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INTERMEDIATION EFFICIENCY AND PRODUCTIVITY OF COMMERCIAL BANKS IN KENYA; A Data Envelopment and Malmquist Productivity Index Analysis

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ABSTRACT

This paper analyses the intermediation efficiency and productivity of Kenyan commercial banks between 2001 and 2011. It is anchored on the research evaluating the intermediation efficiency and productivity of commercial banks in Kenya. The study adopts a non-parametric approach Data Envelopment Analysis (DEA) to analyze intermediation efficiency in the banking sector and Malmquist Productivity Index (MPI) to measure productivity growth of banks in Kenya. The study finds that while the 2007/2008 post-election violence and the Global Financial Crisis caused a short-term increase in efficiency in 2008 primarily due to cost-cutting, increases in non-performing loans in 2009 after the crisis caused a more sustained decline in bank efficiency. It is also found that in 2009 there was high technological improvement in the banking industry with large banks showing increase in technological innovations by the largest percentage as compared to medium and small banks. Nonetheless the large decline in bank output in the same period resulted into a decline in bank productivity. In general the results show that though the banks in Kenya have a high efficiency score they is need to improve in their scale of operations so as to be fully efficient.

Keywords: *Basel, Intermediation efficiency, Data Envelopment Analysis, Malmquist Productivity Index.*

1.0 INTRODUCTION

Following the international capital adequacy framework prudential guidelines, Kenya has strengthened capital regulations and official supervisory agencies. However, Barth *et al.* (2008) sees no basis for the view that countries around the world have primarily reformed for the better. The regulatory capital for commercial banks in Kenya is expected to be Ksh.1 billion by end 2012, a 300% increase from KSh.250 million in 2007 (Central Bank of Kenya, Annual Report, 2007).The corollary of this in efficiency terms is however unclear despite several Kenyan researchers (Kamau, 2011; Beck et al., 2010; Mathuva, 2009) supporting the Central Bank of Kenya's move to gradually raise bank capital levels and to tightly monitor the operations of banks.

While it is agreeable that expansion in bank capital may be efficiency enhancing since equity serves as an alternative source of funding, it is also used to mitigate the risks of bank failure and the externalities associated with it. Existing evidence does not suggest that strengthened capital regulations and empowered supervisory agencies will improve banking system stability, enhance the efficiency of intermediation, or reduce corruption in lending (Barth *et al.*, 2004, 2008; Gropp and Heider, 2009; Kumar *et al.*, 2009; Fiordelisi*et al.*, 2010). For instance, Gropp and Heider (2009) clearly states that while there is a strong link between banking regulations and supervisions and bank efficiency more demanding regulatory practices appear to significantly decrease the efficient operations of banks.

Further, holding regulatory capital comes at a cost. If there are significant costs to raising bank capital, regulatory imposed capital requirements can have real effects. Banks may choose to exit the industry rather than

satisfy the requirements. Such "exit" may occur through a reduction in bank loans rather than a reduction in bank assets per se. In such an event, otherwise worthy borrowers would not obtain bank loans. There would be a "credit crunch" which refers to the possibility that banks are reluctant to lend to worthy loan applicants because of capital requirements.

In Kenya, studies conducted limit themselves to variables such as bank capital adequacy and stability. However, the researchers in Kenya and other developing nations do not address the issue of whether there is anything peculiar about banks raising capital. Whether the Basel capital adequacy framework, because of its risk sensitive measures of capital, may have affected the efficiency of the banking sector in Kenya is yet to be determined. Aside from the risk sensitive nature of the capital requirements, evidence has shown, the level of the required capital (to assets ratio) may have an effect on bank efficiency of operation and overall economic development of the country (Fiordelisi*et al.*,2010; Pasioura*et al.*,2009; Barth *et al.*,2004, 2008).

2.0 OVERVIEW OF BANKING SECTOR PERFORMANCE IN KENYA

By African standards and in comparison with other East African economies, Kenya's banking sector has for many years been credited for its size and diversification. Unlike most other countries in the East African region, Kenya has a variety of financial institutions and markets - banks, insurance companies, stock, and bond markets - that provide an array of financial products (East AFRITAC 2007-2008). As at 31st December 2010, the banking sector comprised of the Central Bank of Kenya, as the regulatory authority, 44 banking institutions (43 commercial banks and 1 mortgage finance company), 2 representative offices of foreign banks, 5 Deposit-Taking Microfinance Institutions (DTMs) and 126 Forex Bureaus. 31 of the banking institutions are locally owned while 13 are foreign owned.

Banking industry in Kenya is governed by the Companies Act, the Banking Act, the Central Bank of Kenya Act and other various prudential guidelines issued by the Central Bank of Kenya (CBK). The CBK is responsible for regulation and supervision of banks. Over the past decades, there have been numerous revisions to the Banking Act, Central Bank of Kenya Act and prudential guidelines aimed at strengthening CBK's supervisory role (Banking Act Chapter 488 and Central Bank of Kenya Act Chapter 491, 2004). The Banking Act has been reviewed over time to give more legal powers to the regulatory authority and enhance the capital requirements.
In 2000, the Central Bank adopted the Basel I standards on capital adequacy. This led to the introduction of additional capital adequacy ratios of 8% and 12 % for core capital and total capital to risk weighted assets respectively. In 2007 CBK enforced the implementation of the Basel 1 amendments particularly the market risk amendment and adopted Risk Based Supervision (RBS). Consequently, bank capital requirement increased from 250 million in 2008 to 1 billion by end 2012. However it's worth noting that the capital ratio remained unchanged at 8% and 12% for core capital and total capital to risk weighted assets respectively. These reforms are in tandem with the prevailing global trends that require financial institutions to maintain capital commensurate with the risk inherent in their business. Accordingly, the capital adequacy levels provided is intended at ensuring that each institution maintains a level of capital that adequately covers depositors and creditors, is commensurate with the risk carried by the bank, and promotes public confidence in the institution (CBK, 2008).

2.1 CAMEL Rating System

The Central Bank applies the CAMEL rating system to assess the soundness of financial institutions which is an acronym for Capital Adequacy, Asset Quality, Management Quality, Earnings and Liquidity. Capital adequacy is measured by the ratio of Total Capital to Total Risk Weighted Assets and the minimum regulatory requirement is 12.0 percent. Asset Quality is measured by the ratio of Net Non-performing Loans to Gross Loans. Liquidity is the ability to fund increases in assets and meet obligations as they fall due, it is crucial to the sustainability of any banking institution. The importance of liquidity transcends the individual bank as any liquidity shortfall at an individual institution may have systemic repercussions due to inter-linkage of banking business. The high liquidity ratio in Kenyan banking sector demonstrates the sector's preference for liquid investments mainly government securities (CBK Annual Report, 2010).

Using the Camel Rating System, since the Central Bank adopted the Basel I prudential guidelines in 2000 there has been a continuous improvement in financial stability, as indicated by the financial soundness indicators used by CBK in Table 2.

Table 2: Kenya Financial Soundness Indicators (%)

Performance measure	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Core capital/ TRWA	14.5	14.1	14.7	16.3	16.0	16.4	17	18	19	20
Total Capital/ TRWA	17.1	17.4	17.2	16.6	16.4	16.5	19	20	21	22
Liquid assets to total assets	34.4	33.7	33.2	32.4	33.1	30.5	35.1	36.6	39.8	44.5
Non-performing loans to gross loans	39.4	39.6	34.9	29.3	25.6	21.3	10.9	8.4	8.0	6.3
NPLs/total assets (%)	20.7	16.1	14.0	12.1	10.6	8.5	4.3	4.0	3.0	2.1
Return on Assets	1.31	2.83	2.62	3.02	2.62	3.02	4.11	4.03	4.5	4.7
Net interest income to gross income	43.6	43.8	50.5	50.7	50.2	50.2	50.1	48.3	52.9	49.1
Non-interest expenses to gross income	58.6	66.9	62.9	63.9	55.7	52.8	50.8	48.7	47.1	50.9

Source: Central Bank of Kenya Annual Reports (Various Issues)

The Sector recorded improved performance as indicated by Capital Adequacy, Asset Quality Earnings and Liquidity. The growths on assets quality were mainly underwritten by an increase in loans and advances. The increased deposits were supported by aggressive deposit mobilisation by banks and branch expansion. The increased profitability shown by return to assets was largely attributable to the growth in credit. The decline in gross non-performing loans was supported by enhanced credit appraisal standards adopted by banks in 2009 (CBK Annual Reports, 2000-2010).

2.2 Materials and Methods

2.2.1 Bank Efficiency Measurement

While the multiproduct nature of the banking firm is widely recognised, there is no all-encompassing theory of the banking firm and no agreement on the explicit definition and measurement of banks' inputs and outputs (Wezel, 2010).Following the no 'perfect approach' for evaluating entire financial institutions the intermediation approach may be more appropriate. The main consequence of the intermediation approach is that deposits are considered as inputs, and interest on deposits as a component of total costs, together with labour and capital costs. A similar approach was adopted by Casu & Molyneux (2000); Barth, et al., (2008, 2004); Pasiouras et al., (2008) Kumar et al., (2009) and Kamau, (2011).

Moreover, Casu & Molyneux (2000) argued the intermediation approach may be superior for evaluating the importance of frontier efficiency to the profitability of financial institutions, since the minimisation of total costs, not just production costs, is needed to maximise profits.

Accordingly, in this study we specify two outputs and two inputs:
Outputs: Y_1= total loans
Y_2 = other earning assets
Inputs: X_1 = total costs (interest & non-interest expenses, personnel expenses)
X_2 = total customers and short term funding (total deposits).

2.2.2 Data Envelopment Analysis: Non-parametric Approach

Data Envelopment Analysis (DEA) is a multi-factor productivity analysis model for measuring the relative efficiencies of a homogenous set of decision making units (DMUs). DEA uses the principles of linear programming theory to examine how a particular DMU like a bank operates relative to other DMUs in the sample. The method constructs a frontier based on actual data. Firms on the frontier are efficient, while firms off the efficiency frontier are inefficient. An efficient firm does not necessarily produce the maximum level of output given the set of inputs. Further, efficiency means that the firm is a "best practice" firm in the taken sample (Talluri, 2000).

The DEA model as a measure of efficiency is a methodology directed to frontier rather than central tendencies. It is able to identify any apparent slack in input used or output produced and provides insight on possibilities for increasing output and/or conserving input in order for an inefficient decision-making unit to become efficient. Further, DEA does not explicitly make any assumptions regarding the functional form of the frontier but empirically builds a best-practice function from observed (actual) inputs and outputs (Talluri, 2000).

DEA also uncovers relationships, which remain hidden for other methodologies, allowing ranking DMUs according to their technical efficiency scores and single out the driving forces for inefficiencies (Kumar, 2009). DEA selects the weights that maximize each bank's efficiency score under the conditions that no weight is negative, that any bank should be able to use the same set of weights to evaluate its own efficiency ratio, and that the resulting efficiency ratio must not exceed one. In general, a bank will have higher weights on those inputs that it uses least and on those outputs that it produces most (Wezel, 2010).

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

$$Efficiency = \frac{weighted\ sum\ of outputs}{weighted\ sum\ of inputs} \quad (1)$$

This ratio accommodates multiple inputs and outputs in efficiency estimation and measures the relative efficiency based on input and output weights. However, a unique set of weights for all banks may be difficult to identify, because different banks have different input and output combinations. Therefore, for the purpose of this study a common efficient frontier is computed under the assumption that the banks operating in Kenya share the same technology.

The general model with each of the banks, consuming 2different inputs to produce *2* different outputs, translates into the following programming problem which is solved *n* times; each time for a different bank in the sample.

$$max \quad \sum_{k=1}^{2} v_k y_{ki} \Big/ \sum_{j=1}^{2} u_j x_{ji}$$

$$s.t \quad \sum_{k=1}^{2} v_k y_{ki} \Big/ \sum_{j=1}^{2} u_j x_{ji} \leq 1$$

$$v_k, u_i \geq 0 \quad (2)$$

Where;

$k = 1\ to\ 2$ outputs,

$j = 1\ to\ 2$ inputs,

$i = 1\ to Banks\ in\ the\ sample$,

$y_{ki} = amount of output k produced by Bank\ i$,

$x_{ji} = amount of input j utilized by Bank\ i$,

$v_k = weight given to output k$,

$u_j = weight given to input j$.

Equation (2) can be converted to a linear programming problem as shown in equation (3) below.

$$max \quad \sum_{k=1}^{2} v_k y_{ki}$$

$$s.t \quad \sum_{j=1}^{2} u_j x_{ji} = 1$$

$$\sum_{k=1}^{2} v_k y_{ki} - \sum_{j=1}^{2} u_j x_{ji} \leq 0$$

$$v_k, u_i \geq 0 \quad (3)$$

The above linear programming problem aims to maximize the outputs of bank *i* subject to virtual inputs of bank *i* while maintaining the condition that the virtual outputs cannot be exceeded by virtual inputs of any banks. Both the fractional programming problem and the linear programming problem have the same objective function. It measures the relative efficiency of bank *i* based on the performance of the other banks in the industry.

For that, the weighted input and output ratio is maximised subject to given constraints. The first constraint of the model limits the estimated efficiency of the banks to one. The second constraint in the above model indicates that all variables, including input and output weights, are non-negative. Efficiency indices of efficient firms are equal to one. Furthermore, there is at least one efficient unit that is used as the referencing unit for estimating relative weights for the inefficient units.

2.2.3 Overall Bank Productivity Measure

This study use Malmquist Total Factor Productivity (TFP) index to measure productivity change and to decompose this productivity change into technical change and technological efficiency change. The Malmquist Productivity Index (MPI) uses a distance function approach to measure productivity improvements. Following DEA, if inefficiency does exist, the movements of any given bank over time will depend on both its position relative to the corresponding frontier (technical efficiency) and the position of the frontier itself (technical change). These enable us to distinguish between improvements emanating from the bank's catch up to the frontier and that resulting from the frontier shifting up over time. For this purpose, the output - oriented Malmquist index - is used to assess the sources of factor productivity change in banks. The index decomposes total factor productivity change into efficiency change and technological change. Malmquist index is written as follows:

$$M_o^{t+1}(y_t, x_t, y_{t+1}, x_{t+1}) = \frac{d_o^{t+1}(y_{t+1}, x_{t+1})}{d_o^t(y_t, x_t)} \left[\frac{d_o^t(y_{t+1}, x_{t+1})}{d_o^{t+1}(y_{t+1}, x_{t+1})} \times \frac{d_o^t(y_t, x_t)}{d_o^{t+1}(y_t, x_t)} \right]^{1/2}. \quad (4)$$

where the subscript o indicates an output-orientation, M is the productivity of the most recent production point (x_{t+1}, y_{t+1}) (using $t+1$ technology) relative to the earlier production point (x_t, y_t) (using t technology), d are output distance, and all other variables are as previously defined.

A score of greater than unity indicates productivity progress in the sense that the bank delivers a unit of output in period $t+1$ using fewer inputs. In other words, the bank in period $t+1$ is more efficient relative to itself in period t. Similarly, a score less than unity implies productivity regress and a unit score indicates constant productivity.

However, a major criticism levelled against the DEA methodology is that it assumes absence of measurement error and statistical noise. Accordingly, errors are taken as measures of inefficiency. This difficulty of drawing statistical inference when using DEA has been overcome by use of regression analysis. The basic idea of what has become known as the "Two-Step" procedure is to treat the efficiency scores as data or indices and use linear regression to explain the variation of these efficiency scores (McDonald, 2009).

3.0 RESEARCH FINDINGS AND DISCUSSIONS

3.1 Growth of banks

The number of banks, their asset distribution, and variables used in efficiency computation in the 2001-2011 period of analysis are shown on table2. The statistics show that the Kenyan banking sector has significantly grown not only in size but also in there trading activities as shown by the increase in bank outputs (loans and investment) and inputs (deposits and total cost) during the 2001–2010 period of analysis.

Table 3.1: Number of Banks, their Mean Assets and Variables included in the Estimation of Efficiency

Year	No. of Banks	Ksh. Millions				
		ASSETS	OUTPUTS		INPUTS	
			Loans	Investment	Deposits	Expenses
2001	38	10369.18	5273.84	3156.21	9430.71	1103.18
2002	38	11222.18	5434.71	3408.05	8578.92	1102.45

2003	38	12254.42	5824.55	4047.50	10019.39	996.55
2004	39	14290.56	7141.21	3745.85	11065.18	957.97
2005	39	15703.64	8245.26	4137.18	12618.97	1219.03
2006	39	18350.18	9590.49	4985.87	15235.15	1459.15
2007	41	22750.32	11632.90	6065.83	17982.51	1770.49
2008	41	29407.90	15834.00	7421.56	23615.24	2466.34
2009	41	33555.22	17630.88	8955.22	28052.27	2961.39
2010	41	41928.68	22287.44	10970.22	33527.32	3324.59
2011	41	51957.29	29599.22	11331.68	41229.98	4141.41
	% Change	400 %	462%	259%	337%	73%

Correlations among input and output variables can be used to show the appropriateness of such variables (Kamau 2011). The analysis on table 3.2 shows that the correlation between the variables is not only significant but also very strong at 0.01 significant levels. The recorded high correlation coefficients between input and output variables, confirm that the selected input and output variables for efficiency computation is appropriate.

Table3.2: Correlation of inputs and outputs variables included in DEA efficiency estimation

Pearson Correlations					
	Loans	Investment	Expenses	Deposits	
Loans	1	.829**	.971**	.973**	
Investment		1	.840**	.895**	
Expenses			1	.969**	
Deposits				1	
**. Correlation is significant at the 0.01 level (1-tailed).					
		Loans	Investment	Expenses	Deposits
Kendall's tau b	Loans	1.000	.605**	.822**	.818**
	Investment		1.000	.629**	.741**
	Expenses			1.000	.810**
	Deposits				1.000
Spearman's rho	Loans	1.000			
	Investment	.784**	1.000		
	Expenses	.949**	.807**	1.000	
	Deposits	.946**	.899**	.945**	1.000
**. Correlation is significant at the 0.01 level (1-tailed).					

3.2 Data Envelopment Analysis (DEA) Results

From the results of the DEA efficiency analysis relative to the entire Kenyan commercial banks common frontier, a 'benchmark' efficiency score of unity that no individual firm can exceed is established. This allows comparison of each bank against the same benchmark.

Using two bank inputs to produce two outputs solves the following linear mathematical programming problem as revealed by equation 2. The linear programming problems are solved by using the DEAP Version 2.1 Computer Program, by Tim Coelli. The terminology adopted is the standard terminology.

$$max \quad \sum_{k=1}^{2} y_{ki}$$

$$s.t \quad \sum_{j=1}^{2} x_{ji} = 1$$

$$\sum_{k=1}^{2} y_{ki} - \sum_{j=1}^{2} x_{ji} \leq 0$$

Where using each bank k in the sample with input j to produce output i, the aim is to maximize the defined bank outputy_{ki} given each banks amount of inputs x_{ji}. A common frontier is defined for each of the years under observation2001-2011 periods on the assumption that bank in Kenya use the same technology.

The principal technical efficiency results presented in this study are derived by allowing for input orientation variable returns to scale (VRS). VRS results are presented because they are more plausible in a real-world where decision making units (DMUs) operate in less than optimal conditions. The CRS assumption is only appropriate when all the units operate at an optimal scale. However, constraints in the operating environment for instance imperfect competition, financial and human resource constraints amongst other factors may cause a bank to operate at non-optimal scale.

In order to check that the results are not too sensitive to the presence of outliers, a procedure used, among others, by Casu and Molyneux (2000) was followed. After solving the DEA problems using all the observations composing the sample, all banks presenting CRS, VRS and Scale efficiency score equal to unity were deleted and the DEA problems solved once more. Elimination of banks with Scale efficiency of unity follows that constraints such as size amongst other factors cause banks in Kenya to operate at non-optimal scale. This procedure resulted to elimination of two banks from our analysis namely; Jamii Bora and Habib A G Zurich bank. Table 3.3 below illustrates the average efficiency scores relative computed once more on the new sample.

Table 3.3: Annual Ranking of Individual Bank Efficiency Scores

Pst	mean	bank/ Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	1.00	Barclays Bank Kenya	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2	1.00	Dubai bank Kenya	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
3	1.00	Habib Bank	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
4	0.99	Stan. Chart. Bank Kenya	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.87	1.00	1.00	1.00
5	0.99	Dvp.Bank	1.00	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.87	1.00
6	0.96	Citibank N.A.	1.00	1.00	1.00	1.00	1.00	0.88	0.79	0.92	1.00	1.00	1.00
7	0.95	NIC Bank	0.62	0.97	1.00	1.00	0.99	0.93	1.00	1.00	1.00	1.00	1.00
8	0.94	Diamond Trust	0.79	0.86	1.00	0.86	0.94	1.00	0.94	0.99	1.00	0.98	1.00
9	0.94	K - Rep Bank	1.00	0.85	0.93	1.00	1.00	1.00	1.00	1.00	0.91	0.82	0.82
10	0.94	KCB	0.91	0.88	0.86	0.89	0.97	0.91	0.88	1.00	1.00	1.00	1.00
11	0.93	CBA	1.00	0.88	1.00	1.00	0.84	1.00	0.94	0.94	0.84	0.83	1.00

12	0.93	Equity Bank			1.00	0.89	0.81	0.72	1.00	1.00	1.00	0.98	1.00
13	0.93	HFC	1.00	0.67	0.87	0.89	0.91	0.92	0.97	1.00	1.00	1.00	1.00
14	0.93	National Bank	0.82	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.62	0.75	1.00
15	0.92	Bank of India Kenya	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.59	0.52	1.00
16	0.91	Bank of Baroda Kenya	1.00	0.88	0.94	1.00	0.84	1.00	0.93	1.00	0.60	1.00	0.86
17	0.91	Victoria Bank Kenya	0.53	1.00	1.00	0.90	0.81	1.00	0.98	1.00	0.89	1.00	0.89
18	0.91	I & M Bank Kenya	0.50	0.81	0.99	1.00	0.98	1.00	0.94	1.00	0.83	0.93	1.00
19	0.88	Trans- National bank Kenya	0.41	0.71	0.85	0.92	1.00	1.00	1.00	1.00	0.98	1.00	0.83
20	0.87	Co - operative	0.68	0.77	0.76	0.84	0.91	0.90	0.79	1.00	0.96	0.99	0.97
21	0.86	Oriental Bank Kenya	0.19	1.00	1.00	0.73	1.00	1.00	1.00	1.00	0.80	0.90	0.81
22	0.85	Middle East Bank Kenya	0.83	0.94	0.80	0.83	0.66	0.94	0.98	0.89	0.72	0.82	0.90
23	0.83	Chase Bank	0.96	1.00	1.00	0.98	0.90	0.88	0.76	0.71	0.57	0.63	0.73
24	0.82	Bank of Africa	0.66	0.67	0.90	1.00	0.85	0.87	0.85	0.83	0.68	0.74	1.00
25	0.82	CFC-Stanbic	0.42	0.59	0.68	0.86	0.90	0.97	1.00	1.00	0.87	0.92	0.77
26	0.78	Paramount Bank	0.50	0.76	0.81	0.87	0.73	1.00	0.74	0.84	0.58	0.86	0.88
27	0.78	Credit Bank	0.70	0.94	0.83	0.84	0.79	0.86	0.93	0.79	0.57	0.61	0.70
28	0.77	Equatorial Bank Kenya	0.78	0.82		0.96	0.83	1.00	0.78	0.69	0.72	0.50	0.61
29	0.76	Ecobank Kenya	0.29	1.00	0.78	0.79	0.92	0.75	0.73	0.68	0.54	0.96	0.95
30	0.76	Family Bank							0.87	0.99	0.65	0.68	0.60
31	0.75	Guardian Bank	0.29	0.92	0.91	0.95	0.89	0.90	0.83	0.44	0.75	0.64	0.77
32	0.74	Prime Bank Kenya	0.58	0.67	0.76	0.84	0.77	0.91	0.73	0.86	0.61	0.64	0.81
33	0.73	Giro Bank Kenya	0.23	0.80	0.82	0.81	0.85	0.81	0.77	0.89	0.65	0.79	0.65
34	0.73	Fidelity Bank Kenya	0.55	0.72	0.82	0.91	0.69	1.00	0.79	0.74	0.60	0.62	0.63
35	0.72	ABC bank	0.60	0.75	0.82	0.82	0.79	0.82	0.75	0.74	0.55	0.63	0.64
36	0.70	Imperial Bank Kenya	0.36	0.66	0.82	0.88	0.81	0.86	0.36	0.80	0.71	0.80	0.63
37	0.68	Fina Bank Kenya	0.40	0.71	0.80	0.89	0.70	0.72	0.74	0.75	0.60	0.57	0.60
38	0.67	Gulf Bank v							0.47	0.75	0.66	0.73	0.74
39	0.59	Consolidated bank Kenya	0.51	0.34	0.52	0.61	0.57	0.68	0.70	0.71	0.63	0.61	0.60
	0.84	**MEAN**	**0.70**	**0.85**	**0.90**	**0.91**	**0.75**	**0.93**	**0.87**	**0.94**	**0.79**	**0.83**	**0.77**

Table 3.3 shows the overall efficiency of the banking sector in Kenya was 84 percent, meaning the sector was 26 per cent inefficient in the 2001-2011 period of analysis. Banks were most inefficient in 2001 reporting 30 per cent inefficiency score followed by 2005 with 25 per cent inefficiency. The reported high inefficiency in 2001 is attributable to the high inefficiency in Oriental Commercial Bank which was over 80 per cent inefficient.

Recall, our earlier analysis show Oriental Commercial Bank had more liabilities than assets in 2001, with a negative capital ratio it is therefore logical not to expect the bank to be at the frontier.

The high inefficiency of 21 percent in 2009 from 6 percent in 2008 can be attributed to the fact that the growth in bank output (loans and advances) and inputs (customer deposits) declined following the challenging operating environment in 2008 brought about by the post election violence and global financial crisis.

Overall, the results show high average efficiency scores above 80 per cent. This corroborates Kamau (2011) who found overall average efficiency of 70% on Kenyan bank efficiency using DEA method. Further analysis on the input and output slack values would determine if the inefficiency reported were a result of inefficient use of inputs or outputs.

3.3 Overall Banks Factor Productivity

Following the DEA efficiency scores computed above the movements of any given bank over time will depend on both its position relative to the corresponding frontier (technical efficiency) and the position of the frontier itself (technical change). To enable distinguish between improvements emanating from the bank's catch up to the frontier and that resulting from the frontier shifting up over time due to production increase Malmquist Productivity Index (MPI) measure was used.

MPI measures the productivity change over the period; decompose the changes in productivity into what are generally referred to as a 'catching-up' effect [Technical Efficiency Change (TEC)] and a 'frontier shift' effect [Technological Change (TC)]. TEC is further decomposed into scale change (SE) and pure efficiency change (TE) components as TEC = TE × SE. The value of the decomposition is that it attempts to provide information on the sources of the overall productivity change in the Kenyan banking sector. A value of the index greater than one indicates positive TFP growth while a value less than one indicates TFP decline over the period.

Table 3.5: Malmquist TFP Index Summary of Annual Means; 2001-2011

Year*	Technical Efficiency Change (i)=(iii)(iv)	Technological Change (ii)	Pure Efficiency Change (iii)	Scale Efficiency Change (iv)	Total Factor Productivity Change (v)=(i)(ii)
2002[1]	1.000	1.084	0.992	1.008	1.084
2003	1.063	1.046	1.068	0.995	1.111
2004	1.036	1.016	1.023	1.012	1.052
2005	0.877	1.058	0.966	0.909	0.928
2006	1.174	0.814	1.054	1.113	0.956
2007	0.928	1.061	0.934	0.994	0.985
2008	1.014	1.005	1.018	0.996	1.019
2009	0.806	1.209	0.869	0.927	0.974
2010	1.091	0.930	1.067	1.023	1.015
2011	1.055	0.973	1.043	1.012	1.027
mean[2]	0.999	1.015	1.001	0.998	1.014

Table 3.5 shows that during 2001-2011 period, there was an average productivity change of 1.014. This indicates that on average over the sample period, there was 1.4% productivity progress in the Kenyan banking sector. Looking at the mean efficiency change (.999) and the mean technological change (1.015), the

[1] 2002 relates to the change between 2001 and 2002
[2] All the index averages are geometric means

productivity growth were largely the result of technical change. The positive technological change of 1.5% countered the negative in efficiency change of 0.001%.

The annual changes indicate that total factor productivity increased by 2.7%, 11.1%, in years 2002 and 2003 and declined by -1.5% and -26% in years 2007 and 2009 respectively. The findings for 2002 and 2003 concur with Kamau (2011) while the reported regress in 2007 and 2009 slightly differs with Kamau's who reported -5.6 percent and -5.2 percent in years 2007 and 2009 respectively.

Additionally, since the overall technical efficiency change is the product of pure technical efficiency and scale efficiency, pure efficiency change was 100.1% whereas scale efficiency change stood at 99.8%.This implies that the major source of technical efficiency was pure efficiency change and not scales efficiency. The mean scale efficiency regress of -0.02%, signals deterioration in output, this can be traced to 2007-2009 period of analysis.

The analysis show banks output deteriorated in 2007, 2008 and 2009 as by the negative scale efficiency of -0.006%, -0.004%, -0.073% respectively. This can be attributed to the challenging operating environment in 2007/ 2008 brought about by the post-election violence and global financial crisis resulting into decreased output. On the other hand this can also be a result of the high capital requirement that was pumped into the banks by the Basel II conformity requirement between 2008 and 2009 resulting into increased inputs not reciprocated by the outputs.

3.3.1 Bank-specific Productivity Change and its Decomposition

To provide more information on the sources of the overall productivity change in the Kenyan banking sector, an arbitrary classification of banks into three categories based on their size was done. Those are large banks with Market Share Index >5%, Medium banks = Market Share Index (>1% and <5%) and Small banks = Market Share Index <1%.Using the same methodology of Malmquist TFP Index individual bank specific productivity changes was computed. The Malmquist TFP Index is further decomposed into efficiency change (effch), Technological Change (techch), and the Scale Efficiency change (sech).

Table 3.6 shows percentage rate of productivity change for all banks that had existed during the entire sample period under the defined bank category. A positive sign indicates progress while a negative sign indicates a regress on the individual bank analysed. The sech column sign direction further indicates if a bank operates at increasing return to scale, decreasing return to scale, or constant returns to scale (CRS). Any value >1 means increasing returns to scale, <1 decreasing returns to scale and zero (0) CRS.

Table 3.6: Individual Bank Productivity Change and its Decomposition

	Bank	effch	techch	sech	tfpch
Large banks >5%	Kenya Commercial Bank Ltd	0.90	2.50	-0.10	3.40
	Barclays Bank of Kenya Ltd	-2.30	4.10	-2.30	1.70
	Co-operative Bank of Kenya	0.10	3.60	-1.00	3.80
	Standard Chartered Bank Ltd	1.30	1.00	1.30	2.30
	CfC Stanbic Bank Ltd	1.70	0.90	-0.70	2.60
Medium banks MSI (>1% and <5%)	I & M Bank Ltd	1.80	4.90	0.30	6.80
	Citibank N.A. Kenya	0.00	-0.90	0.00	-0.90
	National Bank of Kenya Ltd	-3.20	1.60	-3.20	-1.70
	Commercial Bank of Africa	-1.20	2.20	-1.40	0.90

	Diamond Trust Bank Ltd	1.20	3.90	-1.30	5.20
	NIC Bank Ltd	1.40	4.20	0.40	5.60
	Bank of Baroda Ltd	0.60	0.00	-0.10	0.60
	Prime Bank Ltd	-1.00	3.20	0.60	2.10
	HFCK	0.00	2.80	0.00	2.80
	Ecobank Kenya Ltd	-2.00	-2.90	-1.50	-4.80
	Bank of Africa Ltd	3.50	3.50	0.10	7.10
	Imperial Bank Ltd	-4.10	0.60	-2.10	-3.60
	Bank of India	0.50	7.40	-0.10	8.00
	Chase Bank Ltd	-1.00	1.30	2.10	0.30
	Dubai Bank Ltd	0.50	0.30	0.50	0.80
	African Banking Corporation	-0.20	1.60	0.20	1.40
	Giro Commercial Bank Ltd	-2.60	2.00	-0.20	-0.60
	Consolidated Bank of Kenya	1.50	-3.20	-0.30	-1.70
	Equatorial Commercial Bank	-2.50	3.00	0.50	0.40
	Development Bank of Kenya	0.00	-6.90	0.00	-6.90
	Habib Bank A.G. Zurich	0.00	2.50	0.00	2.50
Small banks	Guardian Bank Ltd	-2.70	5.00	-0.30	2.20
MSI[3] <1%	K - Rep Bank Ltd	-0.90	-1.20	1.10	-2.10
	Fidelity Commercial Bank Ltd	-0.90	3.10	1.70	2.20
	Victoria Commercial Bank	0.00	4.80	-0.20	4.70
	Trans- National Bank Ltd	2.80	-2.90	0.50	-0.20
	Habib Bank Ltd	1.40	1.50	0.00	2.90
	Credit Bank Ltd	0.20	1.60	-0.10	1.80
	Oriental Commercial Bank	2.70	-7.50	-0.80	-5.00
	Middle East Bank Ltd	-0.40	4.80	-1.00	4.40
	Paramount Universal Bank	2.10	0.70	-0.50	2.90

[3] Market Share Index
All values are percentages

The analysis shows that all large banks reported positive TFP change meaning there was progress unlike the medium and small that reported mixed reactions. Looking at the large banks technological change there all developed in-terms of technology with none reporting a negative sign. However, with the exception of standard chartered bank all the others in the category of large banks operated with decreasing returns to scale. The negative sign signals the bank's deterioration in output and the productivity growth were largely a result of technical change.

It is interesting to compare the performance of Barclays Bank of Kenya Ltd and Development Bank of Kenya Ltd with both banks rated best with an efficiency score 100%. However, on analysing the performance of the two banks, Barclays Bank is the least in productivity growth with 1.7% progress. This is attributable to the bank's deterioration in output with Scale Efficiency change of -2.3%. Despite the decline in output the bank has the highest technological change with 4.1% in its category though not the best in the industry. On the other hand, Development Bank of Kenya Ltd, under the category of small banks, is also the least in productivity growth reporting a regress of -6.9%. Unlike Barclays Bank, it has been operating at CRS and based on the industry's performance the bank regressed in technological development.

Table 3.7: Mean Productivity Change of the Banks by Category

Bank Category	effch	techch	sech	tfpch
Large Banks	1.0034	1.0242	0.9944	1.0276
Medium Banks	0.9975	1.0227	0.9956	1.0203
Small Banks	0.9993	1.0068	1.0003	1.0058

Table 3.7 shows that generally all the bank categories increased in their total productivity and showed technological development over the study period. This is shown by the 2 column of technological change and total factor productivity change; the mean values are all above 1. The productivity progress was 2.76, 2.03, 0.58%, while technological progress is 2.42, 2.27, and 0.68% for large, medium, and small banks respectively. Only large banks show a positive efficiency change (0.0034%) the medium, the small banks show a negative change of -0.0007% and -0.0025% respectively. With positive technological change in medium and small banks the negative efficiency change would only mean that, these bank categories could not catch up with the large banks in the use of their inputs or despite their technological development.

Partly the findings concur with Kamau (2011), that the performance of large banks show increase in technological innovations by the largest percentage as compared to medium and small banks. Following Kamau's argument, large banks have resources to spend in new technology. However, our finding disagree that large foreign-owned banks are better than large local banks. Table 3.6 shows the large local banks like Kenya Commercial Bank Ltd and Co-operative Bank of Kenya have the highest productivity index though not the best in the industry.

4.0 CONCLUSION

The results confirm that the banking industry in Kenya witnessed important changes during the estimation period. Similar to Kamau (2011) findings the results suggest that the increased performance of banks in Kenya during the sample period was mainly due to technological change and not other efficiencies (such as superior management or organisation). There is evidence that some banks responded more positively and productively to the opportunities offered by new technology than other banks, as reflected in the greater dispersion in bank performance in the initial DEA results over time.

The study provides interesting insights into the dynamics of the Kenyan banking system and it is believed that the results should be of interest to management, policy makers, bank regulators and other stake holders. Although the study have provided insight on the importance of efficiency and technological change, further research could useful to expand on the implications of the results for bank strategies and the reasons for the differences in performance across different banks in Kenya.

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