Funding structure and technical efficiency

A data envelopment analysis (DEA) approach for banks in Ghana

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Abstract

Purpose – The purpose of this paper is to examine the effect of funding structure on technical efficiency of banks in Ghana, between 2011 and 2016.
Design/methodology/approach – Employing the random-effect and the truncated panel data of 25 banks, the results present new evidence.
Findings – The findings reveal that Ghanaian banks are less technically efficient, as the average efficiency scores generated is below the threshold of 1. Furthermore, the results show that banks in Ghana finance their operations mainly with deposit source of funding. The results reveal a significantly positive relationship between funding structure and technical efficiency. However, internally generated source of funds was negatively linked with technical efficiency. This is not surprising because banks that rely on external funds attract higher costs than internally generated funds, and this puts pressure on managers to perform. The results are relevant to emerging economies when the authors use additional macroeconomic factors.
Research limitations/implications – Thus, a proportionally larger deposit base funding would typically lead to an overall increase in technical efficiency of banks in Ghana. Shareholders should put pressure on managers to plough back earnings in order to increase the use of internally generated funds, thus, increasing technical efficiency. Banks that are inefficient should make some adjustments to their weights of inputs and/or outputs combinations by following their benchmark banks (efficient banks) to improve their efficiency.
Practical implications – The results of this study have important implications for regulators, investors and policy makers, particularly an emerging economy. The implication of the study to investors is that investors should be able to identify an appropriate source of funds that can be used efficiently to maximize their wealth in emerging markets. It is important for regulators and managers of banks to improve technical efficiency by considering the role that macroeconomic and monetary environment play when identifying and using various sources of funds as a strategy to improve bank efficiency.
Social implications – Consequently, future research should investigate the impact of funding structure on technical efficiency for other regions and considering their interactions with institutional quality, macroeconomic factors and financial stability.
Originality/value – To the best of the authors' knowledge, the study is the first to fulfill an urgent need to explore a robust approach of measuring technical efficiency and funding structure within the context of banks over six-year period, prompting insightful avenues to the survival, growth and performance of financiers in emerging economy.

Keywords Macroeconomic factors, Efficiency scores, Constant return to scale, Funding structure, Variable return to scale

Paper type Research paper

1. Introduction

One of the key factors of economic growth in emerging markets is the financial sector's ability to develop appropriate financial policies required for investment opportunities (Huang and Ritter, 2005). On funding structure, literature has mixed results of the effect of

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the various sources of funds on bank efficiency. Funding structure is a financial tool to determine how banks are financing optimal choice (Amidu and Wolfe, 2012). This allows banks to raise capital as a source of refinancing that could affect their value (Abor, 2005; Amidu and Wolfe, 2012). The financial market is interested to know the implications of financing decisions on the viability and profitability of a company (Abor, 2005). Banks which are financially leveraged, finance their operations by (all) debt capital. Therefore, the banking sector is considered an important source of funding. Berger and Humphrey (1997) reported that the financing strategy of banks is essentially a mixture of capital which banks consider appropriate to strengthen their activities. What motivates banks to improve their efficiency depends on the dynamic and competitive environment in which they operate, as well as choice of funding made when using borrowed money (deposits) and other sources of funds to finance their activities. Thus, a bank is said to be technically efficient if it can produce a given level of output, using a minimal amount of input (Charnes *et al.*, 1978).

This paper empirically analyzes the interaction among funding structure, technical efficiency of banks and other macroeconomic factors by employing a data set that covers an emerging economy, particularly, Ghana. It examines the following three hypotheses:

H1. Deposit funding increases technical efficiency of banks.

H2. Non-deposit funding increases the technical efficiency of banks.

H3. Internal funding decreases technical efficiency of banks.

Although no previous study has tested these hypotheses from the Ghanaian economy, several papers have examined the effect of capital structure on efficiency among several sectors and economies. Most of the studies measured the leverage effect on performance (Abor, 2005), and the results were inconclusive (Michaelas *et al.*, 1999; Gill *et al.*, 2009) due to the different use of sophisticated performance measures, and the influence of the institutional framework in relation to specific countries (Weill, 2004). For instance, Haslem *et al.* (1999) examined data envelopment analysis (DEA) efficiency of US banks operating internationally; Yudistira (2003) observed the efficiency of Islamic banks between 1997 and 2000 using DEA; Havrylchyk (2006) determined the efficiency of the Polish banking sector; and Staub *et al.* (2010) studied the cost efficiency and the allocative efficiency of banks in Brazil. In context, these studies were specific to each country and in developed countries, and did not focus on emerging markets (Aboagye *et al.*, 2012; Amidu and Wolfe, 2012). Studies on the determinants of technical efficiency were made during the unstable macroeconomic environment, using data from Malaysia (Sufian, 2010). A number of studies that have been done, particularly in Ghana, did not focus on DEA approach for measuring technical efficiency and how it is influenced by funding sources (Mahjabeen, 2010). This study examines, in general, technical efficiency for banks in emerging markets, using the DEA approach. It further investigates which of the funding structure variables, bank-specific variables and macroeconomic variable-influence the technical efficiency of banks in emerging economies, which previous studies fail to consider. Previous studies highlight a call for further studies on the relationship between the funding structure and technical efficiency in emerging economies (Amidu and Wolfe, 2012) and determinants of technical efficiency of banks. Thus, understanding the composition of bank funding structure, and its effect on technical efficiency, whose knowledge loses a lot in the literature, constitutes a knowledge gap in the context of emerging markets. This study aims to bridge the existing knowledge gap.

The paper is conducted in the context of an emerging economy where the capital market is relatively developing and the banks are the main financial providers of economic activities. The contribution of this paper is to find appropriate measures of both

funding structure and banking efficiency for Ghana, and examine how these are interrelated in macroeconomic and monetary environments. From the perspective of economic policy, it is important to identify the various sources of funding employed by banks so that effective actions can be taken to improve efficiency. This study appears to be the first to analyze how the funding structure of banks behaves in terms of producing maximum outputs (efficiency) in emerging market. The results reveal that technical efficiency is positively and significantly related to deposit funding and non-deposit funding. However, the findings reveal a negative relationship between internal funding and technical efficiency of banks. Thus, banks that rely on deposit funding and non-deposit funding to impact efficiency are safer than those that finance their assets with internally generated funds. This suggests that banks are directing their internally funds into other activities, which do not influence efficiency.

The rest of the paper is organized into: literature review of related studies (Section 2), data and methodology (Section 3), empirical results (Section 4) and conclusion and policy implications of the paper (Section 5).

2. Literature review

2.1 Theoretical review

Capital structure plays a vital role in corporate finance. The theory of capital structure was first developed by Modigliani and Miller (1958). The main obstacle that companies face is the plethora of options to choose from when it comes to alternative capital structures. Theoretical models of the Modigliani–Miller hypothesis indicate that companies choose a combination of debt and equity to minimize the cost of capital. The capital structure of a firm is a mixture of different securities (Abor, 2005). According to Abor (2005), the capital structure is defined as a specific mix of debt and equity that a company uses to finance its operations. Levels of financial leverage will decline as companies with growth opportunities tend to borrow less. Conversely, the signaling theory holds that the growth of a firm can lead to increased financial leverage of the company since companies with high growth prospects will be reflected in the capital markets. Therefore, increases in share price with the recognition by banks can reduce the cost of debt for the particular company or small business enterprise (Titman and Wessels, 1988).

In the trade-off model, the objectives of leverage and dividends are driven by different forces, namely; potential bankruptcy and agency costs. Potential bankruptcy costs push firms toward less leverage target, while agency costs push firms toward more leverage. The forces of the trade-off make predictions about how the indisputable objective of leverage and dividend payments vary from company to company with profitability and investment opportunities. According to Myers and Majluf (1984), "pecking order" refers to a theory of finance indicating that companies use internally generated funds in the form of retained earnings before resorting to external sources. They further argued that the theory of pecking order explains the financing decision of the company that is usually determined by the preference of the company's internal financing over external financing, due to the high costs involved in issuing funding external.

2.2 Funding structure of banks

Conceptually, commercial banks finance their balance sheets with a capital base including equity, subordinated debt and a combination of debt and equity, including debt medium and long term (IMF, 2013). According to the IMF (2013), as banks are more familiar with domestic markets, renewed funding structures seem to be pointing toward building a strong domestic investor base. Therefore, banks are trying to strengthen their deposit base by investing more. In addition, key components of funding for banks and those popularly discussed by the public include retail deposits of households and enterprises

and wholesale funding or financing that do not accept deposits; and short-term and issuing long-term debt (both domestic and offshore) (Alu *et al.*, 2014). Banks are "all debt financing" and finance their assets with borrowed money. Therefore, the financing structure is "a tool that defines how banks make their optimal choice of financing sources of funding" (Amidu and Wolfe, 2012). The main cost for financial institutions is the cost of obtaining the funds used for lending to households and businesses to support a growing economy. The banks get their funds from deposits, wholesale debt markets or no deposit funds, securitization, internal funds and equity.

2.3 Technical efficiency

Efficiency in general is a technical term; thus, any producing unit or decision-making unit (DMU) is said to be technically efficient when it can produce the maximum amount of output using the given level of input, or it can produce the given level of output using minimum amount of input. The two broad approaches used to measure efficiency are the accounting approach and the econometric techniques. The accounting method uses financial ratios to evaluate the efficiency or corporate performance. The parametric approach commonly used is stochastic frontier approach (SFA) and the non-parametric method is the DEA (Berger and Humphrey, 1997). They claim that the whole idea of measuring the performance of the bank is to inform managers and government policy-making processes on the effects of deregulation, mergers and market structure efficiency.

The financial industry exhibits different operating processes when choosing inputs and outputs items while the manufacturing industry has explicit input and output items. Favero and Papi (1995) described five methods of determining input and output variables and stated them as the production approach, intermediation approach, asset approach, user cost approach and valued-added approach. In banking literature, there is on-going discussion regarding the appropriate definition of inputs and outputs. Till today, there is no agreement on the explicit definition and measurement of banks' inputs and outputs (Fethi and Pasiouras, 2010). Two popularly known approaches, (i.e., production approach and intermediation approach) appear in the literature regarding the measurement of inputs and outputs of a bank (Humphery, 1985).

The production approach considers banks as using purchased inputs to produce deposits and various categories of bank assets. Banking literature treats and measures both loans and deposits as outputs in terms of the number of accounts. The production approach considers only operating costs and excludes the interest expenses paid on deposits since deposits are viewed as outputs. On the other hand, the intermediation approach views banks as financial intermediaries and it uses the volume of deposits, loans and other variables as inputs and outputs of banks. In this case, the intermediation approach views banks as using deposits together with purchased inputs to produce various categories of bank assets. Outputs are measured in monetary values and total costs include all operating and interest expenses. Johnes *et al.* (2009) measured inputs of banks as the combination of deposits and short-term funding, fixed assets, general and administrative expenses and equity. The outputs of banks included the total credit facilities or total loans and other earning assets. Chang *et al.* (2011) also measured input variables for DEA model as personnel expenses, interest fees and incidental expenses. Moreover, the output variables used in their DEA model included net profit, operating profit, interest gain, total loans, total deposit and non-performing loans ratio. DEA for bank performance does not require any underlying assumption of a functional form relating to inputs and outputs of the banks. Given the set of inputs and outputs of different banks, it constructs its own functional form and avoids the danger of misspecification of the frontier. DEA does not make the assumption that all DMUs are using the same technology, but instead evaluates the efficiency of DMU of the banks

relative to its peer or combination of peers. Furthermore, DEA readily incorporates the existence of multiple outputs.

Although an analytical relationship exists among constant return to scale (CRS) and variable return to scale (VRS) models, input and output efficiency scores are different in VRS unlike in CRS models (Emrouznejad *et al.*, 2008). The assumption of CRS is applicable when all DMUs are operating at an optimal scale (Gordo, 2013). Imperfect competition, changes in regulations, improvement in banking technology, constraints on finance, mergers and acquisition and other external variables may cause firms not to be operating at the most productive and optimal scale. Thus, an assumption under VRS is appropriate for such situations (Gordo, 2013). However, the study employs both the CRS and VRS conditions to determine the banks that are more efficient.

2.4 Empirical review

The two broad approaches used to measure performance are the accounting approach and the econometric techniques. The accounting method uses the financial ratios to evaluate corporate performance. Samad (2004) used financial ratios to evaluate profitability, liquidity performance and credit quality of seven local commercial banks in Bahrain during the period 1994–2001. He compared his results with the banking industry in Bahrain and his results concluded that commercial banks in Bahrain are less profitable, less liquid and exposed to high credit risk than the banking industry. Tarawneh (2006) used financial ratios to rank the performance of Oman commercial bank. He also found out that management operational efficiency, asset management and bank size positively influenced performance. However, the method had limitations that led to the development of alternate methods such as the parametric and the non-parametric approach. The commonly used parametric approach is the SFA and the non-parametric is the DEA method (Berger and Humphrey, 1997). They assert that the whole idea of measuring bank performance is to inform managers and government policy-decision makers of the effects of deregulation, mergers and market structure on efficiency.

Previous empirical literature in developed countries and developing countries, like Ghana, shows that there is no consensus on the relationship between funding structure and corporate performance both in the financial firms and non-financial firms (Weill, 2004). Little or no work has been done on both the parametric and non-parametric approach of technical efficiency of firms in Ghana, particularly the DEA method. Hollis and Sweetman (2007) found a positive relationship between the deposit to asset ratio funding structure and profitability. Empirical evidence on the relationship between leverage and bank performance presents contradictory results. Most of the research used profitability to measure bank's performance and financial leverage ratios as a measure of debts financing option. The leverage ratios used include: total debt, long-term debt and short-term debt. Abor (2005) studied the relationship between capital structure and profitability of listed firms in Ghana Stock Exchange during a five-year period, and found that short-term and total debt are positively related to firm's ROE, whereas long-term debt is negatively related to firm's ROE. A research conducted by Hyun and Kang (2011) on impact of financial leverage on profitability in lodging companies showed that there was no significant relationship between debt ratio and growth opportunities in his study. According to the results of the study, long-term debt ratio was negatively related to profitability (ROA). Most lodging firms showed a decrease in total revenue during the period. The study found an inverted U-shaped relationship between debt ratio and profitability. The inverted U-shaped relationship between debt ratio and profitability indicated that there is an optimal debt ratio, and that firms which exceed the optimal level are not effective in increasing a firm's value or profitability. The results of the study indicated that when debt ratio exceeds the optimal ratio, it may have an effect on profitability of the lodging industry firms.

This paper attempts to use the DEA method to measure technical efficiency in Ghana. Compared to raw measures of performance, efficiency scores from technical efficiency approach allow the inclusion of several outputs and inputs and provide consequently synthetic measures of performance. Efficiency scores from the technical efficiency method have the advantage to offer relative scores that take directly into account the comparison with the best companies (Charnes *et al.*, 1978). Consequently, the paper measures technical efficiency using the efficiency scores from the DEA model and it examines the effect of funding structure on technical efficiency among banks in Ghana.

More recently, Tan (2016) used the two-step GMM estimator to analyze the relationship between capital structure and technical efficiency of banks in China and the results shows a weak positive association between capital and bank technical efficiency. Bitar *et al.* (2018) examined the effect of capital ratios on the risk, efficiency and profitability of banks from OECD countries. Their findings suggest that imposing higher capital ratios may have a negative effect on the efficiency and profitability of highly liquid banks. Furthermore, Ozili (2018) found that banking efficiency, foreign bank presence, banking concentration, size of banking sector, government effectiveness, political stability, regulatory quality, investor protection, corruption control and unemployment levels are significant determinants of bank stability in Africa. Musah (2017) examined the effect of capital structure on profitability of commercial banks in Ghana, by employing 23 banks over a six-year period from 2010 to 2015. He observed that short-term financing reduces bank profitability in Ghana. Our study differs from these studies in terms of appropriate measure of bank efficiency using the DEA and funding structure using the funding sources of banks, as well as the effect of funding structure on technical efficiency, considering macroeconomic factors in emerging economies. The results differ from other existing studies due to its significant contribution to future research, policy implications and applications to practice in a developing country like Ghana

3. Data and methodology

The study used a panel data that consist of 25 banks in Ghana over a six-year period. Data were sourced from Bank Scope. We retrieve annual data from 2011 to 2016.

3.1 Model specification

We regress efficiency scores as a function of funding structure, bank-specific variables and macroeconomic variables. The general panel data model to be estimated is adopted from Fernández *et al.* (2016), expressed as follows:

$$\begin{aligned}\text{Technical efficiency} = f(&\text{Funding structure variables, Bank} - \text{specific variables,}\\ &+\text{Macroeconomic factors}),\end{aligned}$$

$$\begin{aligned}\text{TE} = C_0 + C_1\,&\text{Funding structure variables}_{it} + C_2\,\text{Bank}\\ &-\text{specific variables}_{it} + C_3\,\text{Macroeconomic variables}_{t} + \varepsilon_{it}.\end{aligned} \tag{1}$$

Following the general panel regression model, the two models were specified as follows:

$$\begin{aligned}\text{TE}(\text{DEA}_{\text{CRS}})_{it} = {}&\alpha_0 + \alpha_1(\text{DpTA})_{it} + \alpha_2(\text{NDpTA})_{it} + \alpha_3(\text{IFTL})_{it} + \alpha_4(\text{CAR})_{it}\\ &+ \alpha_5(\text{Bank Risk})_{it} + \alpha_6(\text{SIZE})_{it} + \alpha_7(\text{TANG})_{it} + \alpha_8(\text{COMP})_{it}\\ &+ \alpha_9(\text{CONC.})_{it} + \alpha_{10}(\text{GDP growth})_{it} + \alpha_{11}(\text{lnInt.rate})_{it}\\ &+ \alpha_{12}(\text{lnINFrate})_{it} + \varepsilon_{it},\end{aligned} \tag{2}$$

$$\begin{aligned}\mathrm{TE}(\mathrm{DEA}_{\mathrm{VRS}})_{it} = {} & \beta_0 + \beta_1(\mathrm{DpTA})_{it} + \beta_2(\mathrm{NDpTA})_{it} + \beta_3(\mathrm{IFTL})_{it} + \beta_4(\mathrm{CAR})_{it} \\ & + \beta_5(\mathrm{Bank\ \ Risk})_{it} + \beta_6(\mathrm{SIZE})_{it} + \beta_7(\mathrm{TANG})_{it} \\ & + \beta_8(\mathrm{COMP})_{it} + \beta_9(\mathrm{CONC.})_{it} + \beta_{10}(\mathrm{GDP\ \ growth})_{it} \\ & + \beta_{11}(\mathrm{lnInt.rate})_{it} + \beta_{12}(\mathrm{lnINFrate})_{it} + \varepsilon_{it}, \end{aligned} \tag{3}$$

where TE ($\mathrm{DEA}_{\mathrm{CRS}}$) is the technical efficiency scores generated from DEA under the CRS; TE ($\mathrm{DEA}_{\mathrm{VRS}}$) the technical efficiency scores generated from DEA under the VRS; DpTA (deposit source of funding) the ratio of deposit to total asset; NDpTA the ratio of non-deposits to total asset (which is the non-deposit funding); IFTL the internal sum of net profits before extraordinary items and loan loss provisions relative to bank loans; CAR (capital ratio) the equity to debt ratio; Bank Risk the standard deviation of return on asset; Bank Size the log of total assets; TANG (tangibility) the ratio of fixed asset to total assets; COMP (Competition) = (Price−Marginal cost)/Price; CONC. (Concentration) measured as HHIA, which is the sum of the squared market shares of each bank assets; GDP growth the rate of change of GDP over time; lnInt.rate the natural logarithm of monetary policy rate; lnINF.rate the natural logarithm of inflation rate; $\varepsilon_{\mathrm{it}}$ is the error term for bank i at time t; and c, α and β are parameter estimates (coefficients) of the explanatory variables.

3.2 Dependent variables

The study analyzed the technical efficiency of the banks using DEA approach. The efficiency scores were generated under both methods (CRS and VRS) and they were proxies for technical efficiency of banks. A number of studies in developed economies, particularly China (Sufian, 2010), Europe (Chortareasa *et al.*, 2012) and other developing countries (Pasiouras, 2008; Barth *et al.*, 2013), have used DEA and the truncated or Tobit regression to estimate the relationship between capital ratio and bank efficiency. However, these studies were concentrated on developed countries and emerging economies neglecting the Ghanaian context, but yielding similar findings. Moreover, Bitar *et al.* (2018), Chortareasa *et al.* (2012) and Bitar *et al.* (2017) used the traditional approach, more precisely, the ratio of bank cost to income, as a proxy for cost efficiency, where higher values denote managerial inefficiency. They found an inverse relationship between bank efficiency and capital structure. For robustness, we employ the technical efficiency, precisely the DEA technique, where scores of 1 indicate efficient banks.

DEA (basic CCR model) technique was used to measure the technical efficiency based on two assumptions. These include the CRS and VRS. The model for the technical efficiency scores is expressed as follows:

$$\text{Maximize}\ \ h_0 = \frac{\sum_i^s U_i y_{iq}}{\sum_j^m V_j x_{jq}}. \tag{4}$$

Subject to:

$$\frac{\sum_i^s U_i y_{ik}}{\sum_j^m V_j x_{jk}} \leqslant 1, \tag{5}$$

$$k = 1, 2, \ldots, n,$$

where U_i, $i = 1, 2, \ldots, s$, are weights assigned to ith output; V_j, $j = 1, 2, \ldots, m$, are weights assigned to jth input; x_j the inputs of the jth bank; y_i the output produced by the ith bank; k the observed bank (inefficient bank) and q is the best practice bank (efficient bank).

The choice of the inputs and outputs is guided by the choices made in previous studies and also on the data availability (Casu and Molyneux, 2003; Kao and Liu, 2004; Zhao *et al.*, 2008). This study uses intermediation approach with restricted choice of variables. We assumed an input-oriented approach of both CRS and VRS. This preference measurement for CRS is due to the fact that banks operate at an optimal scale or with the same size while the preference measurement for VRS is due to its reliability and a better fit to banks operating under imperfect competitive environment in Ghana. The banks strive to offer the best possible products and financial intermediation services for their clients. Therefore, they are more likely to strengthen their competitive advantage by making the same output with less input. The study adopted an intermediation approach which assumes that the banks' main aim is to transform deposits (liabilities) and cost (interest expense) into loans (assets) and other earning assets. Following Zhao *et al.* (2008), the study used two input variables (total cost and total deposits) and two output (total loans and other earnings). Studies that used the DEA did not capture the assumptions (CRS and VRS) under which banks operate in emerging economy (Chortareasa *et al.*, 2012; Barth *et al.*, 2013).

3.3 Explanatory variables

The measure of capital structure in literature has been inconsistent due to the different financing choices made by various DMUs (Abor, 2005, 2007, 2008; Bitar *et al.*, 2018). In theory, employing capital structure (defined as a specific mix of debt and equity) to the banking industry provides a misleading interpretation since banks are homogenous firms considered as financially leveraged that finance their operations mainly by debt. We measure the funding structure of banks in Ghana, using the three funding modes (Amidu, 2013), indicated as follows:

(1) Deposit funding = ratio of deposit to total asset.

(2) Non-deposit funding = ratio of non-deposit to total asset.

(3) Internal funding = sum of net profit before extraordinary items and loan loss provisions relative to total loans.

In Ghana, commercial banks' reliance on deposit funding reduces bank profitability (Musah, 2017) which contradicts similar work by Amidu (2013) due to the different measures of bank profitability. In theory, higher funding sources ensure that banks have sufficient funds to absorb unexpected risk or losses (Demirgüç-Kunt *et al.*, 2013), which subsequently improves bank efficiency. Thus, banks that rely on deposit funding and internal sources of funding are safer than wholesale funds (Amidu, 2013). We investigate if the three modes of funding used by banks translate into bank efficiency in emerging economy.

The paper also employs a number of control variables that affect efficiency scores. The controls are categorized into bank-specific characteristics and the characteristics of macroeconomic and monetary environment. Bank-level controls include: bank risk and ratio of debt to equity (CAR) to indicate that bank exposure to higher risk and use of debt respectively can decrease bank efficiency while bank size and tangibility measures log of total asset and ratio of fixed asset to total asset respectively and we expect a positive relationships with bank efficiency (Tarawneh, 2006).

Furthermore, we control for macroeconomic factors affecting technical efficiency of banks. Inflation (consumer price index) and GDP growth are included in the regression to account for differences in macroeconomic environments. The monetary policy rate, proxy for short-term interest rate, also accounts for differences in monetary environment. During periods of inflationary movements, banks are able to charge higher price margins to increase efficiency (Jokipii and Monnin, 2013) and more so, bank efficiency tends to be

higher during periods of economic growth since loan defaults are lower during such periods (Bikker and Metzemakers, 2005). Increasing monetary policy rates tends to increase bank efficiency because banks transfer higher rates to customers to improve efficiency; therefore, we expect positive relationship between interest rate, GDP growth and bank efficiency.

We finally examined the relationship between funding structure and technical efficiency using the random-effect model and truncated regression model, taking into account the macroeconomic and monetary environment of emerging economy. The regression models were specified into the random-effect model and the truncated regression model, which is relevant to the current study since empirical evidence in this model remains scarce from the Ghanaian context. Due to substantial missing observations, and omitted variables, we were unable to run system GMM. The random-effect model was used to capture the multiple characteristics for arbitrary patterns of observed data. In the second model, the truncated model was used to capture a situation where some observations on both the dependent variable and regressors are lost and dependent variables have values of 0, 1 and discrete values (Luhnen, 2009). Robust standard errors for the random-effect and truncated model were employed to control for autocorrelation, heteroskedascity and endogeneity problems. This allows us to cluster the standard errors by country and year. Before comparing the random-effect model to the truncated regression, the study used the Hausman test to confirm whether the random-effect model was appropriate over the fixed effect model. The results would be relevant to policy makers in Ghana and provide fruitful direction for future research to investigate the effect of funding structure in emerging economies at large.

4. Empirical results and discussion

This section presents the results and discussions on the effect of funding structure on technical efficiency by first showing the average efficiency scores of the banks from 2011 to 2016, and then presenting the nature of the data set in order to ensure the robustness of the findings.

4.1 Technical efficiency

Table I shows the cross-sectional DEA_{CRS} and DEA_{VRS} efficiency scores. From the table, the lower efficiency scores (less than 1) were classified as inefficient banks, because the input units were under-utilized to produce a given level of output.

From the results in Table I, we observe that technical efficiencies for CRS and VRS do not reveal similar rankings among the banks in Ghana. From Table I, four banks were technically efficient under CRS assumption while ten banks were considered to be efficient under the VRS assumption. Majority of the banks were efficient under VRS because banks are considered to have greater scale advantage. However, banks that were inefficient (scores less than 1) suggest some marginal fluctuations in their respective scores, implying that their respective costs and deposits were not fully utilized. From Table I, the overall average technical efficiency scores are 0.8347 and 0.9069 under CRS and VRS, respectively. The average efficiency scores under the VRS (DEA_{VRS}) are greater than average efficiency scores under the CRS (DEA_{CRS}). This is due to the fact that the DEA_{VRS} is more flexible and envelops the data in a tighter way than the DEA_{CRS}. It can be concluded from the overall average efficiency score (given, $DEA_{CRS} = 0.8347$; and $DEA_{VRS} = 0.9069$) that banks in Ghana are said to be technically inefficient. The high level of inefficiency for the financial system in Ghana implies a managerial failure to fully exploit potential technology available to them. The implication is that managers of the banks must ensure that they fully utilize their inputs to generate a maximum level of output to be efficient.

Name of bank	DEA_{CRS}	Rank	DEA_{VRS}	Rank
Access Bank	1	1	1	1
ADB	0.83431	14	1	2
Bank of Africa	0.80391	16	0.82795	19
Bank of Baroda	0.74623	20	1	3
Barclays Bank	0.83639	12	0.9943	11
BSIC-Bank	0.92766	6	1	4
CAL Bank	0.60249	25	0.60855	25
ECOBANK	0.7745	17	1	5
Energy Bank	0.7026	23	0.79359	20
Fidelity Bank	0.83625	13	0.87267	18
First Atl. Bank	0.72823	22	0.78783	21
GCB	0.81877	15	1	6
GT Bank	0.72875	21	0.75452	23
HFC	0.62901	24	0.63884	24
Int. Com. Bnk	0.87334	9	1	7
Merchant Bank	1	2	1	8
NIB	0.76163	19	0.76598	22
Prudential Bank	0.89221	8	0.89995	16
SG SSB	0.85827	11	0.895	17
Stanbic Bank	0.86268	10	0.9842	12
Standard Chartered Bank	0.77138	18	0.95235	14
UBA	0.91002	7	0.92483	15
UNIBANK	0.96829	5	0.97256	13
UT Bank	1	3	1	8
Zenith Bank	1	4	1	10
Average	0.834677		0.906925	

Table I. Average efficiency scores for Ghanaian banks (2010–2016)

4.2 Descriptive statistics

In examining the relationship between funding structure and technical efficiency, the study presents the summary statistics of the explanatory variables, Pearson's correlation in order to screen and test the reliability of the data set. The number of observations varies between funding structure variables and macroeconomic indicators. The missing observations can be explained by the fact that certain information was not available in a particular year. The variable inflation factor (VIF) shows the acceptability of the variables in the data set, following a rule of thumb threshold of 10. The Shapiro Wilk normality test (SWilk) is used to test for the null hypothesis of no normal distribution. The descriptive statistics confirm no existence of an outlier, variables are all acceptable in the model (mean VIF of 3.23), and conclude that the variables are normally distributed around the mean (p value $> z$ for the SWilk test).

Deposits are portions of the banks' total debt payable within a year. From Table II, with a minimum of 0.2189 and a maximum of 0.89, deposit funding records a mean (median) value and standard deviation of 0.6347 (0.6933) and 0.2004, respectively. The standard deviation of deposit funding gives an indication that the overall deposit source of funding among the banks has a low variability across the sample. This implies that banks in Ghana finance their assets more with deposits (i.e. 63 percent deposits) with less risk associated with deposit funding. Non-deposit funding recorded a mean (median) value of 0.1595 (0.13), standard deviation of 0.1807 with a minimum and maximum value of −0.74 and 0.9, respectively. This suggests that banks in Ghana use an average of 15.95 percent of non-deposits to finance their total assets. The standard deviation associated with non-deposit funding shows that the non-deposit funding of the banks has a high variability across the sample. The higher standard deviation of non-deposits accounts for the reason

Variable	Obs.	Mean	Median	sd	Min.	Max.	VIF	SWilk
Deposit funding (DpTA)	148	0.6347	0.6933	0.2004	0.2189	0.8942	3.19	6.780***
Non-deposit funding (NDpTA)	148	0.1595	0.13	0.1807	−0.74	0.9	2.03	7.610***
Internal funding (IFTL)	148	0.0623	0.065	0.0816	−0.1625	0.6686	1.19	8.177***
Capital ratio (ETA)	150	0.1114	0.1470	0.1203	0.0089	0.7089	2.51	5.890***
Bank risk	149	0.0097	0.0055	0.0126	0.000014	0.0708	1.19	7.987***
Competition (COMP)	150	0.4581	0.7106	0.3668	0.1941	1.3854	3.52	5.756***
Concentration (HHIA)	150	0.0416	0.0644	0.0309	0.0607	0.0644	1.36	1.015***
Tangibility	146	0.0301	0.0247	0.0264	0.000033	0.2151	1.11	7.592***
Bank size	146	8.6295	8.8074	1.1129	7.1452	9.6651	1.61	9.480***
GDP growth	150	0.0633	0.0879	0.0533	0.0713	0.1501	9.16	3.730***
Interest rate (lnInt.rate)	150	2.7877	2.7213	0.1899	2.5588	3.1355	5.84	4.981***
Inflation rate (lnINF.rate)	150	1.7633	1.85	0.2385	1.38	2.01	6.09	5.707***
Mean VIF							3.23	

Notes: DpTA is the ratio of deposit to total asset; DpTA is ratio of non-deposits to total asset; IFTL is the sum of net profits before extraordinary items and loan loss provisions relative to bank loans; CAR is the ratio of equity to debt; Bank risk is the standard deviation of return on asset; Bank size is log of total asset; TANG is the ratio of fixed asset to total assets; COMP is the ratio of the difference between interest income and marginal cost to income interest; CONC is the sum of the squared market shares of each bank; GDP growth is the rate of change of GDP over time, lnINF.rate is the natural logarithm of inflation rate; and lnInt.rate is the natural logarithm of monetary policy rate. ***Denotes significance level at < 0.01

Table II.
Summary statistics

why banks use deposit funding over the non-deposit funding. Moreover, the average non-deposit funding of the banks in Ghana is lower than deposit funding. Internal capital source of funding of the banks in Ghana is also low and it accounts for a mean (median) value of 0.0623 (0.065), standard deviation of 0.0816 and a minimum and maximum values, of −0.1625 and 0.6686 respectively, as shown in Table II. This implies that banks fund their loan portfolio (asset) with less net profit before extraordinary items and loan loss provisions, than with other sources of funds. In this case, banks' reliance on internal sources of funds is low and it violates the perking order theory, which states that firms prefer internal funding (e.g. retained earnings) to external financing. The statistics show the importance of using deposit source of funds over the other sources of funding.

From Table II, the average (median) of equity to debt is 0.1114 (0.1470), standard deviation of 0.1203. This means that for every 1 unit of financing, banks employ 0.11 units of equity of their assets, as against debt financing. Since banks are financially leveraged, the results attest to the fact that banks in Ghana rely more on debt to finance their operations, as compared to equity and other internal sources. This contradicts the perking order theory and it explains why there is always pressure on banks to pay off debts at shorter periods. Bank competition recorded a mean (median) of 0.4581 (0.7106), standard deviation of 0.3668 with minimum and maximum of 0.1941 and 1.3854, respectively. This implies that completion among banks in Ghana is high. In terms of concentration, the banks recorded an average (median) of 0.0416 (0.0644), standard deviation of 0.0309 with a minimum and maximum values of 0.0607 and 0.0644, respectively. Exposure to risk by the banks recorded a mean (standard deviation) of 0.0097 (0.0126); bank size recorded a mean (median) and standard deviation value of 8.75 (8.765) and 0.447, respectively. Tangibility had a mean (median) and standard deviation of 0.0308 (0.0241) and 0.0263, respectively. On average, the bank size in Ghana can be said to be large while the tangibility of the banks is low on average. The mean (standard deviation) of GDP growth is 0.0633 (0.0533), which indicates that GDP growth is relatively low, comparing the average with a minimum value of 0.0713 and maximum value of 0.1501. Inflation and interest rate recorded mean (standard deviation) of 2.78 (2.72) and 1.76 (1.85), respectively.

Therefore, the macroeconomic variables exhibit a high coefficient of variation across the sample, which indicates a high variability of GDP growth, interest rate and inflation rate across the sample.

4.3 Correlation matrix

The study estimates the correlation coefficient among the variables, in order to determine the strength of a linear association between the dependent and independent variables. For multicollinearity to occur, the correlation coefficient between two variables should be 0.7 or more. As shown in Table III, we observe potential multicollinearity caused by competition, GDP growth and inflation, which is confirmed by a relatively high VIF recorded for GDP growth (9.16) and inflation (6.09). The overall mean VIF is 3.23 and also shows that each of the variables has a VIF below 10 (see Table II). However, the regression results omitted variables that are highly correlated to handle the problem of multicollinearity.

4.4 Regression results

The regression analysis depicts the relationship between funding structure and technical efficiency for CRS and VRS. Regression results for random-effect model and truncated regression model are presented in Table IV and all assumptions in relation to the distribution of data variables in the model were tested for normality. The study employed the Hausman test to ascertain whether the fixed effect or the random effect is more appropriate. From Table IV, a χ^2-statistic from the Hausman test (under the random-effect model) is not significant, indicating that the random-effect estimation is preferred to the fixed effect. The dependent variable (efficiency score for CRS and VRS) was regressed on the explanatory variables (funding structure variables, firm-specific variables and macroeconomic variables), and the results are presented in Table IV.

	DpTA	NDpTA	IFTL	CONC.	TANG	SIZE	Bank risk	GDP growth	CAR	COMP	lnInt. rate	lnINF. rate
DpTA	1.0000											
NDpTA	−0.4118	1.0000										
IFTL	−0.0326	−0.0228	1.0000									
CONC.	0.2664	−0.0513	0.0369	1.0000								
TANG	0.1740	−0.0680	−0.1384	−0.1236	1.0000							
SIZE	0.4808	0.1170	0.0566	0.3042	−0.0009	1.0000						
Bank risk	−0.2030	0.0171	−0.0816	−0.1508	0.0802	−0.1287	1.0000					
GDP growth	0.2673	−0.1017	0.0833	0.8813	−0.1123	0.2419	−0.1907	1.0000				
CAR	−0.0691	−0.1049	0.2241	0.6849	−0.0965	0.0825	0.0882	0.6378	1.0000			
COMP	0.2964	−0.0489	−0.0546	0.9267	−0.0146	0.2452	−0.1138	0.8217	0.5538	1.0000		
lnInt. rate	0.0976	−0.0004	−0.1561	0.6014	−0.1483	0.2165	0.0400	0.3652	0.4042	0.4782	1.0000	
lnINF. rate	0.1113	−0.0510	−0.0946	0.5250	−0.1549	0.0998	0.0163	0.5641	0.3959	0.4136	0.7790	1

Notes: DpTA is the ratio of deposit to total asset; DpTA is ratio of non-deposits to total asset; IFTL is the sum of net profits before extraordinary items and loan loss provisions relative to bank loans; CAR is the ratio of equity to debt; Bank risk is the standard deviation of return on asset; Bank size is log of total asset; TANG is the ratio of fixed asset to total assets; COMP is the ratio of the difference between interest income and marginal cost to income interest; CONC is the sum of the squared market shares of each bank; GDP growth is the rate of change of GDP over time; lnINF.rate is the natural logarithm of inflation rate; and lnInt.rate is the natural logarithm of monetary policy rate

Table III.
Correlation matrix for explanatory variables

Table IV. Truncated regression results

	Random-effect model				Truncated model			
	CRS		VRS		CRS		VRS (4)	
	1	2	3	4	5	6	7	8
DpTA	0.5258*** (0.0989)	0.5199*** (0.0371)	0.5879*** (0.0744)	0.5541*** (0.0608)	0.4625*** (0.0994)	0.4434*** (0.0971)	0.5276*** (0.0988)	0.5379*** (0.0961)
NDpTA	0.2493*** (0.0846)	0.2561*** (0.061)	0.1915*** (0.0303)	0.1858*** (0.0523)	0.2133** (0.0841)	0.212*** (0.0804)	0.1716*** (0.0532)	0.1904*** (0.0527)
IFTL	−0.3723** (0.1448)	−0.3716** (0.1590)	−0.3861*** (0.1230)	−0.2866** (0.1433)	−0.3538** (0.1409)	−0.3669*** (0.1268)	−0.3119** (0.1592)	−0.2653* (0.1415)
CAR	0.2945* (0.1528)	0.3855** (.1516)	0.1198 (0.1147)	0.2043* (0.1149)	0.2640 (0.2144)	0.3257 (0.2063)	0.4694* (0.2402)	0.5272** (0.2415)
Bank risk	−0.0439 (0.1044)	−1.5736 (1.3099)	−0.0684 (0.0746)	−2.1286 (1.583636)	0.0045 (0.1236)	−1.8095* (1.0191)	−0.0286 (0.1702)	−1.5168 (1.3295)
Bank size	0.0187* (0.0108)	0.0219*** (0.006)	0.0323*** (0.0045)	0.0549** (0.0214019)	0.0339 (0.0297)	0.0249 (0.0295)	0.2181*** (0.0383)	0.2075*** (0.0408)
TANG.	0.0916 (0.4440)	0.1224 (0.2566)	−0.6889* (0.4086)	−0.4586 (0.3743)	0.2225 (0.4350)	0.2109 (0.3931)	0.2073 (0.5808)	0.1849 (0.5747)
COMP.	0.2704*** (0.0876)	0.3136** (0.1262)	0.2095** (0.0943)		0.2954** (0.1172)	0.3198*** (0.1161)	0.3997*** (0.1300)	0.4420*** (0.1233)
CONC.	−3.7387** (1.4968)		−0.8049 (1.4692)		−4.6666** (2.3624)		−5.5240** (2.7576)	
GDP growth				−0.5444*** (0.1446)				
Int.Rate		0.1094*** (0.0396)		0.261*** (0.0452)		0.1067 (0.0781)		0.2124** (0.1034)
INF.rate		−2.7373*** (0.9216)		−2.2839*** (0.7122)		−2.7131*** (0.9998)		−3.7266*** (1.0437)
_cons	−0.0023 (0.0533)	−0.2976 (0.1058)	−0.0633 (0.0359)	−0.9110 (0.2282)	−0.0889 (0.2597)	−0.2572 (0.2810)	−1.6477 (0.3245)	−2.1117 (0.4027)
observation	150	145	150	145	143	143	143	143
R^2	0.5433	0.4028	0.5071	0.4097				
LP test	–	–			89.83	91.70	58.27	59.92
Wald χ^2 (6)					68.91***	73.62***	135.32***	163.17***
Hausman test								
χ^2 (6)	7.68	6.32	8.41	5.99				
Prob > $\overline{\chi}^2$	0.6604	0.7074	0.5887	0.7411				
Heteroskedasticity test								
χ^2 (74)	1.60	0.01	0.03	0.30				
Prob > χ^2	0.2064	0.9349	0.8718	0.5819				
Serial correlation test								
F(1, 5)	1.083	2.096	0.476	1.241				
	0.3457	0.2074	0.5210	0.3159				

Notes: Dependent robust standard error. The dependent variables are TE-DEA$_{CRS}$ (technical efficiency under constant return to scale) and TE-DEA$_{VRS}$ (technical efficiency under variable return to scale); robust standard errors of regression coefficient is presented in parenthesis (standard error are white robust to serial correlation and heteroskedasticity). *,**,***Denote significance level at < 0.1, < 0.05 and < 0.01, respectively

Funding structure and technical efficiency of banks. The results presented in Table IV compare the random-effect model and truncated regression model. In this model, macroeconomic and monetary variables were not included in the regression. The signs associated with the coefficient estimates for the two models were consistent and we observe that more of the explanatory variables (under CRS) used in the random-effect model are significantly associated with technical efficiency rather than the truncated regression model. From the results, we observe that capital ratio and bank size were positively and significantly linked to technical efficiency under CRS when the random effect was used. Tangibility was negatively and significantly (10 percent) linked to technical efficiency under VRS, when the random effect was employed. However, under the VRS, we observe that more of the explanatory variables were good determinants of technical efficiency. There is little or no efficiency loss when the truncated regression model was employed. Following the work by Vock *et al.* (2012), a complication occurs when the response is censored for some observations, which often arises when sample measures are collected over time and for that matter maximum likelihood estimators will not be consistent when the random-effect density is misspecified. In our case, although the samples are randomly selected and normally distributed, the dependent variables, which comprise a mixture of continuous and discrete distribution of efficiency scores, allow us to truncated regression model and compare results with the random-effect model. Since the response variables take both count values and non-negative values, we report on the truncated regression model since it provides a better fit to clustered count data.

From the truncated model, the results indicate a significantly positive relationship (coefficient = 0.4625) between deposit funding and technical efficiency (under CRS), and statistically significant at 1 percent. This suggests that banks that specialize in financing their operations with deposits tend to have higher technical efficiency, when operating in an optimal scale. Similarly, under CRS, the coefficient of non-deposit was estimated to be positive (0.1215) and statistically significant at the 5 percent level. The degree of relationship between non-deposit funding and technical efficiency is lower than the degree of relationship between deposit funding and technical efficiency. This is captured by a higher coefficient estimate of 0.4625 for deposit funding compared to a coefficient funding of 0.2133 for non-deposit funding. The findings show a significantly negative (−0.3538) relationship between internal funds and technical efficiency (CRS) and it is statistically significant at 5 percent. This is unexpected and it contradicts the capital structure theory, showing that financing operations with internal funds (IFTL) reduces banks' technical efficiency under CRS. This implies that banks are not using internal funds to finance activities or operations that would enhance efficiency or productivity of the banks.

From the regression result, equity to debt funding (CAR) has no significant relationship with technical efficiency (CRS) but we find an evidence to support a positive and statistically significant (10 percent) relationship between equity to debt ratio and technical efficiency for VRS. This implies that funding banks' debt with equity increases banks technical efficiency under the VRS. There is a positive and insignificant relationship between bank size and technical efficiency under CRS assumption but was statistically significant under VRS assumption. This means that under the assumption that banks operate at an optimal scale (similar size), bank size would not have any significant effect on efficiency but would have a positive significant relationship under situations of competition, technology and limitations. Moreover, previous studies provide an ambiguity between bank size and efficiency. This study agrees with study by Havrylchyk (2006), who reported no significant relationship between bank size and efficiency. Competition has a positive and significant relationship with technical efficiency for CRS and VRS and reveals that competition among the banks increases technical efficiency. Banks concentration decreases technical efficiency among

banks, as supported by a negative relationship between bank concentration and technical efficiency under both CRS and VRS conditions.

Funding structure and bank efficiency: macroeconomic and monetary environments. We provide accurate inference on the relationship between funding structure and bank efficiency in emerging economy (Ghana) by considering the macroeconomic and monetary environments in which the banking industry in Ghana operates. This is because banks operating in developing economies could derive some benefits resulting from competition, GDP growth, changes in monetary policy rate and inflation. From Table IV, dropping concentration and GDP growth in Column 2 shows a positive and significant relationship between interest rate and bank efficiency under the CRS. This result was not expected because increasing interest rate will increase loan default rate, which will in turn decrease efficiency. However, the positive relationship suggests that in monetary periods, banks in emerging economies heavily rely on deposit funding to attract growth opportunities that yield higher returns (interest) in order to increase efficiency. Inflation rate was negatively linked to technical efficiency of banks under the CRS, which is also not expected because banks attempt to increase their interest margins when inflation goes up – thereby increasing efficiency. On the contrary, during inflationary periods, banks increase their lending rates to attract more loan default exposures, which eventually decreases bank efficiency (under CRS) as a result of the minimal use of deposit funding sources. Similar result is presented in Columns 6 and 8, under the truncated regression model, except that interest rate was not statistically significant with bank efficiency under the CRS.

In Column 4, after dropping competition and bank concentration, GDP growth was negatively and significantly associated with bank efficiency. This suggests that banks do not benefit from periods of economic growth because loan defaults tend to be higher during such periods, and consequently decreasing banking efficiency under the VRS. Our results remain unchanged when we use additional macroeconomic control variables. However, our results hold for a robustness check when the variables were added. Moreover, the introduction of the macroeconomic variables in the model does not support earlier findings by Amidu (2013) who found a relationship between funding strategies and bank returns but macroeconomic indicators were not statistically significant. In the recent work done in Ghana by Musah (2017), he failed to consider macroeconomic factors.

5. Summary and conclusion

The main purpose of the study is to examine the effect of funding structure on technical efficiency of the banks in Ghana. The findings show that banks in Ghana employ deposit funding more to finance their assets or operations. This confirms the work of Amidu and Wolfe (2012), who used evaluated funding strategies by employing 985 banks sampled from 55 emerging and developing countries. This study has shown how banks' relative efficiencies could be determined using DEA. Banks with DEA score of 1 can be said to be technically efficient. From the findings, the overall mean technical efficiency scores for the banks in Ghana were 74.56 and 82.27 percent under CRS and VRS, respectively. Thus, banks in Ghana can be said to be technically inefficient. The study used both the random-effect model and truncated regression model. Comparisons with the truncated regression and random-effect models are presented and it can be concluded that with random-effect model, the truncated regression provides a better fit to data whose response variable (dependent variable) consists of a mix of continuous and discrete distribution. Moreover, we observed that the random-effect model is biased to DEA technical efficiency scores that range between 0 and 1 and the distribution of efficiency is truncated above from unity. Thus, the study considers the truncated model appropriate and reports on the relationships that exist between funding structure and technical efficiency.

The results reveal that technical efficiency is positively and significantly related to deposit funding and non-deposit funding. However, the findings reveal a negative relationship between internal funding and technical efficiency of banks. Thus, banks that rely on deposit funding and non-deposit funding to impact efficiency are safer than those that finance their assets with internal generated funds. This suggests that banks are directing their internal funds into other activities, which does not influence efficiency. The implication is that an increase in policy rate (as found by Alu *et al.*, 2014) may cause banks to make use of deposit sources of funding except for internal funds. It can also be explained that banks finance their operations with less internal funding, but rather lend out more internal funds to economic sectors or they pay out dividends to shareholders and investors with internal funds. This supports the results by Alu *et al.* (2014), who found that banks finance loans to the primary and secondary sectors using internal funds. Internal funding is again negatively related to technical efficiency. The implication to investors is that investors or shareholders should put pressure on managers to plough back earnings in order to increase the use of internally generated funds; thus, increasing technical efficiency.

A reasonable interpretation of the results is that banks using a proportionally larger deposit base funding would typically lead to an overall increase in technical efficiency under both the assumptions of CRS and VRS. This is consistent with Cull and Peria (2013). Thus, all banks in Ghana should therefore broaden their services toward financing their operations or assets with other sources of funding since the study found deposit funding to have a significant effect on banks' technical efficiency and generating profits.

Therefore, inefficient banks in Ghana can improve their efficiency by making some adjustments to their weights of inputs (total cost and deposits) and/or output combinations by following target banks or benchmark (efficient) banks. Banks should focus on increasing the use of other sources of funds (internal sources and non-deposit funding) to finance their operations in order to improve their efficiency. Managers of inefficient banks in Ghana should make some adjustments to its inputs and/or output combinations by following the target or benchmark banks to improve their efficiency.

Our results have important implications for regulators, investors and policy makers, particularly an emerging economy. The implication of the study to investors is that investors should be able to identify appropriate sources of funds that can be used efficiently to maximize their wealth in emerging markets. It is important for regulators and managers of banks to improve technical efficiency by considering the role that macroeconomic and monetary environment play when identifying and using various sources of funds as a strategy to improve bank efficiency. Moreover, our results provide evidence of the significant impact of funding sources of banks for improving banking efficiency as shown extensively in other regions, even when different proxies were used for emerging economy. Banks in Ghana are still less capable of using the DEA approach; rather, they use the traditional ratios as measures of efficiency. We provide evidence that an appropriate measure of capital structure for banks (i.e. the funding structure) and the DEA approach for technical efficiency of banks are more effective to examine their relationship. Consequently, future research should investigate the impact of funding structure on technical efficiency for other regions and considering their interactions with institutional quality, macroeconomic factors and financial stability.

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