the zone of decreasing returns to scale and suggested that they need to down size their operations to observe efficiency gains. One (1) bank operates at lower scales sizes indicating increasing returns to scale (irs) because they want to achieve greater economies of scale if they increase their volume of operation Ramanathan (2003). At the drs and irs, the selected banks are not 100% efficient in cost, administration (management of inputs) and scale conditions implying a condition of "not in the most productive scale sizes".

4. Factors affecting total loans, interest income, and other income.

Using stochastic frontier analysis (sfa), the three (3) outputs (Total loans, interest income and other income) were regressed individually to operating expense, total deposit and interest expense. This is to detect the best output function for the selected banks. Table 7 shows the stochastic production frontier for the three (3) outputs. A 100% increase in inputs usage (operating expense, total deposit and interest expense) affect total loans by 7.8%, 55.5% and 16.5%, respectively. The combine effects of the inputs (79.8%) implied decreasing returns to scale (drs) operation. On the average, this indicates banks operate and received total loans at a decreasing rate per year.

Interest income responded 11.8%, 24% and 44.6% for every 100% contribution of operating expense, total deposit, and interest expense in the operation of banks. The total responsiveness (80.3%) of interest income reveals decreasing returns to scale (drs) implying positive interest income achieved by banks that decline every year.

Marginal contributions of operating expense and total deposit to other income amounts to 44.4% and 36%, respectively. A growing interest expense decreases other income by -5.8%. The banks operate at decreasing return to scale (drs = 74.6%) that implies declining positive returns on other income.

Table 7. Stochastic production frontier for the outputs.

		y1 = total loans			y2 = interest income			y3 = non-interest income		
Stochastic Production Frontier		mle			mle			mle		
parameter	variable	coeff	t-ratio	sig.	coeff	t-ratio	sig.	coeff	t-ratio	sig.
b_o	constant	3.152	5.94	0.005	1.884	12.13	0.000	0.937	2.10	0.005
b_1	*OPERATING EXPENSE*	0.078	1.39	0.100	0.118	4.92	0.000	0.444	7.14	0.005
b_2	*TOTAL DEPOSIT*	0.555	9.47	0.005	0.240	9.40	0.000	0.360	5.97	0.005
b_3	*INTEREST EXPENSE*	0.165	2.09	0.020	0.446	14.64	0.000	-0.058	-0.60	ns

Among the three stochastic production frontier functions, total loans (y1) is selected on the basis of revealing more significant t-ratios in the deterministic and technical inefficiency portions. Majority of the parameters have significant t-ratios below the 5% level of significance.

5. The effects of age (years), size, and ownership to technical inefficiency.

Table 8 shows the technical inefficiency of banks as affected by size (assets), ownership (private = 1, govt = 0), and bank type (univ. = 1, commercial = 0) at 5% level of significance. Banks with larger asset size is more efficient in their operations than their counterparts with smaller asset size. In line with the results of Abu-Alkheil, Burghof, & Khan (2012) they suggest that the banks with higher efficiency levels are larger in size (total assets), more likely to show profitability and loans intensity, obtain lower levels of debt, and have comparably smaller market share. Zreika & Elkanj (2011) also suggested in their study on 40 banks in Lebanon that technical efficiency is the highest in large banks and lowest in small banks. Government owned banks are more efficient in their operations than the privately owned banks during 2004 – 2012. Staub, Souza, and Tabak (2010) showed that 127 banks in Brazil using DEA, state owned banks have higher efficiency level than private bank; this is supported by agency hypothesis. Commercial banks performed better in efficiency in their operations than universal banks. Age is not statistically

significant at 5%. However, it tends to show that older banks are operating efficiently than younger age banks.

Table 8. Factors affecting technical inefficiency of banks.

		y1 = total loans			y2 = interest income			y3 = non-interest income		
Stochastic Production Frontier		mle			mle			mle		
parameter	variable	coeff	t-ratio	sig.	coeff	t-ratio	sig.	coeff	t-ratio	sig.
d_0	constant	0.318	0.89	ns	-0.448	-0.46	ns	1.510	2.29	0.005
d_1	*SIZE (ASSETS)*	-0.000	-3.29	0.001	0.000	-3.42	0.005	0.000	-3.37	0.005
d_2	*AGE*	-0.001	-0.48	ns	-0.001	-0.38	ns	-0.002	-0.24	ns
d_3	*OWNERSHIP*	0.502	1.89	0.050	1.077	1.12	ns	-0.109	-0.19	ns
d_4	*BANKTYPE*	0.325	2.05	0.050	-0.074	-0.77	ns	-0.769	-1.75	0.05
σ^2	sigma-squared	0.108	5.87	0.005	0.064	4.47	0.000	0.752	5.80	0.005
γ	gamma	0.709	4.32	0.005	0.922	20.17	0.000	0.944	41.12	0.005

The Technical Efficiency Effects Frontier (B&C, 1993; Coelli, 1996) of the study use 15 banks and 9 years for a panel data (cross-sectional and time series) with a total of 135 observations. It approximates the total loans of banks as affected by their operating expense, total deposit and interest expense. The model 2 of Battese and Coelli 1995 as mentioned by Coelli (1996) shows that it is the appropriate tool to determine the deterministic and technical inefficiency of total loans. In this model 2, the mu is not equal to zero ($\mu \neq 0$) because it assumes a distribution that behaves generally truncated normal. Eta ($\eta = 4$) is prompted in the instruction file because we consider time-varying efficiencies (9 years) and consider technical inefficiencies brought about by size (assets), ownership (private = 1, govt = 0), and bank type (univ. = 1, commercial = 0).

The value of sigma squared (= 0.108) is greater than zero signifying that the total loans varies from bank to bank and year to year. The variation is due to inefficiencies to each bank. The value of gamma (=0.709) is greater than zero indicating that the distance from the best practice (frontier) is due to technical inefficiency and not entirely due to chance or random variation.

The average mean TE of 0.616 is obtained by using the SFA model it indicate that selected universal and commercial

banks are producing 62% of the output that could be theoretically produce with the same amount of inputs by a technical efficient banks. Therefore, they need to increase their output by 38% to be efficient.

7. Conclusions, Recommendations, and Directions for Future Research

There were major research objectives determined in the study: (1) to measure the level of productivity of universal and commercial banks over the test period; (2) to determine the factors affecting total factor productivity and technical efficiency of universal and commercial banks over the study period; (3) to determine the factors affecting total loans, interest income and non-interest income; (4) to determine the best and least input and out slacks performers among the universal and commercial banks; and (5) to find out the effect of size, age, ownership, classification of banks.

This study based its analysis from productivity and efficiency of universal and commercial banks for a test period of 2004 to 2012, data provided from the Securities and Exchange Commission and respected banks website for the annual report. The DEA-Malmquist Productivity Index and Stochastic Frontier Analysis were the methods used to attain the objective of the study, and to provide findings that will be very helpful for the government decisions making body.

Productivity of the selected banks in the study improves the productivity as evidences in the DEA analysis. This productivity needs to be sustained considering their cost efficiency and gaps for improvement.

Improvement in productivity is caused either overall efficiency or technological change. This may call for the industry to give considerable awareness to technological progress, the development of ordinary applications and enhancement of a more advanced technological system and

procedures that will capable the banking industry to remain productive. Moreover, majority of the banks achieved improvement or growth in productivity due to overall cost efficiency rather than technological progress. Overall perspective of the improvement on annual cost efficiency is caused by advantageous conditions and managerial efficiency of the selected banks.

Further results revealed that banks operating at higher scale sizes are operating at decreasing returns to scale denoting positive but decreasing annual output, implies that banks operation cannot be sustained in the future. Also, banks that reached there most productive scale size they been able to convert their inputs efficiently, economically manage their operation and enjoyed advantageous condition indicated their scale efficiency. But operating at constant returns to scale because inputs effectively produced the outputs needed with the minimum use of time and resources.

The null hypothesis that there is no significant difference in the productivity of universal and commercial banks is rejected. Kruskal-Wallis test showed that the selected bank varies in their productivity and efficiency at 5% level. While the null hypothesis that there is no significant difference in total factor productivity and technical efficiency of Universal and Commercial banks is also been rejected. Finally, the hypothesis that is no positive relationship to size, age, ownership and classification of the bank is also rejected. It indicates that in general banks technical inefficiency is affected by age, size, ownership and their classification.

Banks usually examine its performance using a traditional method but now a day using a tool like DEA and SFA is a much well known way to measure banks efficiency.

Universal and Commercial banks are challenged to sustain this productivity, yet, to plan and design strategies/activities to fill-in the space/gaps for improvement.

On the productivity of the Universal and Commercial banks, overall cost efficiency due to scale efficiency and pure efficiency change cause the banks to be more efficient than technological efficiency change. The empirical study showed that there is a space for improvement when it comes to technological aspect of the universal and commercial banks. The results also revealed that there is a need that arises from the lack of improvement in technology used by the banks. It is therefore, necessary to invest in technological innovation to improve the quality of service for the customers. Investment to develop Internet banking, online banking, mobile banking that will provide easy access to the customers. The position of a bank in the industry and the competition may vary depending on its technological services. The Bangko Sentral ng Pilipinas therefore need to re-align some policies that will help the banking industry technologically abreast with world's best in the financial market, then the negative impact as a result of limited access to technology can be addressed.

The total loans as suggested in the study affects the productivity and efficiency of the banks, therefore the banks are encourage to increase its total loans, and provide more funds to be intermediated for the customers.

The results that revealed that larger asset sizes bank are more efficient than smaller ones, suggest that mergers and consolidations is necessary now a days with the situation of the banking industry.

This study provides some information and discussion for future researchers and policy makers. The result of this study that larger asset size banks are found to be more efficient than smaller banks, suggested that Universal and Commercial banks at present are encouraged to focus and consider upsizing their assets, some banks may consider consolidations and mergers, and even partner with other banks. This may result to higher technical efficiency and productivity.

In the future it is suggested to conduct a study on banks efficiency and productivity on all banking firms including foreign banks with different set of input and output variables. By and large, to measure other environmental variables such as GDP, Inflation rate and etc. to determine its effect to the inefficiency of the banks. Nevertheless, this study has many limitations and shortcomings and future research will properly address them.

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