



Are the best African banks really the best? A Malmquist data envelopment analysis

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3 **Are the best African banks really the best?**
4 **A Malmquist data envelopment analysis**
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12
13 **Abstract**
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15 **Purpose-** This paper has tried to examine whether the African commercial banks selected as
16 the best African banks by *Global Finance Magazine* really are the best.
17

18 **Design/methodology/approach-** Panel data envelopment analysis (DEA) was used, as well
19 as the Malmquist total factor productivity index (*tfpch*) to distinguish productive banks from
20 unproductive banks. Nineteen commercial banks were selected from the 30 best African
21 banks as identified by *Global Finance Magazine*.
22

23 **Findings-** Of the 19 banks, five were found to be unproductive. Bank productivity was
24 attributed mainly to the technological change (*techch*), and different methods marked
25 different results, for example, the regional winner bank (Standard Bank of South Africa)
26 selected by *Global Finance Magazine* ranked ninth in this study while the Bank Windhoek
27 Limited, Namibia ranked first.
28

29 **Practical implication-** The study confirms the applicability of the DEA for the banking
30 industry. The model witnesses the variability among the banks' efficiency and productivity.
31 Besides, the study reveals different results to the *Global Finance Magazine's* best bank
32 selection. For example, the Standard Bank of South Africa, which is selected as the regional
33 winner, is now ranked ninth under the DEA Malmquist's total factor productivity.
34

35 **Originality/value-** The study shows that the DEA model can be applied not only for
36 analysing the firm's efficiency, but also for objective rating, ranking and selecting best banks.
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38 **Keywords:** Banking, Efficiency, Finance, Performance, Productivity, Ranking

39 **Paper type:** Research paper
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1. Introduction

Global Finance Magazine identified 30 commercial banks as the best African banks in 2015 (*Global Finance Magazine*, 2015). The criteria used for screening the best banks include growth in assets, profitability, strategic relationships, customer service, competitive pricing and innovative products.

The banking industry is one of the most regulated government industries in any country. Evaluating banks' overall performance and monitoring their financial condition is important to depositors, owners, potential investors, managers and, of course, the regulators (Yue, 1992:31). Financial statement analysis (FSA) and data envelopment analysis (DEA) have been applied to evaluate and monitor overall bank performance.

According to Ahmad *et al.* (2007), the most commonly used indicators of bank performance or efficiency are the accounting ratios (such as CAMELS) and efficiency scores obtained from various frontier efficiency approaches; that is, DEA (as cited by Avkiran, 2011:323). Financial statement analysis (FSA) has been used in practice with the belief that the result of the business activities of the firm would be reflected in its financial statement (Ho and Zhu, 2004:426). The CAMELS rating is one of the tools most widely used by principal regulators all around the world for judging the Capital adequacy, Asset quality, Management capacity, Earnings ability, Liquidity and Sensitivity to the market risk (CAMELS) of the financial institutions, including commercial banks (Kabir and Dey, 2012:16).

DEA is defined as "a mathematical programming methodology that can be applied to assess the relative efficiency of a variety of institutions using a variety of input and output data" (Yeh, 1996:980). Avkiran (2011:323) also defines DEA as "an efficient frontier technique that computes a comparative ratio of weighted outputs to weighted inputs for each decision-making unit (DMU) using linear programming".

DEA has been demonstrated to be effective for benchmarking to measure the efficiency of banks for the past two decades (Paradi *et al.*, 2011:100). In addition, Liu *et al.* (2013:893) argue that the DEA is capable of relatively evaluating the individual efficiency or performance of a decision-making unit (DMU) within a target group of interest that operates in a certain application domain such as the banking industry. For a more detailed understanding of DEA, consult Charnes *et al.* (1978).

According to Yue (1992:39), the DEA analysis of the banking industry requires only data on the quantity of inputs and outputs because of the difficulties inherent in defining and measuring the price of banks' inputs and outputs. Besides, Avkiran (2011:323) argues that the DEA's ability to capture the interaction among banks' multiple inputs and outputs in a scalar value (i.e. in a single number) is its distinct advantage over the traditional ratio analysis.

As mentioned above, *Global Finance Magazine* identified 30 banks as the best banks in Africa in 2015. But, *are they really the best? Why?* To answer this question, the study has applied a DEA-Malmquist total factor productivity (TFP) index, which is recommended for panel data to measure productivity change and to decompose this productivity change into technical change and technical efficiency change (Coelli, 1996).

2. Literature Review

The origin of an enveloping curve or efficiency frontier dated back to the academic works of Farrell (1957). He uses a multiple inputs and single output production frontier in order to measure decision-making units' (DMUs) production efficiency by evaluating technical efficiency and allocative (price) efficiency assuming constant returns to scale (CRS). The development of DEA was first framed and described in its current form by Charnes *et al.*

(1978). They enrich the Farrell's efficiency measurement into a method that combines and transforms multiple inputs and multiple outputs into a single firm efficiency index assuming CRS. Banker *et al.* (1984) further extend the Charnes *et al.*'s CRS to variable returns to scale (VRS) that splits the technical efficiency into pure technical efficiency and scale efficiency.

The major challenge faced by the researcher, while determining the relative efficiency, is the selection of appropriate banks' inputs and outputs. The review of prior studies revealed that different studies use a relative variety of inputs and outputs, even if their objective is the same, that is, the measurement of bank efficiency.

The DEA application is commonly categorized into two approaches (Berger and Humphrey, 1997; Cooper *et al.*, 2011; Hancock, 1989; Sealey and Lindley, 1977; Yue, 1992:35):

- *The production approach* views banks as producers of services and products using labour and other resources as inputs and providing deposits, loans and others (in value or number of transactions) as outputs.
- *The intermediation approach* views banks as an intermediary between the depositor and borrower, that is, collecting deposits and other funds from customers (inputs) and then lending the money in various forms of loans, mortgages, and other assets (e.g. investments).

Therefore, the selection of input and output variables for analysing bank efficiency through DEA depends upon which one of the above approaches is followed. Researchers such as Jemrić and Vujčić (2002) and Savić *et al.* (2012) recommend using the intermediation approach because the idea of the intermediation approach is to look more technically at what banks do; besides, this approach is inclusive of interest expenses, which often account for one-half to two-thirds of the bank's total costs and, thus, minimisation of total costs, not just production costs, is needed to maximise profits (Vinh, 2012).

Thus, this study has used the variant intermediation approach while selecting the inputs and outputs for analysing the African banks' efficiency by using the DEA-Malmquist Index analysis, because the observed data is panel data for the latest five years' observation (i.e. 2010 - 2014).

DEA, perhaps, permits flexibility for the selection of input and output variables. The selected variables must be in the realm of the bank, which subsequently perceives variation in its efficiency. Berger *et al.* (1997:152) state that as bank branches pay virtually identical interest rates, there cannot be much inefficiency embedded in the interest expenses. Besides, Oral and Yolalan (1990) advise that while there are no specific rules about the input-output combination, the application of DEA requires a careful identification of inputs and outputs that are meaningful within the framework of the competitive environment of the sample to be compared (as cited by Yeh, 1996: 982).

The empirical practices regarding the selection of inputs and outputs for operating the DEA are presented below as follows.

Bhattacharya *et al.* (1997), Charnes *et al.* (1978), and Sathye (2001) use an intermediation approach with deposits, labour, and physical capital as inputs, and total loans and securities as outputs. Sufian (2007) applies a variation of the intermediation approach by using total deposits and fixed assets as inputs, and total loans and other income as outputs.

Yue (1992:36) employs a variation of the intermediary approach by using interest income (IC), non-interest income (NIC), and total loans (TL) as outputs; whereas interest expenses (IE), non-interest expenses (NIE), transaction deposits (TD) and non-transaction deposits (NTD) are used as inputs.

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3 Ferrier and Lovell (1990), Fried *et al.* (1993), and Sherman and Gold (1985) apply a
4 production (institution) approach by using the number of employees and physical capital as
5 inputs, and the number of accounts (or its related transactions) as output.
6

7 Taylor *et al.* (1997:347) use total income as a single output while total deposits and total non-
8 interest expenses are used as the two inputs to generate output for the DEA bank studies.
9 Others, such as Charnes *et al.* (1990), Sun (1989) and Thompson *et al.* (1993) use total loans
10 and non-interest income as two outputs, whereas total labour, physical capital, deposits, number
11 of branches, and purchased funds are used as five inputs (as cited in Taylor *et al.*, 1997:347).
12

13 The number of full-time staff, fixed assets, capital and loanable funds are chosen as input
14 variables, while real estate loans, commercial and industrial loans, consumer loans,
15 miscellaneous loans, and current deposits are chosen as output variables (Aly *et al.*, 1990).
16

17 Siems (1992) uses input variables, including the number of full-time staff, salary expenses,
18 fixed assets, interest expenses, other non-interest expenses and the number of loans, as well
19 as output variables, including assets, total deposits and interest revenue.
20

21 Elyasiani *et al.* (1994) choose deposits, number of staff and capital amounts as input items
22 while real estate loans, miscellaneous loans and investment amounts are used as output items.
23

24 Elyasiani and Mehdian (1995) adopt the intermediation approach using time-saving deposits,
25 current deposits, fixed assets and capital leases, and the number of full-time staff as input
26 items, while output items include investments, real estate loans, commercial and industrial
27 loans and miscellaneous loans.
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29 Rangan *et al.* (1988) apply the intermediation approach by selecting three inputs (labour,
30 capital and purchased funds) and five outputs (three types of loans and two types of deposits);
31 Webb (2003) employs the intermediation approach by using three inputs, namely deposits,
32 interest expenses and operational expenses, while total income and total loans are outputs; and
33 Reisman *et al.* (2003) apply the intermediation approach by selecting three inputs, namely fixed
34 assets, number of employees and deposits; and two outputs, namely loans and securities
35 portfolios.
36

37 Berger *et al.* (1997:147) use both the intermediation approach and the production approach in
38 choosing which costs, outputs and input prices are included in the DEA specification. Under
39 the intermediation approach, costs include total operating expenses plus interest expenses,
40 outputs are measured as the number of dollars intermediated, and both physical input prices
41 and financial input prices (i.e. interest rates paid) are included. On the other hand, under the
42 production approach, costs include operating expenses only, outputs are measured as the
43 numbers of transactions completed, and only physical input prices are specified.
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45 Fukuyama (1993, 1995) employs labour, capital and funds from customers as inputs, and
46 revenue from loans and revenue from other business activities as outputs; Yeh (1996) uses
47 interest revenue, non-interest revenue and loans as output items, and interest expenses, non-
48 interest expenses and deposits as input items; Bhattacharyya *et al.* (1997) select interest
49 expenses and operating expenses as input items, while loans, deposits and investments are
50 output items; Lin (2002) chooses operating costs, total deposits, fixed assets, the number of
51 staff, average salary and interest expenditure as input items, and total loans as an output item;
52 Wang *et al.* (2005) use capital and assets as input items, and net income, return on total assets
53 (ROA) and return on equity (ROE) as output items; and Sakar (2006) chooses the number of
54 branches, the average number of staff of each branch, total assets, total loans and total deposits
55 as input items, and the ratio of net interest revenue to assets, the ratio of net interest revenue to
56 operating revenue, the ratio of non-interest revenue to assets, ROA and ROE as output items.
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To sum up, the above reviewed literature confirms that the choice of input and output combination depends upon the researchers' intention for research and their justification for including an item as an input or output. This study adopted Yue's (1992) input and output variables, that is, interest expenses (IE), non-interest expenses (NIE), transaction deposits (TD) and non-transaction deposits (NTD) as inputs, while interest income (IC), non-interest income (NIC), and total loans (TL) are outputs. These items are believed to demonstrate the inflow and outflow of inputs and outputs among the depositor ↔ bank ↔ borrower for applying the intermediation approach to the banks' DEA Malmquist index.

The empirical evidences of prior studies are summarised below as follows.

Benli and Degirmen (2013:139) conclude that the Malmquist total factor productivity index applies the group analysis to determine which group is working efficiently; Avkiran (1999:206) confirms that the Malmquist total factor productivity index results give bank management a quality benchmark. Comparison of a bank's operations with the efficient banks shows the adjustments in inputs or in outputs that would have resulted in moving an inefficient bank toward the DEA-efficient frontier for the given year. Barros (2004) reports that DEA allows for the identification of appropriate benchmarks, which are potentially important for the commercial banks and, above all, for those that are performing poorly.

According to Vinh (2012:113), the findings help establish suitable policies to improve banks' efficiency and help them understand the underlying reasons for their banks' efficiency and how to improve it efficiently.

On the other hand, Percin and Ayan (2006) recommend that the generalisation of the Malmquist productivity index (MPI) results can be improved by the following:

- A larger panel data set should be used, that is, more years could be included in the Malmquist productivity index analysis.
- Inputs and outputs should be exhaustively identified and included in the efficiency analysis.
- Using consistent input and output data with different time periods may be highly valuable to track the efficiency changes over a certain period of time and across different geographical locations.

3. Problem Statement

Empirical evidence proved that the DEA-Malmquist index helps measure commercial bank efficiencies. As a result, analysts may undertake rankings and suggest remedies for sustaining and improving further efficiencies.

Global Finance Magazine, with input from industry analysts, corporate executives and banking consultants, identified 30 commercial banks (including the regional best bank called the Standard Bank of South Africa) as the best emerging market banks in Africa in 2015. Criteria for choosing the winners included growth in assets, profitability, strategic relationships, customer service, competitive pricing, and innovative products (*Global Finance Magazine*, 2015).

Only the two criteria (i.e. growth in assets and profitability) can be objectively computed from the bank's financial statements. Growth in asset and profitability index may not show the real efficiency of bank performance. The source of growth in the asset may be attributed to external sources, that is, borrowing and owners' investment. Though there is growth in the asset, the asset may be idle, which is unproductive.

Besides, the profitability ratio may indicate that the bank is generating high profit. However, empirical evidence asserted that bank managers may use their discretionary power to manage

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3 bank earnings, usually through loan loss provision. According to Das *et al.* (2012:58), there
4 are many tools used by firms to smooth the income, and loss provision is one of them. Since
5 it does not involve any cash outflow, firms find it a very potential tool for smoothing; since
6 LLP is a major accrual under the control of bank managers, it leaves them with a room for
7 income smoothing (Yang, 1999:21); and Anandarajan *et al.* (2003:46) describe that the extant
8 literature indicates that the loan loss provision (LLP) is a tool extensively used for the
9 purpose of risk management, reducing earnings volatility (income-smoothing), enhancing
10 managers' compensation and avoiding capital adequacy regulation.

11
12 The rest *Global Finance Magazine's* criteria are subject to subjective contextual
13 interpretations that do not help evaluate a bank's efficiency quantitatively. A bank is said to
14 be financially and operationally sound if it can use its scarce resources efficiently/optimally
15 and ensures high profitability, sustainability and expansion. For that reason, there is a need to
16 use quantitative models to prove that the banks are operationally efficient. DEA is among the
17 widely used models for evaluating commercial banks' efficiency since the late 1970s. The
18 *Global Finance Magazine* (2015) rated the observed 19 banks as the best African banks, but,
19 *are they really the best banks?* The study has applied the DEA-Malmquist productivity index
20 in order to test whether they really are the best.

21 22 23 **4. Objectives**

24 The objective of this study was to investigate how efficient the best African banks are and
25 what needs to be changed to improve the performance of the banking sector.

26 27 **5. Research Methodologies**

28 Of the 30 best banks identified, 19 banks were observed. These banks provided consolidated
29 and complete financial statements (Balance Sheet and Income Statement) for the latest five
30 years', which is available online in the Bankscope data (*Bureau van Dijk Bankscope*, 2015).
31 They have also fulfilled the requirement of the Malmquist's balanced panel data. Five years'
32 of recent (2010 – 2014) financial statements of the 19 best banks, as identified by the *Global*
33 *Finance Magazine* (2015), were observed (i.e. 19 bank observations for each year). The list
34 of the 30 best African banks is annexed (*Table 8*).

35
36 Among the bank efficiency measures, this study opted for data envelopment analysis (DEA)
37 because it is supported by many empirical researchers. Percin and Ayan (2006: 219) argue that
38 the DEA approach does not require any assumptions about the functional form, that is, it does
39 not need any prior information on the underlying functional forms and weights among various
40 input and output factors. It is, hence, more robust and comprehensive than any of the typical
41 productivity ratios commonly used in financial analysis (Guan *et al.*, 2006; Zhu, 2000).

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43 The intermediary approach to the selection of inputs and outputs was followed, that is, DEA
44 efficiency is defined as an "intermediary approach" that examines the bank's function as a
45 financial intermediary between savers and borrowers (Yeh, 1996:980). Thus, the Malmquist
46 productivity index (MPI) procedure was employed because 1) it helps make firm intra (trend)
47 and inter (cross-sectional) productivity differences, 2) the observed bank data are panel data,
48 and 3) MPI allows for the decomposition of productivity change into technical efficiency
49 change and technological change, where the product of these two components of MPI yields
50 a frontier version of productivity change (Percin and Ayan, 2006:226).

51
52 Four inputs (i.e. interest expenses- IE, non-interest expenses- NIE, transaction deposits- TD
53 and non-transaction deposits- NTD) and four outputs (i.e. interest income- IC, non-interest
54 income- NIC, gross loans- GL and other earning assets- OEA) were used; where the
55 transaction deposits (TD) refer to the "deposits and short-term funding" and the non-
56 transaction deposits (NTD) refer to the "other interest bearing liabilities".

The study followed the output approach. Thus, the DEA-Malmquist productivity index (MPI) is specified as follows:

Percin and Ayan (2006:226 - 227) explain that MPI is a valuable tool since it allows for the decomposition of productivity change into technical efficiency change and technological change. The product of these two components of MPI yields a frontier version of productivity change. According to Fare et al. (1994:70), Ng (2008:385, 2011:431) and Rezitis (2006:123), the output-based Malmquist index of productivity change within the framework of distance function is:

$$M_o(X_{t+1}, Y_{t+1}, X_t, Y_t) = \left(\frac{d_o^t(X_{t+1}, Y_{t+1})}{d_o^t(X_t, Y_t)} * \frac{d_o^{t+1}(X_{t+1}, Y_{t+1})}{d_o^{t+1}(X_t, Y_t)} \right)^{\frac{1}{2}} \dots (1)$$

This represents the productivity of the production point (x_{t+1}, y_{t+1}) relative to the production point (x_t, y_t) . Where d_o^t is a distance function measuring the efficiency of conversion of inputs x_t to outputs y_t in the period t (Ramanathan, 2005). The value of m greater than one indicates positive total factor productivity (TFP) growth, whereas the value of m lower than one indicates a decline from period t to $t+1$.

MPI is the geometric mean of the two outputs-based Malmquist index (Fare et al., 1994:68). One index uses period t technology and the other uses period $t+1$ technology (Coelli, 1996). Mathematically, this can be written as (Fare et al., 1994:71; Ng, 2008:385, 2011:431; Rezitis, 2006:124):

$$M_o(X_{t+1}, Y_{t+1}, X_t, Y_t) = \left(\frac{d_o^{t+1}(X_{t+1}, Y_{t+1})}{d_o^t(X_t, Y_t)} \right) * \left(\frac{d_o^t(X_{t+1}, Y_{t+1})}{d_o^{t+1}(X_{t+1}, Y_{t+1})} * \frac{d_o^t(X_t, Y_t)}{d_o^{t+1}(X_t, Y_t)} \right)^{\frac{1}{2}} \dots (2)$$

Where, the first term on the right of the equality defines technical efficiency change, whereas the second term defines technology change. Technical efficiency change (i.e. The change in how far observed production is from maximum potential production) measures the change in the constant return to scale (CRS) technical efficiency of Period $t+1$ over period t (Ramanathan, 2005). If technical efficiency change is greater than 1, then there is an increase in the technical efficiency of converting inputs to outputs.

The technical efficiency can be extended by decomposing the CRS technical efficiency change into scale efficiency and pure variable return to scale (VRS) technical efficiency components, that is, the distance functions relative to a VRS (instead of a CRS) technology. CRS and VRS values are used to calculate the scale efficiency effect.

6. Results and Discussions

An output oriented (i.e. output maximisation) Malmquist DEA involving data on four outputs and four inputs for 19 firms observed over a five-year period (2010 - 2014) was analysed. The input and output data were converted into its equivalent November 6, 2015 USD denomination. All data were described in USD millions.

Total factor productivity (TFP) is the product of technical efficiency and technology changes. The technical efficiency is also the product of pure technical efficiency and scale efficiency. DEAP 2.1 statistical software was applied to compute DEA-Malmquist efficiency and productivity. Therefore, the results for technical efficiency, technology, pure technical efficiency, scale efficiency and total factor productivity are presented as follows:

The DEA Malmquist TFP index is an efficiency index, which represents the efficiency changes from period t to period $t+1$. The Malmquist TFP index, which is greater (less) than one reflects an efficiency increase (decrease) or technical progress (regress). If the value of

Malmquist index or any of its components is greater than 1, that denotes improvements in the relevant performance, whereas values less than 1 denote regress or deterioration in performance (Fare *et al.*, 1994).

Tables 1 - 4 display the Malmquist index of annual means, that is, the efficiency change, technical change, pure technical change, scale efficiency change and the total factor productivity change for the 19 selected banks under this study for the period of 2010 – 2014 on an annual basis. Year 2010 is considered as the base year because the Malmquist TFP index measures the efficiency change from period t to period $t+1$.

According to Table 1, the Year 2 (2011) Malmquist index shows that only nine out of 19 banks increased their total productivity index (i.e. $tfpch > 1$). Except for Bank of Africa-Mali, Barclays Bank of Uganda Limited and Standard Chartered Bank Zambia Plc- SCBZ Plc, the source of increase or decrease in total productivity index is technological progression or retrogression. Bank Windhoek Limited- Namibia (2.785), Equity Group Holdings Limited-Kenya (1.554) and Standard Bank- SA (1.343) are ranked first, second and third, respectively, in terms of their $tfpch$ index. Though, the ten banks $tfpch$ are less than one and less than the annual mean (i.e. 0.893), the three least $tfpch$ are for Banque de Kigali-Rwanda (0.244), Société Générale de Banques en Côte d'Ivoire S.A.- SGBCI (0.364) and Attijariwafa Bank- Morocco (0.597), respectively, which is caused by the significant technological regression. Besides, Table 7 portrays the three banks' change in output (∂O) and input (∂I) have increased in year 2 as compared to year 1 (i.e. 18.62% & 33.51%, 8.39% & 14.33% and 12.92% & 13.16%, respectively). Total productivity ratios (O/I) for the year 2 are 1.005, 1.032 and 1.148, respectively. Their O/I ratio indicates that the total productivity ratio is greater than 1. However, the ∂O and ∂I show that less than a proportionate increase in output per unit increase in input in Year 2 (2011), that is, operating at a decreasing return to scale (DRS). This result implies that their technology did not leverage their efficiency (i.e. $tfpch$ index).

Table 2 reveals that in Year 3 (2012), 15 out of 19 banks increased their total productivity index (i.e. $tfpch > 1$). Except for Barclays Bank of Uganda Limited, the source of increase or decrease in total productivity index is technological progression or regression. First Rand Bank Ltd- South Africa (4.597), GCB Bank Limited- Ghana (3.247) and Trust Merchant Bank s.a.r.l- Congo (3.089) are ranked first, second and third, respectively, in terms of their $tfpch$ index. The least $tfpch$ accounts for Arab Banking Corporation- Algeria (0.511) even though the other three banks' $tfpch$ are less than one and less than the annual mean (1.271) caused by significant technological regression. The change in output (∂O) and input (∂I) for the Algerian bank have decreased in year 3 as compared to year 2 (i.e. -74.07% and -67.21%, respectively). Total productivity ratio (O/I) for the year 3 is 1.077 (Table 7). Its O/I ratio indicates that the total productivity ratio is greater than 1. But, the ∂O and ∂I show that more than a proportionate decrease in output per unit decrease in input in Year 3 (2012), that is, operating at a decreasing return to scale (DRS). The result indicates that its technology did not leverage its efficiency (i.e. $tfpch$ index).

Table 3 discloses that, out of the 19 banks, 13 banks increased their total productivity index (i.e. $tfpch > 1$) in Year 4 (2013). Except for Standard Chartered Bank Botswana Ltd, Banque de Kigali- Rwanda, Barclays Bank of Uganda Limited and First Rand Bank Ltd- South Africa, the source of increase or decrease in total productivity index is technological progression or regression. Arab Banking Corporation- Algeria (2.832), Equity Group Holdings Limited- Kenya (1.496) and Attijariwafa Bank- Morocco (1.410) are ranked first, second and third, respectively, in terms of their $tfpch$ index. The five banks' $tfpch$ are less than one as well as less than the annual mean, except for Banque de Kigali- Rwanda where its $tfpch$ (0.960) is above the annual mean (0.946). Two least $tfpch$ are for First Rand Bank Ltd-

South Africa (0.199) and Standard Bank- SA (0.254), which is substantially caused by a significant technological regression. The change in output (∂O) and input (∂I) for the two banks have increased in year 4 as compared to year 3 (i.e. 12.8% & 11.99% and 36.17% & 37.03%, respectively). Total productivity ratios (O/I) for the year 4 are 1.077 and 1.068, respectively (Table 7). Their O/I ratio indicates that the total productivity ratio is greater than 1. The ∂O and ∂I show that less than a proportionate increase in output per unit increase in input in Year 4 (2013) for the Standard Bank- SA is operating at a decreasing return to scale (DRS). However, the First Rand Bank Ltd- South Africa is operating at an increasing return to scale (IRS), where $\partial O > \partial I$. Thus, efficiency (i.e. *tfpch index*) was not leveraged due to technological regression.

According to Table 4, the Year 5 (2014) Malmquist index shows that only 13 out of 19 banks increased their total productivity index (i.e. *tfpch* > 1). Except for Standard Chartered Bank Botswana Ltd, Banque de Kigali- Rwanda, Barclays Bank of Uganda Limited and First Rand Bank Ltd- South Africa, the source of increase or decrease in total productivity index is technological progression or retrogression. Standard Bank- SA (3.417), Standard Chartered Bank Botswana Ltd (2.858) and First Rand Bank Ltd- South Africa (2.319) are ranked first, second and third, respectively, in terms of their *tfpch* index. The six banks' *tfpch* are less than one and less than the annual mean (i.e. 1.147). The two least *tfpch* are for Attijariwafa Bank- Morocco (0.416) and Banque Internationale Arabe de Tunisie- BIAT (0.565), which is caused by the significant technological regression. Based on Table 7, the change in output (∂O) and input (∂I) have increased in year 5 as compared to year 4 (i.e. 6.28% & 3.15%, respectively) and the total productivity ratio (O/I) for the year 5 is 1.204 in the Moroccan bank. Its O/I ratio indicates that the total productivity ratio is greater than 1. The ∂O and ∂I also show that there was more than a proportionate increase in output per unit increase in input in Year 5 (2014), that is, operating at an increasing return to scale (IRS). On the other hand, the change in output (∂O) and input (∂I) in the Tunisian bank have decreased in year 5 as compared to year 4 (i.e. -2.36% & -0.55%, respectively), whereas the total productivity ratio (O/I) for the year 5 is 1.193. Its O/I ratio indicates that the total productivity ratio is greater than 1 and its ∂O and ∂I show that more than a proportionate decrease in output per unit decrease in input in Year 5 (2014), that is, operating at a decreasing return to scale (DRS). Therefore, efficiency (i.e. *tfpch index*) was not leveraged because of the technological regression.

In summary, the *Malmquist index of annual means* displayed in Tables 1- 4 shows that the results are not consistent, that is, the same bank becomes efficient as well as inefficient in different years during the period. For example, the Standard Bank of SA is efficient in Years 2, 3 and 5, but inefficient in Year 4. The banks' efficiency is, thus, evaluated on an aggregate basis following the *Malmquist index summary of the firm means* (Table 5) for a period of 2010 - 2014.

Table 5 portrays the *Malmquist index summary of the firm means*, that is, the efficiency change, technical change, pure technical change, scale efficiency change and the total factor productivity change for the 19 selected banks under this study for the period of 2010 - 2014 on an aggregate basis. Results show that the source of increase or decrease in the total productivity index (*tfpch*) is either technological progression or retrogression, except for Banque de Kigali-Rwanda.

Of the 19 banks, three banks increased (*effch* > 1), 15 banks remained unchanged (*effch* = 1) and one bank decreased (*effch* < 1) mean annual technical efficiency. This implies that apart from the three banks, the rest of the banks failed to progress their managerial efficiency to maximise their outputs (i.e. interest income, non-interest income, total loans and other earning assets). Only three banks increased their technical efficiency of converting inputs to outputs.

Twelve banks progressed ($techch > 1$) and seven banks regressed ($techch < 1$) their mean annual technological changes. This implies that the majority of the banks renovated their system by introducing state-of-the-art technologies into their service system.

Total factor productivity (TFP) increased for 14 of the commercial banks. In reference to the results in technical efficiency and technological changes, the increases on the TFP can be attributed to the technological changes (i.e. innovations) other than the technical efficiency (i.e. managerial efficiency). Among the banks with the highest TFP score increases are Bank Windhoek Limited- Namibia (58.1%), Trust Merchant Bank s.a.r.l.- Congo (33.1%), Standard Chartered Bank Botswana Ltd (26.2%) and Bank of Africa- Mali (23.5%), respectively. Even though, their TFP is greater than 1, Bank of Africa- Senegal (3.4%) and Barclays Bank of Uganda Limited (1.2%), respectively, can be mentioned among the banks with the lowest increase in TFP score.

Total factor productivity (TFP) decreased for five of the commercial banks. Among the banks with the highest decrease in TFP score are Banque de Kigali- Rwanda (28.6%) and Société Générale de Banques en Côte d'Ivoire S.A.- SGBCI (23.9%).

The results indicate the following:

- The major cause for the decrease in the TFP score for the four banks is a technological regression. This may be due to the lack of new technology being introduced into their service system.
- The cause for the decrease in the TFP score for the Banque de Kigali- Rwanda is both a technical efficiency loss of 3.9% and a technological regress of 25.6%. The cause for the decrease in the technical efficiency loss and the technological regress may be due to lack of managerial competence, lack of experienced and trained manpower, operating at DRS in Year 2011 and 2014 and lack of new technology being introduced into their service system, respectively.
- The cause for the highest increase in the Bank Windhoek Limited- Namibia's TFP is due to a technological progress of 58.1% and operating at IRS from Year 2012 - 2014. The result also portrays that the reason for the lower increase in the Barclays Bank of Uganda Limited's TFP is due to a technical efficiency gain of 3.1% and a technological regress of 1.9%. It has operated at DRS from Year 2013 - 2014.

Finally, *Table 5* depicts that the banks have demonstrated almost similar levels of efficiency scores in their pure technical efficiencies (i.e. three banks increased, one bank decreased and 15 banks had no change) and scale efficiencies (i.e. two banks increased, two banks decreased and 15 banks had no change).

7. Conclusions and Recommendations

7.1. Conclusions

Global Finance Magazine has identified 30 African banks as the best in 2015. The criteria used for selection were growth in assets, profitability, strategic relationships, customer service, competitive pricing and innovative products. However, the mathematical or statistical model used was not clearly described.

This study applied the DEA-Malmquist productivity index (MPI) over 19 banks in the five years (2010 - 2014) in order to examine whether the banks identified as the best African banks by the *Global Finance Magazine* (2015) are really the best from the data envelopment analysis (efficiency measure) point of view.

The Malmquist index of annual means as well as the Malmquist index summary of the firm means for the period of 2011 - 2014 that are portrayed in *Tables 1 - 5* show that the determinant source of increase or decrease in the total productivity index (*tfpch*) is either technological progression or regression.

The Malmquist index summary of firm mean results (*Table 5*) may be summarised as follows:

- Fourteen banks scored TFP above 1, which indicates their performance has improved. However, 5 banks scored TFP below 1, which indicates their performance has deteriorated.
- The most productive bank with the highest TFP score is Bank Windhoek Limited – Namibia (*tfpch* = 1.581) and the most unproductive bank with the lowest TFP score is Banque de Kigali- Rwanda (*tfpch* = 0.714).
- *Global Finance Magazine* identified the Standard Bank of South Africa as the regional winner. However, according to this study, it is not on the list of the top five productive banks; it is ranked ninth. The five top banks with a TFP score greater than 1 (i.e. *tfpch* > 1) are ranked in descending order in *Table 6*.
- All banks with a deteriorated performance (i.e. *tfpch* < 1) had a technological change score of less than 1 (i.e. *techch* < 1). This implies that the banks did not renovate themselves by instilling new technologies to leverage their managerial (technical) efficiencies. Except for one bank, their technical efficiency score is equal to 1 (i.e. *effch* = 1), which denotes stagnation.

Thus, the study may conclude that a significant number of banks, that is, the five banks with *tfpch* < 1 (26.32%), which have been selected as the best African banks, are not the best from an efficiency and productivity measurement index point of view (*tfpch*).

7.2. Recommendations

The result indicates that the major factor for most of the banks with a TFP score above 1 is mainly their technological change, that is, their *techch* score is greater than 1. Therefore, further expansion is recommended in order for them to capitalise on and operate at a higher productivity frontier; a positive technological change leads to a right shift in the productivity frontier to make more technically efficient use of resources. This shift will also force them to positively change their static managerial (technical) efficiency (i.e. *effch* = 1).

The major factor for most of the banks with a TFP score below 1 is their technological change (i.e. *techch* < 1). This indicates that the banks are operating to the left of the productivity frontier, that is, under efficiency. Therefore, further expansion is not recommended. As an alternative, the renovation of their service system is worthwhile to support the static managerial (technical) efficiency (i.e. *effch* = 1) in order to improve their total factor productivity performance.

This study proved that different selection criteria and methods provide different results. For instance, the bank that was selected as the first and regional winner (Standard Bank of South Africa) by *Global Finance Magazine* is now ranked ninth and a significant number of banks that were identified as best banks (those five banks with *tfpch* < 1) were found to be unproductive under this study.

Given the selection criteria, that is, growth in assets, profitability, strategic relationships, customer service, competitive pricing, and innovative products, *Global Finance Magazine* states that it has conducted a poll of its corporate readership in order to increase the accuracy

and reliability of the results. However, another person may not come to the same conclusion with this approach due to the following:

- The growth in assets may be attributed to borrowing and owners' investment. Profitability is also subject to bank managers' earnings management attributable to how they manage their discretionary loan loss provision. Thus, these two factors may not reflect the firm's true productivity and efficiency gesture.
- Customer service satisfaction is heterogeneous, where different people have different perceptions of the same service setting. Besides, customer service may be considered to be a derivative of the strategic relationships, competitive pricing and innovative products. These are among the bank attributes that a bank customer considers while evaluating the bank service, for which customers may have different perceptions.

Therefore, using quantitative criteria (which are available in the audited bank financial statements) along with any of the widely applied mathematical/statistical models (such as Data Envelopment Analysis and Stochastic Frontier Analysis) is recommended to select the best performing banks; these models are more objective and replicable.

8. References

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Table 1: Malmquist Index Annual Means for Year 2 (2011)

firm	effch	techch	pech	sech	tfpch
Standard Bank SA	1.000	1.343	1.000	1.000	1.343
Arab Banking Corporation - Algeria	1.000	1.017	1.000	1.000	1.017
Société Générale de Banques en Côte d'Ivoire S.A. - SGBCI	1.000	0.364	1.000	1.000	0.364
Standard Chartered Bank Botswana Ltd	1.000	0.883	1.000	1.000	0.883
Attijariwafa Bank- Morocco	1.000	0.597	1.000	1.000	0.597
Bank of Africa - Madagascar	1.000	1.155	1.000	1.000	1.155
Bank of Africa - Mali	1.194	0.874	1.182	1.010	1.044
Bank of Africa - Senegal	1.000	0.801	1.000	1.000	0.801
Banque de Kigali-Rwanda	1.000	0.244	1.000	1.000	0.244
Bank Windhoek Limited - Namibia	1.000	2.785	1.000	1.000	2.785
Banque Internationale Arabe de Tunisie - BIAT	1.000	0.655	1.000	1.000	0.655
Barclays Bank of Uganda Limited	1.186	0.870	1.166	1.017	1.032
Commercial Bank of Ethiopia	1.000	1.283	1.000	1.000	1.283
Ecobank Togo	1.000	0.715	1.000	1.000	0.715
Equity Group Holdings Limited- Kenya	1.000	1.554	1.000	1.000	1.554
First Rand Bank Ltd-South Africa	1.000	0.871	1.000	1.000	0.871
GCB Bank Limited -Ghana	1.000	0.767	1.000	1.000	0.767
Standard Chartered Bank Zambia Plc-SCBZ Plc	1.313	0.964	1.232	1.065	1.266
Trust Merchant Bank s.a.r.l.-Congo	1.000	0.837	1.000	1.000	0.837
mean	1.033	0.865	1.028	1.005	0.893

Note:

effch = Technical efficiency change; *techch* = Technological change; *pech* = Pure technical efficiency change; *sech* = Scale efficiency change; *tfpch* = Total factor productivity (TFP) change.

Table 2: Malmquist Index Annual Means for Year 3 (2012)

firm	effch	techch	pech	sech	tfpch
Standard Bank SA	1.000	1.128	1.000	1.000	1.128
Arab Banking Corporation - Algeria	1.000	0.511	1.000	1.000	0.511
Société Générale de Banques en Côte d'Ivoire S.A. - SGBCI	1.000	1.093	1.000	1.000	1.093
Standard Chartered Bank Botswana Ltd	1.000	0.899	1.000	1.000	0.899
Attijariwafa Bank- Morocco	1.000	1.447	1.000	1.000	1.447
Bank of Africa - Madagascar	1.000	0.910	1.000	1.000	0.910
Bank of Africa - Mali	1.000	1.134	1.000	1.000	1.134
Bank of Africa - Senegal	1.000	1.037	1.000	1.000	1.037
Banque de Kigali-Rwanda	1.000	1.094	1.000	1.000	1.094
Bank Windhoek Limited - Namibia	1.000	1.576	1.000	1.000	1.576
Banque Internationale Arabe de Tunisie - BIAT	1.000	1.115	1.000	1.000	1.115
Barclays Bank of Uganda Limited	0.946	1.171	0.975	0.971	1.109
Commercial Bank of Ethiopia	1.000	1.220	1.000	1.000	1.220
Ecobank Togo	1.000	0.880	1.000	1.000	0.880
Equity Group Holdings Limited- Kenya	1.000	1.022	1.000	1.000	1.022
First Rand Bank Ltd-South Africa	1.000	4.597	1.000	1.000	4.597
GCB Bank Limited -Ghana	1.000	3.247	1.000	1.000	3.247
Standard Chartered Bank Zambia Plc-SCBZ Plc	1.000	1.005	1.000	1.000	1.005
Trust Merchant Bank s.a.r.l.-Congo	1.000	3.089	1.000	1.000	3.089
mean	0.997	1.275	0.999	0.998	1.271

Table 3: Malmquist Index Annual Means for Year 4 (2013)

firm	effch	techch	pech	sech	tfpch
Standard Bank SA	1.000	0.254	1.000	1.000	0.254
Arab Banking Corporation - Algeria	1.000	2.832	1.000	1.000	2.832
Société Générale de Banques en Côte d'Ivoire S.A. - SGBCI	1.000	0.762	1.000	1.000	0.762
Standard Chartered Bank Botswana Ltd	0.915	1.221	1.000	0.915	1.117
Attijariwafa Bank- Morocco	1.000	1.410	1.000	1.000	1.410
Bank of Africa - Madagascar	1.000	1.045	1.000	1.000	1.045
Bank of Africa - Mali	1.000	1.199	1.000	1.000	1.199
Bank of Africa - Senegal	1.000	1.249	1.000	1.000	1.249
Banque de Kigali-Rwanda	0.974	0.986	0.979	0.994	0.960
Bank Windhoek Limited - Namibia	1.000	1.194	1.000	1.000	1.194
Banque Internationale Arabe de Tunisie - BIAT	1.000	1.221	1.000	1.000	1.221
Barclays Bank of Uganda Limited	1.057	0.976	1.026	1.030	1.031
Commercial Bank of Ethiopia	1.000	0.702	1.000	1.000	0.702
Ecobank Togo	1.000	1.005	1.000	1.000	1.005
Equity Group Holdings Limited- Kenya	1.000	1.496	1.000	1.000	1.496
First Rand Bank Ltd-South Africa	0.681	0.292	0.788	0.864	0.199
GCB Bank Limited -Ghana	1.000	0.729	1.000	1.000	0.729
Standard Chartered Bank Zambia Plc-SCBZ Plc	1.000	1.067	1.000	1.000	1.067
Trust Merchant Bank s.a.r.l.-Congo	1.000	1.088	1.000	1.000	1.088
mean	0.977	0.968	0.988	0.989	0.946

Table 4: Malmquist Index Annual Means for Year 5 (2014)

firm	effch	techch	pech	sech	tfpch
Standard Bank SA	1.000	3.417	1.000	1.000	3.417
Arab Banking Corporation - Algeria	1.000	0.797	1.000	1.000	0.797
Société Générale de Banques en Côte d'Ivoire S.A. - SGBCI	1.000	1.105	1.000	1.000	1.105
Standard Chartered Bank Botswana Ltd	1.093	2.616	1.000	1.093	2.858
Attijariwafa Bank- Morocco	1.000	0.416	1.000	1.000	0.416
Bank of Africa - Madagascar	1.000	1.067	1.000	1.000	1.067
Bank of Africa - Mali	1.000	1.639	1.000	1.000	1.639
Bank of Africa - Senegal	1.000	1.103	1.000	1.000	1.103
Banque de Kigali-Rwanda	0.875	1.163	0.899	0.974	1.017
Bank Windhoek Limited - Namibia	1.000	1.193	1.000	1.000	1.193
Banque Internationale Arabe de Tunisie - BIAT	1.000	0.565	1.000	1.000	0.565
Barclays Bank of Uganda Limited	0.954	0.933	1.000	0.954	0.890
Commercial Bank of Ethiopia	1.000	1.537	1.000	1.000	1.537
Ecobank Togo	1.000	1.260	1.000	1.000	1.260
Equity Group Holdings Limited- Kenya	1.000	0.722	1.000	1.000	0.722
First Rand Bank Ltd-South Africa	1.468	1.580	1.268	1.158	2.319
GCB Bank Limited -Ghana	1.000	1.033	1.000	1.000	1.033
Standard Chartered Bank Zambia Plc-SCBZ Plc	1.000	0.858	1.000	1.000	0.858
Trust Merchant Bank s.a.r.l.-Congo	1.000	1.116	1.000	1.000	1.116
mean	1.015	1.129	1.007	1.009	1.147

Table 5: The Malmquist Index Summary of Firm Mean for the Period of 2010-2014

Banks	<i>effch</i>	<i>techch</i>	<i>pech</i>	<i>sech</i>	<i>tfpch</i>
Standard Bank SA	1.000	1.070	1.000	1.000	1.070
Arab Banking Corporation - Algeria	1.000	1.041	1.000	1.000	1.041
Société Générale de Banques en Côte d'Ivoire S.A. - SGBCI	1.000	0.761	1.000	1.000	0.761
Standard Chartered Bank Botswana Ltd	1.000	1.262	1.000	1.000	1.262
Attijariwafa Bank- Morocco	1.000	0.844	1.000	1.000	0.844
Bank of Africa - Madagascar	1.000	1.040	1.000	1.000	1.040
Bank of Africa - Mali	1.045	1.181	1.043	1.003	1.235
Bank of Africa - Senegal	1.000	1.034	1.000	1.000	1.034
Banque de Kigali-Rwanda	0.961	0.744	0.968	0.992	0.714
Bank Windhoek Limited - Namibia	1.000	1.581	1.000	1.000	1.581
Banque Internationale Arabe de Tunisie - BIAT	1.000	0.843	1.000	1.000	0.843
Barclays Bank of Uganda Limited	1.031	0.981	1.039	0.992	1.012
Commercial Bank of Ethiopia	1.000	1.140	1.000	1.000	1.140
Ecobank Togo	1.000	0.945	1.000	1.000	0.945
Equity Group Holdings Limited- Kenya	1.000	1.145	1.000	1.000	1.145
First Rand Bank Ltd-South Africa	1.000	1.166	1.000	1.000	1.166
GCB Bank Limited -Ghana	1.000	1.170	1.000	1.000	1.170
Standard Chartered Bank Zambia Plc-SCBZ Plc	1.070	0.971	1.054	1.016	1.039
Trust Merchant Bank s.a.r.l.-Congo	1.000	1.331	1.000	1.000	1.331
Mean*	1.005	1.048	1.005	1.000	1.053
The Malmquist index summary of annual means					
Year	<i>effch</i>	<i>techch</i>	<i>pech</i>	<i>sech</i>	<i>tfpch</i>
2011 (Year 2)	1.033	0.865	1.028	1.005	0.893
2012 (Year 3)	0.997	1.275	0.999	0.998	1.271
2013 (Year 4)	0.977	0.968	0.988	0.989	0.946
2014 (Year 5)	1.015	1.129	1.007	1.009	1.147
Mean*	1.005	1.048	1.005	1.000	1.053
Note:					
<ul style="list-style-type: none"> ▪ <i>effch</i> = Technical efficiency change; <i>techch</i> = Technological change; <i>pech</i> = Pure technical efficiency change; <i>sech</i> = Scale efficiency change; <i>tfpch</i> = Total factor productivity (TFP) change. ▪ * All Malmquist indexes represent geometric means. 					

Table 6: Top five banks with *tfpch* > 1

Banks	<i>effch</i>	<i>techch</i>	<i>pech</i>	<i>sech</i>	<i>tfpch</i>
Bank Windhoek Limited - Namibia	1.000	1.581	1.000	1.000	1.581
Trust Merchant Bank s.a.r.l.-Congo	1.000	1.331	1.000	1.000	1.331
Standard Chartered Bank Botswana Ltd	1.000	1.262	1.000	1.000	1.262
Bank of Africa - Mali	1.045	1.181	1.043	1.003	1.235
GCB Bank Limited -Ghana	1.000	1.170	1.000	1.000	1.170
Note:					
<ul style="list-style-type: none"> ▪ <i>effch</i> = Technical efficiency change; <i>techch</i> = Technological change; <i>pech</i> = Pure technical efficiency change; <i>sech</i> = Scale efficiency change; <i>tfpch</i> = Total factor productivity (TFP) change. ▪ * All Malmquist indexes represent geometric means. 					

Table 7 below presents summary data on the sum of outputs (ΣOutput), sum of inputs (ΣInput), total productivity ratios ($\Sigma\text{O}/\Sigma\text{I}$), changes in output (∂o) and changes in input (∂i) for the Year 2010 – 2014.

Table 7: Σ Output, Σ Input, Total Productivity (O/I), ∂O and ∂I for Year 2010 – 2014 (Mil. USD)

Year	Name of Banks	Σ Output	Σ Input	$\Sigma O/\Sigma I$	∂O (%)	∂I (%)	Retu. to Scale
2010	Standard Bank SA	63587.66	59602.82	1.067			
	Arab Banking Corporation - Algeria	349.13	249.29	1.400			
	Société Générale de Banques en Côte d'Ivoire S.A. - SGBCI	1122.22	1030.92	1.089			
	Standard Chartered Bank Botswana Ltd	1024.18	968.68	1.057			
	Attijariwafa Bank- Morocco	30283.76	26325.86	1.150			
	Bank of Africa - Madagascar	409.60	381.20	1.075			
	Bank of Africa - Mali	315.78	306.37	1.031			
	Bank of Africa - Senegal	196.92	185.53	1.061			
	Banque de Kigali-Rwanda	256.26	226.47	1.132			
	Bank Windhoek Limited - Namibia	1197.99	1087.11	1.102			
	Banque Internationale Arabe de Tunisie - BIAT	3516.99	2965.19	1.186			
	Barclays Bank of Uganda Limited	319.11	311.06	1.026			
	Commercial Bank of Ethiopia	3073.52	2722.18	1.129			
	Ecobank Togo	328.81	302.92	1.085			
	Equity Group Holdings Limited- Kenya	1376.82	1231.48	1.118			
	First Rand Bank Ltd-South Africa	43665.62	40940.57	1.067			
	GCB Bank Limited -Ghana	586.03	520.24	1.126			
Standard Chartered Bank Zambia Plc-SCBZ Plc	253.98	338.38	0.751				
Trust Merchant Bank s.a.r.l.-Congo	153.04	211.85	0.722				
2011	Standard Bank SA	68403.50	64547.79	1.060	7.57	8.30	DRS*
	Arab Banking Corporation - Algeria	345.48	253.84	1.361	-1.05	1.82	DRS
	Société Générale de Banques en Côte d'Ivoire S.A. - SGBCI	1216.35	1178.61	1.032	8.39	14.33	DRS
	Standard Chartered Bank Botswana Ltd	912.76	878.44	1.039	-10.88	-9.32	DRS
	Attijariwafa Bank- Morocco	34195.50	29790.07	1.148	12.92	13.16	DRS
	Bank of Africa - Madagascar	454.07	412.69	1.100	10.86	8.26	IRS
	Bank of Africa - Mali	315.23	312.95	1.007	-0.17	2.15	DRS
	Bank of Africa - Senegal	203.70	217.34	0.937	3.44	17.14	DRS
	Banque de Kigali-Rwanda	303.97	302.35	1.005	18.62	33.51	DRS
	Bank Windhoek Limited - Namibia	1399.42	1286.03	1.088	16.81	18.30	DRS
	Banque Internationale Arabe de Tunisie - BIAT	3952.51	3256.60	1.214	12.38	9.83	IRS**
	Barclays Bank of Uganda Limited	336.52	328.00	1.026	5.45	5.44	IRS
	Commercial Bank of Ethiopia	4700.59	4164.37	1.129	52.94	52.98	DRS
	Ecobank Togo	429.13	400.64	1.071	30.51	32.26	DRS
	Equity Group Holdings Limited- Kenya	1807.81	1727.78	1.046	31.30	40.30	DRS
	First Rand Bank Ltd-South Africa	45824.66	43388.31	1.056	4.94	5.98	DRS
	GCB Bank Limited -Ghana	636.04	648.05	0.981	8.53	24.57	DRS
Standard Chartered Bank Zambia Plc-SCBZ Plc	290.23	333.76	0.870	14.27	-1.37	IRS	
Trust Merchant Bank s.a.r.l.-Congo	235.59	284.35	0.829	53.94	34.22	IRS	
2012	Standard Bank SA	54996.40	51152.51	1.075	-19.60	-20.75	IRS
	Arab Banking Corporation - Algeria	89.60	83.23	1.077	-74.07	-67.21	DRS
	Société Générale de Banques en Côte d'Ivoire S.A. - SGBCI	1270.83	1182.01	1.075	4.48	0.29	IRS
	Standard Chartered Bank Botswana Ltd	901.03	836.94	1.077	-1.29	-4.72	IRS
	Attijariwafa Bank- Morocco	37293.28	31823.38	1.172	9.06	6.83	IRS
	Bank of Africa - Madagascar	393.53	447.88	0.879	-13.33	8.53	DRS
	Bank of Africa - Mali	346.04	337.45	1.025	9.77	7.83	IRS
	Bank of Africa - Senegal	235.63	240.60	0.979	15.68	10.70	IRS
	Banque de Kigali-Rwanda	375.38	355.13	1.057	23.49	17.45	IRS
	Bank Windhoek Limited - Namibia	1564.01	1400.50	1.117	11.76	8.90	IRS
	Banque Internationale Arabe de Tunisie - BIAT	4348.23	3687.76	1.179	10.01	13.24	DRS
	Barclays Bank of Uganda Limited	338.44	304.30	1.112	0.57	-7.23	IRS
	Commercial Bank of Ethiopia	6857.04	5863.23	1.169	45.88	40.80	IRS
	Ecobank Togo	489.89	467.24	1.048	14.16	16.62	DRS
	Equity Group Holdings Limited- Kenya	2394.75	2147.90	1.115	32.47	24.32	IRS
	First Rand Bank Ltd-South Africa	51430.03	48107.82	1.069	12.23	10.88	IRS
	GCB Bank Limited -Ghana	824.98	739.39	1.116	29.71	14.09	IRS
Standard Chartered Bank Zambia Plc-SCBZ Plc	337.33	362.43	0.931	16.23	8.59	IRS	
Trust Merchant Bank s.a.r.l.-Congo	293.55	379.38	0.774	24.60	33.42	DRS	

Year	Name of Banks	Σ Output	Σ Input	$\Sigma O/\Sigma I$	∂o (%)	∂I (%)	Retu. to Scale
2013	Standard Bank SA	74890.29	70093.15	1.068	36.17	37.03	DRS
	Arab Banking Corporation - Algeria	434.04	313.74	1.383	384.43	276.97	IRS
	Société Générale de Banques en Côte d'Ivoire S.A. - SGBCI	1383.60	1328.73	1.041	8.87	12.41	DRS
	Standard Chartered Bank Botswana Ltd	947.15	886.26	1.069	5.12	5.89	DRS
	Attijariwafa Bank- Morocco	38890.86	33288.66	1.168	4.28	4.60	DRS
	Bank of Africa - Madagascar	441.59	451.77	0.977	12.21	0.87	IRS
	Bank of Africa - Mali	496.60	504.14	0.985	43.51	49.40	DRS
	Bank of Africa - Senegal	302.28	296.12	1.021	28.28	23.08	IRS
	Banque de Kigali-Rwanda	582.26	493.72	1.179	55.11	39.03	IRS
	Bank Windhoek Limited - Namibia	1818.60	1608.53	1.131	16.28	14.85	IRS
	Banque Internationale Arabe de Tunisie - BIAT	4908.66	4039.74	1.215	12.89	9.54	IRS
	Barclays Bank of Uganda Limited	376.93	339.33	1.111	11.37	11.51	DRS
	Commercial Bank of Ethiopia	8807.46	7568.46	1.164	28.44	29.08	DRS
	Ecobank Togo	567.48	537.72	1.055	15.84	15.08	IRS
	Equity Group Holdings Limited- Kenya	2741.64	2428.06	1.129	14.49	13.04	IRS
	First Rand Bank Ltd-South Africa	58014.16	53874.48	1.077	12.80	11.99	IRS
	GCB Bank Limited -Ghana	981.91	822.92	1.193	19.02	11.30	IRS
Standard Chartered Bank Zambia Plc-SCBZ Plc	410.85	388.14	1.059	21.80	7.10	IRS	
Trust Merchant Bank s.a.r.l.-Congo	380.51	467.05	0.815	29.62	23.11	IRS	
2014	Standard Bank SA	83802.19	78805.73	1.063	11.90	12.43	DRS
	Arab Banking Corporation - Algeria	460.91	324.25	1.421	6.19	3.35	IRS
	Société Générale de Banques en Côte d'Ivoire S.A. - SGBCI	1651.66	1539.60	1.073	19.37	15.87	IRS
	Standard Chartered Bank Botswana Ltd	1214.35	1150.21	1.056	28.21	29.78	DRS
	Attijariwafa Bank- Morocco	41333.54	34338.07	1.204	6.28	3.15	IRS
	Bank of Africa - Madagascar	461.88	488.44	0.946	4.60	8.12	DRS
	Bank of Africa - Mali	777.01	802.85	0.968	56.47	59.25	DRS
	Bank of Africa - Senegal	451.19	440.84	1.023	49.26	48.87	IRS
	Banque de Kigali-Rwanda	643.02	563.79	1.141	10.43	14.19	DRS
	Bank Windhoek Limited - Namibia	2161.52	1910.66	1.131	18.86	18.78	IRS
	Banque Internationale Arabe de Tunisie - BIAT	4792.64	4017.40	1.193	-2.36	-0.55	DRS
	Barclays Bank of Uganda Limited	400.19	368.36	1.086	6.17	8.55	DRS
	Commercial Bank of Ethiopia	11229.82	9547.64	1.176	27.50	26.15	IRS
	Ecobank Togo	623.38	628.77	0.991	9.85	16.93	DRS
	Equity Group Holdings Limited- Kenya	3307.35	3004.17	1.101	20.63	23.73	DRS
	First Rand Bank Ltd-South Africa	63838.83	58332.44	1.094	10.04	8.27	IRS
	GCB Bank Limited -Ghana	1148.23	981.33	1.170	16.94	19.25	DRS
Standard Chartered Bank Zambia Plc-SCBZ Plc	416.38	485.56	0.858	1.35	25.10	DRS	
Trust Merchant Bank s.a.r.l.-Congo	475.04	553.20	0.859	24.84	18.45	IRS	

*DRS = Discount Returns to Scale, where $\partial o < \partial I$; **IRS = Increasing Returns to Scale, where $\partial o > \partial I$.

Table 8: List of Best African Banks-2015

BEST EMERGING MARKETS BANKS IN AFRICA 2015			
S/N	Country	Bank	Decision
1	Regional Winner	Standard Bank	✓
2	Algeria	Arab Banking Corporation Algeria	✓
3	Angola	Standard Bank Angola	X
4	Botswana	Standard Chartered Bank Botswana	✓
5	Burkina Faso	United Bank for Africa (Burkina Faso)	X
6	Cameroon	United Bank for Africa (Cameroon)	X
7	Côte d'Ivoire	Société Générale de Banques en Côte d'Ivoire	✓
8	DR Congo	Trust Merchant Bank	✓
9	Djibouti	BCIMR	X
10	Ethiopia	Commercial Bank of Ethiopia	✓
11	Gambia	Standard Chartered Bank Gambia	X
12	Ghana	GCB Bank	✓
13	Guinea	FBN Bank Guinea	X
14	Kenya	Equity Bank	✓
15	Madagascar	Bank of Africa - Madagascar	✓
16	Mali	Bank of Africa - Mali	✓
17	Mauritius	Barclays Bank of Mauritius	X
18	Morocco	Attijariwafa Bank	✓
19	Mozambique	Millennium bim	X
20	Namibia	Bank Windhoek	✓
21	Nigeria	First Bank of Nigeria	X
22	Rwanda	Bank of Kigali	✓
23	Senegal	Bank of Africa Senegal	✓
24	Sierra Leone	Standard Chartered Bank Sierra Leone	X
25	South Africa	FirstRand Bank	✓
26	Togo	Eco bank Togo	✓
27	Tunisia	Banque Internationale Arabe de Tunisie	✓
28	Uganda	Barclays Bank of Uganda	✓
29	Zambia	Standard Chartered Bank Zambia	✓
30	Zimbabwe	Stanbic Bank Zimbabwe	X

Source: *Global Finance Magazine* (2015)

✓ = Observed; X = Unobserved, due to incomplete data for the target five years (i.e. 2010-2014)