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Does Risk-Taking Behaviour Matter for Bank Efficiency?

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Abstract
In pursuit of financial intermediation between borrowers and savers banks are exposed to various risks which affect efficiency. Using annual panel data for the period 2010 to 2019, this paper investigates the influence of risk-taking behaviour on bank efficiency in a developing economy. Data envelopment analysis technique was used to obtain the profit efficiency scores of each bank and Tobit regression to estimate the impact of various components of bank risks on profit efficiency. Estimation results established that credit and liquidity risks, significantly influence bank efficiency. Therefore, banks should maintain quality assets and a stable liquidity position as they significantly impact on efficiency.

Keywords: Bank Efficiency, Credit Risk, Liquidity Risk, Capital Risk, DEA

JEL: C23, D57, G21

1. Introduction

Banks are considered important drivers of economic growth due to their financial intermediation role between savers and borrowers. Efficient banks are resilient to shocks hence easing financial constraints to firms and promotes growth during a financial crisis (Diallo, 2018). Banks tend to engage in more risk-taking in their pursuit of higher profitability. But the level of risk that bank managers are willing to tolerate, depends on regulation, competition and corporate governance (Agoraki et al., 2011; Anginer et al., 2013). That notwithstanding excessive risk-taking such as that witnessed during the global financial crisis of 2007-09 leads to the fragility of the financial system (Rajan, 2006). Central banks may respond by imposing higher liquidity and capital requirements and countercyclical provisions for loan losses (BIS, 2011). Failure to account for risk-taking behaviour in efficiency studies may lead to biased estimations (Malikov et al., 2014; Hughes and Mester, 2013). Surprisingly, empirical studies that have investigated inter-temporal relationships between bank risk and efficiency are scant.

A vast literature has incorporated risk measures into frontier efficiency approach using stochastic frontier analysis. However, these studies consider only nonperforming loans and omit other important risks faced by banks such as

liquidity, capital or credit risk. Odunga, et.al (2013) examined factors that influence banks operating efficiency in Kenya but nevertheless omitted capital and liquidity risk. Pessarossi and Weill (2015) for instance finds capital risk to impact negatively on the cost efficiency of Chinese banks while Radic, et al. (2012) finds liquidity and capital risk to influence profit efficiency of investment banks. Banks that exhibit higher proportions of non-performing loans are not cost-efficient (Tabak et al., 2011; Podpiera and Weill, 2008). There is evidence that stringency of capital regulation is associated with higher bank efficiency, (Berger and Bouwman, 2013; Barth et al., 2013) where highly capitalized banks are more cost-efficient (Fiordelisi et al., 2011; Lepetit et al., 2008). Thus, understanding how risk-taking behaviour influences bank efficiency is an important concern.

This study seeks to investigate the impact of risk on bank efficiency in Kenya. Understanding the role of different aspects of risk on banks efficiency is particularly important for the Kenyan banking sector given the rapid expansion of cross-border banking in recent years within East and Central Africa. This exposes the entire region to possible systemic risk/contagion effect in the event of a bank collapse (Mwega, 2014). The benefits of cross border banking have been demonstrated by Beck et al., (2014). Several reforms have also taken place in the banking sector in Kenya with banks such as I&M merging with Giro bank and changing its status to a large peer group. Bank of Africa experienced a decrease in its net assets thus shifting to the small peer group. In 2018, Bank AI Habib of Pakistan was allowed to set up its representative office in Kenya by the Central Bank of Kenya (CBK). Recently, NIC and Commercial Bank of Africa amalgamated to form NCBA Bank thereby boosting the level of shared capital and widened their market share. The period 2013-2019 has been characterized by a persistent increase in non-performing loans (NPLs). Asset quality has been deteriorating, thus amplifying the need for more provisioning on the losses (CBK, 2019).

On the regulatory front, the banking industry has experienced numerous changes in its capital adequacy requirements. For instance, in 2013, the ratio of total capital to total risk-weighted assets stood at 12%. This ratio rose to 14.5% in 2016 (CBK, 2013 & 2016). These developments have increased banks heterogeneity in terms of size and capital structure which may affect banks' risk-taking behaviour and efficiency. Highly capitalized banks may encounter lower moral hazard problems and are therefore more efficient. To maximize profits, highly capitalized banks may increase their level of risk exposure to compensate for the costly capital.

We contribute to the banking literature by estimating a simple model with efficiency coefficients obtained from data envelopment analysis (DEA) approach which allows us to identify the influence of unobserved bank-specific heterogeneity characteristics related to risk-taking behaviour on bank efficiency. This enables us to estimate in a single step the effects of risk-exposure on bank efficiency. Specifically, we account for the influence of capital, liquidity, and credit risks. The rest of this paper is organized as follows: Section 2 presents a brief literature review. Section 3 explains the methodology and data employed. Section 4 reports the estimated results and interprets the findings, while the final section concludes.

2. Related literature

Several studies have been undertaken on bank efficiency using different approaches and models. However, these studies have arrived at contrasting findings. Adopting Seeming Unrelated regression Altunbas et al (2007), evaluated the factors influencing the efficiency of European banks using annual data for the period 1992 to 2000. They established that inefficient banks exhibit high capital levels and had few high-risk debts while efficient banks were found to assume a higher level of risks. While using the Granger causality model to study the relationships between credit, efficiency, and capitalization for the period 1990-1998, William (2004) found that inefficient banks are associated with poor quality of loans.

Altunbas et al (2000) adopted the stochastic frontier methodology in estimating efficiencies while using data for the period between 1993 and 1996. They found that risks do not affect bank efficiency. But in sharp contrast, Ngan (2014) concluded that risks significantly influenced efficiency for Vietnamese banks. Existing literature also reveals that banks cost efficiencies are higher than profit efficiencies. In an evaluation of the efficiency of South African banks using panel data for the period 2000 to 2005 and Stochastic Frontier Analysis, Ncube (2009) found that banks were 85% cost-efficient and 55% profit efficient.

In a study of determinants of the efficiency of Sharia banks in Indonesia for the years 2010 to 2014 and adopting Stochastic Frontier Model, Wahyuni and Pujiharto (2016) found that bank size significantly impacts profit efficiency, whereas, a rise in credit and capital risks resulted in an insignificant improvement of efficiency. These conclusions contradict the results of Casu and Molyneux (2003).

In Kenya, Kamau (2011) used DEA to evaluate the X-efficiency of banks for the period 1997 to 2009 and established a technical efficiency of 47% under constant returns. Using a fixed-effect estimation and panel data for the period 2005 to 2011, Odunga, et.al, (2013) concluded that credit risk significantly correlates with operating efficiency. However, capital had no impact on operating efficiency. The reviewed studies suggest that risk may negatively influence bank efficiency though the findings do not converge. This study improves on previous studies by evaluating the effect of various risks on bank profit efficiency.

3. Methodology and data

Econometric approach

The empirical approach adopted by this study is a two-step analysis. We model the inter-temporal relationships between risk and efficiency for a large sample of banks operating in Kenya. Bank efficiency is proxied by profit efficiency which is more suitable than cost efficiency (De Young and Hassan, 1998). We used the DEA approach developed by Farrel (1957) and later improved by Charnes, et al., (1978) to assess the profit efficiency of banks. The DEA employs linear programming methods to get efficiencies of each bank by using several inputs and outputs (Cooper et al, 1978). Banks with an efficiency score of 1 are considered efficient while those below 1 are considered inefficient.

In the conventional CCR ratio model (1978) of data envelopment analysis, CCR assumes a constant return to scale where an adjustment in leads to an equal change in outputs and hence used in industries which operate optimally (Casu & Molyneux, 2003). But the banking sector does not operate optimally since it is highly regulated and competitive. For this study, we, therefore, adopt the BCC model (1984) which distinguishes between technical and scale inefficiencies. The bank revenue is specified as follows;

$qy = \sum_{n=1}^{N} q_n y_n$ …. (1)

And the cost of each bank is

$wx = \sum_{j=1}^{J} w_j x_j$ … (2)

To obtain the profit we get the difference between revenue and the cost

$\pi = qy - wx$… (3)

The profit-maximizing function of the bank is;

$Max\pi^0 = q'y^0 - w'x^0$…… (4)

Subject to $(x^0, y^0) \in T$

T is the production possibility set of banks.

The optimal profits for the banks are;

$\pi^* = q'y^* - w'x^* \geq \pi^0 = q'y^0 - w'x^0$…. (5)

Thus, profit efficiency becomes;

$\delta = \frac{\pi^0}{\pi^*} \leq 1$… (6)

Where q'= $q_1, q_2 \ldots q_n$ are the prices of the output of vectors while w' = $w_1, w_2 \ldots w_r$ are the input prices and y^0 represent the outputs while x^0 represents the inputs.

To obtain the estimates of maximum profit the linear programming problem is solved as follows;

π^k=$Max\ \sum_{n=1}^{N} q_n y_n$ - $\sum_{j=1}^{J} w_j x_j$……(7)

Subject to

$\sum_{k=1}^{K} \lambda_K x_{jk} \leq x_j$ (j $= 1, 2, \ldots,$ J)

$\sum_{k=1}^{K} \lambda_K y_{nk} \geq y_n$ (n $= 1, 2, \ldots,$ N)

$$\sum_{k=1}^{N} \lambda_K = 1$$

$\lambda_k \geq 0; (k = 1,2, \ldots, K)$

The outputs (y_n) and (x_m) inputs are selected to obtain maximum profits and the non-negative scalar $\lambda_k = 1$ allows for the possibility of both negative and positive profits. Two techniques are applied in the identification of inputs and outputs. The first is the intermediation technique which is most appropriate when investigating firm-level efficiency. The second is the production approach which is most appropriate when analyzing bank branch-level efficiency (Kaparakis et al, 1994). By adopting the intermediation method of analysis, banks are assumed to play an intermediary role of combining labour, physical capital and funds to generate loans and securities (Berger & Humphrey, 1997). The input variables are x_1: funds, x_2: labour and x_3: fixed assets. Correspondingly, W_1 is funds price, W_2 is labour price and W_3 is fixed assets price. The outputs are Y_1 total loans and Y_2 total income with q_1 as the price of loans and q_2 being the price of income. In the second step, we investigate the relationship between bank risk and efficiency scores of each bank following Battese & Coelli (1995).

The empirical model is specified as follows;

$\pi_{it} = \alpha_0 + \alpha_1 \mathrm{CR}_{it} + \alpha_2 LR_{it} + \alpha_3 CAR_{it} + \alpha_4 \ln SIZE_{it} + \alpha_5 INF_t + \alpha_6 GDP_t + \varepsilon_{it}$….. (8)

Where;

π_{it} is profit efficiency of bank i at period t with $i = 1, \ldots, N$

CR_{it} is the credit risk of bank i at time t

LR_{it} is the liquidity risk of bank i at time t

CAR_{it} is the capital risk of bank i at time t

$Size_{it}$ is the size of bank i at time t

$\ln SIZE_{it}$ is the natural logarithm of the total assets of bank i at time t

INF is the inflation rate

GDP is per capita GDP growth.

Studies that have controlled for inflation and economic growth include Hauner (2005), Maudos et.al (2002) and Pasiouras et.al (2007)

$\varepsilon_{it} = v_i + \mu_{it}$ Where υ_i is the unobserved complete set of individual bank-specific effect which controls for all cross-sectional (or 'between banks'), and μ_{it} is the idiosyncratic error. Tables 1 and 2 presents the definition and measurement of variables

Table 1: Description of DEA variables

Variable	**Notation**	**Measurement**
Inputs		
Funds Price	w_1	The proportion of Total interest expense to Total deposits
Labour Price	w_2	The proportion of Staff costs to Total assets
Price of fixed assets	w_3	The proportion of depreciation to Fixed assets
Funds	x_1	Total deposits
Labour	x_2	Employee costs
Fixed assets	x_3	Costs of fixed assets
Outputs		
Total Loans	y_1	Total loans advanced to customers
Total Securities	y_2	Total of income from investment in government securities
Total loans Price	q_1	Ratio of interest income to total loans
Total income Price	q_2	Ratio of income from investments in securities to total securities

Table 2: Description of estimation variables

Variable	Notation	Measurement	Predicted Effect
Profit Efficiency	E_π	Efficiency scores of each bank	-
Capital risk	CAR	The proportion of Equity to Total Assets	Positive
Credit risk	CR	The proportion of NPLs to Total Assets	Negative
Liquidity risk	LR	Ratio of Total loans to Total Deposits	Negative
Inflation rate	INF	Percentage change in the average consumer price measured annually	Negative/Positive
Bank Size	$\ln Size$	The logarithm of the total assets of each bank	Positive
GDP per capita growth	GDP	Growth of GDP per capita	Positive

The DEA BCC model was used to generate profit efficiencies of each commercial bank. After obtaining the efficiency scores a Tobit model was estimated. The Tobit model is suitable when the dependent variable is restricted by a certain limit, the limit being the DEA efficiency scores that range from 0 and 1. OLS estimation would have resulted in biased outcomes of the parameters since it assumes a normal distribution. Panel data for the period 2010 to 2019 was obtained from the annual audited financial statement of commercial banks available at the CBK. Annual macroeconomic data was obtained from the Kenya National Bureau of statistics.

4. Empirical findings

Table 3 presents summary statistics for the inputs and outputs used to obtain the DEA efficiency scores.

Table 3: Efficiency scores

Commercial Bank	Efficiency scores	Ranks
Bank of India	1.00	1
Citibank N.A Kenya	1.00	1
NCBA	1.00	1
KWFT	0.98	2
Bank of Baroda	0.98	2
Equity Bank Kenya	0.97	3
KCB Bank Kenya	0.96	4
First Community Bank	0.94	5
ABSA Bank	0.92	6
HFC Ltd	0.92	6
Diamond Trust Bank	0.91	7
Commercial Bank of Africa	0.88	8
Standard Chartered Bank	0.88	8
African Banking Corporation	0.86	9
National Bank of Kenya	0.86	9
Victoria Commercial Bank	0.86	9
I&M Bank	0.85	10
NIC Bank PLC	0.85	10
Gulf African Bank	0.83	11
Middle East Bank (K) ltd	0.82	12
Prime Bank ltd	0.81	13
Paramount Bank	0.80	14
Co-operative Bank	0.79	15
Guaranty Trust Bank	0.79	15
Habib Bank AG Zurich	0.79	15
Sidian Bank	0.79	15
Stanbic Bank Kenya	0.79	15
Family Bank	0.77	16
Habib Bank ltd	0.76	17

Development Bank of Kenya	0.76	17
Credit Bank ltd	0.73	18
Bank of Africa	0.72	19
Consolidated Bank of Kenya	0.72	19
Jamii Bora Bank	0.71	20
Guardian Bank ltd	0.69	21
UBA Kenya Bank	0.68	22
Ecobank Kenya	0.67	23
Giro Bank	0.66	24
SBM Bank Kenya	0.65	25
Spire Bank	0.65	25
M-Oriental Commercial Bank	0.60	26
Transnational Bank	0.60	26
Mayfair Bank	0.57	27
DIB Bank Kenya	0.52	28
Average Efficiency score	**0.80**	

The average profit efficiency is 80% implying that the banks missed an opportunity to make 20% more profits from similar inputs. The profit efficiency scores are nevertheless high which is expected of a developing economy like Kenya where capital markets are weak and banks are the main source of funding. The efficiency scores range between 0 and 1, a commercial bank with a score of 1 is said to be efficient. There were only four banks that were efficient namely NCBA, KWFT, Citibank and Bank of India. Large banks namely KCB, Equity, ABSA, Standard Chartered, Diamond Trust, Stanbic, Commercial Bank of Africa and I &M also exhibited high-profit efficiencies compared to the medium and small banks. This is because large banks enjoy economies of scale and therefore can generate more revenue. Due to their market power, large banks incur fewer costs of inputs compared to the small banks (Hauner, 2005). Table 4 presents the summary statistics.

Table 4: Summary Statistics

Variable	Observation	Mean	Min	Max	Std. Dev
Efficiency	399	0.8046	0	1	0.2136
Capital risk	399	0.1708	-0.1117	1.5655	0.1067
Credit risk	399	0.0581	0	0.8104	0.6993
Liquidity risk	399	0.7003	0	5.2808	0.3736
Bank Size	399	7.5384	6.2371	8.8289	0.5758
Inflation rate	399	0.0706	0.0396	0.1402	0.0274
GDP per capita	399	0.0321	0.0182	0.0549	0.0093

Standard deviation lies between 0.1067 and 0.6993 which implies that the scores are not spread out implying that they are normally distributed. The maximum value for the data is 5.2808 and -0.1117, the range between the values is close. The minimum value on capital is negative, perhaps due to some banks accumulating losses in their balances resulting in negative values for the shareholders' funds. Credit risk as proxied by NPL reveals a 6% nonperforming ratio. This is a good performance given the challenges faced by the banking industry in Kenya.
Table 5 shows the correlation matrix. The bivariate correlations are low. Credit and liquidity risks have a negative correlation with profit efficiency perhaps because interest revenue declines when non-performing loans increase. Capital risk, bank size and inflation are positively associated with bank efficiency. Credit, liquidity risks and GDP per capita are negatively correlated with profit efficiency.

Table 5: Correlation matrix

	Efficiency	Capital risk	Credit risk	Liquidity risk	Bank size	Inflation	GDP
Efficiency	1						
Capital risk	0.0089	1					
Credit risk	-0.1441*	0.0851	1				

Liquidity risk	-0.1512*	0.0147	0.1084*	1			
Bank size	0.2512*	-0.1190*	-0.1395*	-0.0232	1		
Inflation	0.1505*	0.0274	-0.1323*	0.0419	-0.086	1	
GDP per capita	-0.2068*	-0.0310	0.3014*	-0.0132	0.2174*	-0.3713*	1

* Significant at 5 percent level

Having obtained the efficiency scores, we then evaluated the relationship between risk and efficiency. We estimated a Tobit model, and the findings are presented in Table 6.

Table 6: Estimation results

Variable	Coefficient	t-value	p-value
Capital risk	0.1183	0.89	0.373
Credit risk	-0.3249*	-1.55	0.007
Liquidity risk	-0.1039*	-2.79	0.006
Bank size	0.1324*	5.23	0.000
Inflation	2.3705	3.92	0.142
GDP	-4.3885*	-2.52	0.012

* significant at 5 per cent level

Estimation results reveal that credit risk negatively influences the efficiency of banks. A rise in NPLs leads to an increase in loan provisioning which eventually reduces banks profit which is consistent with Casu & Girardone (2004). Liquidity risk impacts negatively on bank efficiency. This implies that banks management of cash and cash equivalent is weak resulting in banks inability to meet its current obligations thus loss of interest income which reduces banks profitability. These findings corroborate Reddy and Nirmala (2013) and Altunbas (2000). Capital risk has no significant impact on efficiency.

Turning to the control variables, this study established that GDP per capita has a significant negative impact on profit efficiency. With a booming economy, operating expenses or cost per borrower may also rise which may lead to a decline in profit efficiency. It may also be the case that barriers of entry into the banking industry are lifted with economic expansion increasing competition and reducing bank revenue (Tan and Floros, 2012). Contrasting findings have been documented by Maudos et.al (2002) on the efficiency of European banks.

Bank size significantly and positively impacts on efficiency. Perhaps large banks have an opportunity to widen their outputs as they are privileged with economies of scale thus cutting on costs and increasing output (Stever, 2007). This finding supports Al-Sharkas et al. (2008) and Kamarudin et. al (2019) but contradicts Ariff and Can (2008). Contrary to theoretical predictions the impact of inflation rate on efficiency is positive but insignificant.

5. Conclusion

At the onset, this study investigated the impact of banks risks on profit efficiency. The efficiency scores were obtained using the DEA approach. Estimation results established that credit and liquidity risks, significantly influence profit efficiency. Banks revenue declines because of non-performing loans. Banks, therefore, incur extra cost to generate income to meet current obligations when faced with liquidity challenges. All these lead to a loss of income which reduces profit efficiency. This study, therefore, concludes that risk matters for bank efficiency. Specifically, credit and liquidity risks. Banks should aim at choosing the optimum ratio of outputs and inputs so that they can maximize profits and cut on cost. Banks need to maintain a stable liquidity position such that at any point in time they can meet their obligations as they arise. Liquid banks do not incur an extra cost of borrowing from other institutions to meet their current obligations.

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