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Determinants of efficiency in the Ghanaian banking industry

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The twin forces of technological advancement and deregulation have led to financial integration and increased competition in the Ghanaian banking industry. This situation requires an extensive study into efficiency and its determinants in the Ghanaian banking sector, if Ghanaian banks are to survive and compete effectively in the global financial system. This study tries to determine the main determinants of efficiency in the Ghanaian banking industry, using bank specific balanced panel data for 22 banks in Ghana from 2010 to 2016. The study employed Arellano and Bover system generalized method of moment (GMM) estimator to evaluate the determinants of efficiency by regressing micro and macroeconomic variables on two dimensions of bank efficiency: cost and profit efficiency. The results gave an indication that operational cost, credit risk and bank size are the main determinant of cost efficiency in the Ghanaian banking industry; whereas profit efficiency is significantly influenced by only operational cost and credit risk. However, there is weaker evidence on the impact of capital structure, concentration inflation and real gross domestic product (GDP) growth on both cost and profit efficiencies.

Key words: Efficiency, credit risk, bank size, generalized method of moment (GMM).

JEL classification: G21, G28, C30.

INTRODUCTION

The evaluation of efficiency in the banking sector is essential in the assessment of financial soundness and resilience, and provides useful information which can be used in stimulating economic growth since banking institutions are the main financial intermediaries which mobilize financial resources from diverse sources and allocate them to more productive activities.

A key prerequisite for economic recovery and prosperity is sound and well-functioning financial system where banks play a leading role (Gulde et al., 2006). Efficiency estimates provide an accurate measurement of the individual banks' performance as well as the whole industry, and also contains information regarding the stability of the entire financial system.

The importance of efficiency estimates as a measure for the assessment of bank performance is unequivocal, as acknowledged in literature (Berger and Humphrey, 1997), and has attracted the attention of policy makers

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and researchers. The information obtained from the measurement bank's efficiency can be utilized to enhance its overall performance and in turn contribute towards enhancing its competitive edge. The efficiency measure is an instrument for policy decisions on how to enhance bank performance, which also provides information on bank specific and country specific factors related to efficiency gains. The efficiency measure evaluates the capability and performance of banks in converting inputs into financial products and services, in relation to costs incurred and profits generated.

Efficiency is the ability to minimize cost associated with a given output or produce maximum output from a given quantum of inputs or generate maximum profit for a given output. For banks, efficiency refers to cost minimization, improved profitability, channeling greater amount of liquidity through the financial system, service quality and better prices for clients, and greater security in terms of improved liquidity position and capital buffers for absorbing risk (Berger et al., 1993).

Many developing countries have made major reforms in their banking systems in order to establish and promote efficient and sound banking institutions with a high degree of soundness and capable of facilitating a stable financial sector and economic growth (Thagunna and Poudel, 2013).

The establishment of an efficient and solid financial structure was the main rationale for restructuring and transformation of the Ghanaian banking system. The financial sector of Ghana has gone through several restructuring and transformations to enable it provide services efficiently in the globalized financial system (BOG, 2014).

These reforms have brought price liberalization, improvements in the circulation of capital and financial services, deregulation and globalization. In Ghana, banks are the main financial intermediaries. This necessitated restructuring policies in order to improve banking sector efficiency. The twin forces of technological advancement and deregulation have led to financial integration and increased competition in the Ghanaian banking industry. This situation requires an extensive study into efficiency and its determinants in the Ghanaian banking sector, if Ghanaian banks are to survive and compete effectively in the global financial system.

The measurement of efficiency and evaluation of its determinants are of extreme importance due to the accelerated growth of the financial environment experienced in recent economic structure. Globalization has put banks in the Ghanaian industry in strong competition with those in other markets. The evaluation of the determinants of bank efficiency is of extreme importance since it plays a crucial role in the accurate measurement of the performance of the entire banking industry and the overall soundness and stability of the whole financial structure.

Inefficiencies in the banking system can impede economic growth and cause financial crisis since the banks serve as the main financial intermediation channels. This fact has motivated empirical work over the last decade to evaluate efficiency and its determinants in the banking industry. The identification of the determinants influencing efficiency in the banking industry has gained the attention of scholars and regulators of the financial services industry in recent times as it has a direct link to the soundness and stability of the entire financial system and the economy as a whole.

There is therefore the need to assess and determine which among the many potential determinants of bank efficiency emerge as crucial and exerting significant influence. As a result of advances in technology and rapid transformations in the operations and structure of the financial services industry, a proliferation of studies on efficiency of the banking industry has emerged, focusing mainly on the determinants of bank efficiency (Berger et al., 2008; Rozanni and Rahman, 2013).

Indeed, a banking system which efficiently channels financial resources to productive utilization is a powerful mechanism for financial stability and economic growth (Levine et al, 2000). Efficiency is a key factor in making economic changes unavoidable (Mat-Nor et al., 2006). It is therefore imperative for banks to remain efficient and competitive in order to ensure long run survival. As such, there is the need to evaluate, identify and investigate the factors that influence the level of efficiency in banking institutions. Even though efficiency and its determinants have a direct link to the stability of the financial system and economic growth, very little literature of determinants of bank efficiency exist for the Ghanaian banking industry.

This study examines efficiency by identifying and investigating the determinants that influence the level of efficiency in the Ghanaian banking industry, providing in-depth clarification and analysis on how variables were utilized and the restrictions imposed on such variables utilized. We measure efficiency with appropriate determinants to identify their interactions in an economic environment.

This study tries to provide relevant information on how determinants of efficiency influence banks' efficiency and identify areas where improvements could be made to achieve high efficiency. This work contributes immensely to existing literature in many ways. It evaluates the extent to which determinants impact bank efficiency within system generalized moments of method (GMM) context for banks in Ghana, which enable the study to provide empirical evidence on the Ghana banking industry. It also uses different forms of bank efficiency (cost, profit) in analyzing the economic phenomenon as a cross-verification exercise for robustness of the results obtained.

Empirical results of bank efficiency studies show that the extent of efficiency is a direct consequence of a

series of microeconomic, macroeconomic and other external factors which are peculiar to the environment in which the bank performs its activities. The main microeconomic factors identified in literature as determinants of efficiency are operational cost, credit risk, and capital structure, whiles the main macroeconomic factors are inflation level and gross domestic product (GDP) growth. Other external factors like bank size and concentration have also been identified in the literature as the main determinants affecting bank efficiency.

In this study, we theorize that increase in bank size or scale of bank's operations will lead to a rise in efficiency. Banks are likely to derive cost reductions resulting from decrease in per unit cost as a result of increase in scale or size or scale of operations (Srairi, 2010).

Capital structure determines bank's ability to withstand losses. Banks with higher equity to total assets ratio may be over-cautious, rejecting possible profitable investments. Alternatively, a decreasing ratio may lead to capital adequacy problems. Hence, capital structure could impact positively or negatively on efficiency. Operations cost has negative impact on efficiency. This is because greater amounts of lending will decrease production cost, which enables banks to operate much more efficiently (Cebenoyan and Strahan, 2004).

It is also argued that high income from alternative sources such as fees and commissions give rise to high income from sources such as fees and commissions that lead to high operational costs to enable the banks offer such services. Banks that incur higher operational cost will be comparatively less efficient because of the high risk would be taken up as a result of increment of cost (Chen, 2009).

Credit risk is negatively related to efficiency (El-Moussawi and Obied, 2011). This is because increase in non-performing loans leads to decrease in efficiency. Bank's efficiency is mostly found in literature to be positively related to the level of concentration (Grigorian and Manole, 2002; Casu et al., 2004).

Banks normally utilize interest rates to estimate inflation. When inflation is expected to take an upward trend, interest rates are increased, which can lead to increase in default rate, thereby affecting efficiency adversely. GDP growth has a direct relationship with efficiency. GDP growth increases demand for bank services, which leads to increase in efficiency, if there is lower default risk on loans provided during the periods of real GDP growth. The study findings seem to indicate that operational cost, credit risk and bank size are the main determinant of cost efficiency in the Ghanaian banking industry; whereas, profit efficiency is significantly influenced by only operational cost and credit risk.

LITERATURE REVIEW

The concept of efficiency was initially introduced by Farell (1957) under the input oriented measure concept. According to Farell (1957), efficiency is measured by comparing observed and optimal values of production, cost, revenue, profit or all that the production system follows as objective, and which is under appropriate quantities and prices constraints.

Efficiency is linked to the possibility of avoiding waste by producing as much output as the utilization of inputs allows (output oriented measure), or by using less inputs that the production objective plans it (input oriented measure).

Literature proposes two approaches for estimating bank efficiency: mathematical programming approach (non-parametric) and econometric approach (parametric). Stochastic Frontier Approach (SFA) and Data Envelopment Analysis (DEA) are the commonly used parametric and non-parametric methods respectively in the estimation of bank efficiency (Beccalli et al., 2006; Barry et al., 2011; Afsharian, 2011).

There has been a proliferation of studies on the evaluation of bank efficiency and its determinants over the last two decades resulting from rapid structural changes in the financial services industry and increased competition emanating from globalization, focusing mainly on US and European banking industries (Altunbas et al., 2001; Lozano-Vivas et al., 2002; Casu and Molyneaux, 2003; Fries 2005; Andries, 2011). There exists some literature on emerging markets as well (Green et al., 2004; Bonin et al., 2005; Yildrim and Philippatos, 2007; Sarpong et al., 2017).

Studies on the determinants of bank efficiency have mostly been based on regression analysis in which different forms of bank efficiency (cost, profit, production, technical etc.) were regressed on theorized determinants of bank efficiency. Literature shows that the determinants of bank efficiency are internal factors that are specific to the bank and external factors within the environment in which the activities of the bank are performed. The empirical results of studies on bank efficiency show that the extent of efficiency differs over time and from an industry to another, the consequence of a series of micro and macroeconomic factors (McKillop et al., 2002; Casu et al, 2004; Hassan and Marton, 2003; Rossi et al., 2005; Yildrim and Philippatos, 2007).

The microeconomic factors which impact on only some aspect of activity include endogenous factors that are managed by the bank, such as resources utilized, capital structure, size, concentration, market share, technology employed, organizational structure, management style, and exogenous factors that do not depend solely on the banks' management, such as specific legislation, market share, availability of resources and market price. The macroeconomic factors, which influence the efficiency of banks no matter where they perform their activities, include GDP growth and inflation.

Wong et al. (2007) explore the extent to which indicators of market structure, such as concentration and market share, influence the efficiency of banks in Hong

Kong, using Panzar-Rosse approach and the conjectural variation approach, and found concentration to be a key determinant of efficiency. Allen and Rai (1996) in an international bank comparison regress SFA and DEA efficiency estimates on microeconomic factors, and identify capital structure and credit risk as the key determinants of bank efficiency. The authors however did not take into account environmental factors in the explanation of efficiency. Dietsch and Lozano-Viva (2000) in their study consider environmental variables but found an insignificant positive relationship between efficiency and environmental variables (GDP growth, inflation).

Molyneaux and Seth (1998) examine the efficiency of foreign banks in the US for the period 1987 to 1991, and found the risk adjusted capital ratio to be a key determinant of these banks' efficiency. Williams (2003) also consider the efficiency determinants of foreign banks in the Australian banking industry from 1989 to 1993. With SFA efficiency estimates as the dependent variable, the main findings are that size and GDP growth are the main determinants of efficiency.

Bonin et al. (2005) evaluate the determinants and the impact of ownership structure on bank efficiency with an unbalanced panel of 225 commercial banks in eleven transition countries for the period 1996 to 2000 and found credit risk and market share to be the main determinants of bank efficiency, whereas ownership (strategic foreign, majority foreign ant state) does not have significant impact on efficiency because of the undeveloped and evolving nature of transition countries' banking sector.

METHODOLOGY

This study seeks to determine the factors of efficiency by regressing micro and macroeconomic variables on two dimensions of bank efficiency: cost efficiency and profit efficiency. The concept of cost efficiency and profit efficiency are based on the assumption that decision making units (DMU) pursue economic behavioural goals such as the minimization of cost or maximization of profit, and are defined accordingly, in terms of distance to an economic (cost or profit) frontier.

In order to estimate cost efficiency and alternative profit efficiency, the SFA model, as developed by Aigner et al. (1977) is employed. The SFA incorporates both inefficiency and noise in the specification of the model in a composite error term and imposes independence and distributional assumptions to segregate the two error components. Specifically, in the context of the cost frontier, the following specification is assumed:

$$TC_{it} = f(P_{it},\, Q_{it},\, N_{it},\, Z_{it}) + v_{it} - u_{it} \quad (1)$$

Where TC_{it} represents the observed total cost of bank i at period t, observed total cost for bank i at year t, P_{it} denotes the vector of input prices, Q_{it} is a vector of the bank's output, N_{it} ia a vector of fixed netputs and Z_{it} is also a vector of control variables. The error term is segregated into two components: the first one, v_{it}, corresponds to the random fluctuations and is assumed to follow a symmetric normal distribution around the frontier, while the second one, u_{it}, takes the firm's efficiency that may raise cost above the best practice level into account, and is assumed to follow a half normal distribution. The standard translog functional form for the case of "Q" outputs and "P" inputs prices is specified as in equation 2a below:

$$\ln(\mathrm{TC}_{i,t}) = \alpha_0 + \sum_{m=1}^{2} \alpha_m lnQ_{i,t,m} + \sum_{n=1}^{3} \beta_n \ln P_{i,t,n} + {}^1/_2 [\sum_{m=1}^{2}\sum_{k=1}^{2} \alpha_{mk} lnQ_{i,t,m}\, lnQ_{i,t,k} + \sum_{n=1}^{3}\sum_{l=1}^{3} \beta_{n,l} \ln P_{i,t,n} \ln P_{i,t,l}\,] + \sum_{m=1}^{2}\sum_{n=1}^{3} \delta_{m,n} lnQ_{i,t,m} \ln P_{i,t,n} + \lambda_1 \mathrm{t} + \frac{1}{2}\lambda_2 \mathrm{t}^2 + \sum_{m=1}^{2} \lambda_{2+\mathrm{m}} \mathrm{t}\, lnQ_{i,t,\mathrm{m}} + \sum_{n=1}^{3} \lambda_{4+\mathrm{n}} \mathrm{t} \ln P_{i,t,n} + \varepsilon_{i,t} \quad (2a)$$

Where $\mathrm{TC}_{i,t}$ denotes the total cost of production of a given bank i at time t, made up of total operating expenses and interest expense; Q_m (m = 1,2) are output quantities, where Q_1 is total loans, Q_2 is also other interest earning assets; P_n (n = 1,2,3) are input prices, where P_1 is the price of labour (calculated as total personnel expense/total assets), P_2 represents the price of deposits (calculated as total interest expense/related liabilities (deposits and other short term funding)), P_3 denotes the price of equity (calculated as total capital expense/total fixed assets); εn is a two component stochastic error term; and $\alpha, ß, \delta, \text{and } \lambda$ are parameters to be estimated.

Borrowing from the work of Thanh et al. (2016), the study normalizes the dependent variable and all the input prices by price of labour (P_1). This gives a linear homogeneity condition of equation (2a) aforementioned as:

$$\ln(\frac{\mathrm{TC}_{i,t}}{\mathrm{P}_{i,t,1}}) = \alpha_0 + \sum_{m=1}^{2} \alpha_m lnQ_{i,t,m} + \sum_{n=1}^{3} \beta_n \ln(\frac{P_{i,t,n}}{\mathrm{P}_{i,t,1}}) + {}^1/_2 [\sum_{m=1}^{2}\sum_{k=1}^{2} \alpha_{mk} lnQ_{i,t,m}\, lnQ_{i,t,k} + \sum_{n=1}^{3}\sum_{l=1}^{3} \beta_{n,l} \ln(\frac{P_{i,t,n}}{\mathrm{P}_{i,t,1}}) \ln(\frac{P_{i,t,l}}{\mathrm{P}_{i,t,1}})\,] + \sum_{m=1}^{2}\sum_{n=1}^{3} \delta_{m,n} lnQ_{i,t,m} \ln(\frac{P_{i,t,n}}{\mathrm{P}_{i,t,1}}) + \lambda_1 \mathrm{t} + \frac{1}{2}\lambda_2 \mathrm{t}^2 + \sum_{m=1}^{2} \lambda_{2+\mathrm{m}} \mathrm{t}\, lnQ_{i,t,\mathrm{m}} + \sum_{n=1}^{3} \lambda_{4+\mathrm{n}} \mathrm{t} \ln\left(\frac{P_{i,t,n}}{\mathrm{P}_{i,t,1}}\right) + \varepsilon_{i,t} \quad (2b)$$

We formulate the profit function in a similar manner for estimating the profit efficiency estimates. We follow the justification of Berger and Mester (1997) and opt for the alternative profit function instead of the standard profit function. With the alternative profit function, the same variables as the cost function are employed, which means that profits are affected by output prices and such output prices

vary freely. The independent variable is now stated as ln(π+θ+1), where θ denotes the absolute value of the minimum value of profits (π) over all banks in the sample. This transformation enables us to take the natural log of profits, given that profits can also take negative values. The composite error term in the case of the alternative profit function becomes $\varepsilon_{i,t} = v_{it} - u_{it}$, where u_{it} is assumed to follow an exponential distribution.

The independent variables are size proxies by the natural logarithm of total assets, consistent with the study of Altunbas et al. (2007a, b); concentration is proxy by the Herfindahl-Hirschman Index (HHI); operational cost is measured by ratio of total cost to total income, consistent with the studies of Mester (2009); credit risk is proxy by non-performing loans, in consonance with the studies of Kwan and Eisenbeis (1997); capital structure proxy by the ratio of total equity to total assets; yearly inflation and GDP growth.

Both fixed and random effects models have usually been employed in the banking literature for panel data. Challenges are encountered with these models when dependent variables which are lagged or some other regressors are important, especially in the frame of few time periods and many observations (Nickell, 1981). The coefficient may be utterly biased when the lagged dependent variable is correlated with the regressors to some degree. To tacklethis challenge, we employ Arellano (1995) system GMM estimator, which includes differences and lagged levels.

The system GMM estimator assumes that first differences of instrumental variables are uncorrelated with the fixed effect. This model enables the inclusion of much more instruments and can substantially enhance efficiency. Though both the Arellano and Bond (1991) difference GMM model and the Arellano and Bover (1995) system GMM estimator are fit for addressing such challenge, and suitable for situations with 'small T, large N' panels; independent variables that are not strictly exogenous; fixed individual effects; heteroskedasticity and autocorrelation, Roodman (2006) argue that the difference in GMM estimator can be subject to serious finite sample biases if the instruments used have near unit root properties. The utilization of the system GMM estimator results in smaller finite sample bias and much greater precision when estimating autoregressive parameters, using persistent series (Bond, 2002). Since the sample in this study share many of these characteristics, we employ the system GMM model to assess the determinants of efficiency in the Ghanaian banking industry.

In order to pave way for dynamics in the underlying process for recovering consistent estimates of other parameters, we follow the study of Love and Zicchino (2006), by allowing individual heterogeneity in the levels of the variables by introducing fixed effects. The regressors are correlated with the fixed effects because of the lags of the dependent variables and as a result the mean differencing procedure commonly used to eliminate fixed effects might create biased coefficients. This problem is avoided by using forward mean differencing. This transformation maintains the orthogonality between transformed variables and lagged regressors so that we can employ lagged regressors as instruments and estimate coefficients by system GMM. Employing the system GMM model, the reduced form for estimating equations for each efficiency measure is as follows:

$$Y_{i,t} = \alpha Y_{i,t-1} + \beta X_{i,t} + \gamma Z_{i,t-1} + \left(\mu_{i,t} + v_{i,t}\right) \quad (3)$$

Where:

$Y_{i,t}$: Bank i's efficiency (cost, profit) in year t,
$Y_{i,t-1}$: Bank i's performance in year t-1
$X_{i,t}$: a vector of current values microeconomic(bank-specific and external) explanatory variables
$Z_{i,t-1}$: a vector of lagged macroeconomic variables.
μ_i: an unobserved bank-specific time-invariant effect which allows for heterogeneity in the means of the $Y_{i,t}$ series across banks.
$v_{i,t}$: a disturbance term which is independent across banks.

The study employed a balanced panel data from 22 commercial banks within Ghana's banking industry, over the period 2010 to 2016. The banks in the sample were chosen based on the fact that they have been continuously operating over the aforementioned mentioned period and therefore there is continuous financial data for such banks over the entire period. The published annual financial statements and reports were obtained from the banks' respective official sites. Data on inflation and GDP growth was also obtained from the official website of the Ghana statistical service.

RESULTS

Table 1 presents the main descriptive statistics of bank specific variables, industry specific variables, macroeconomic and the input and output variables of cost and profit functions.

The cost efficiency scores based on SFA are presented in Table 2. The efficiency estimates takes a maximum value of 100, which corresponds to the most efficient bank in the sample. The cost efficiency estimates have a minimum value of 76.92% and maximum value of 82.76%, with an average of 80.10%, thereby showing average inefficiency of approximately 20%.

The profit efficiency estimates are also reported in Table 3. The profit efficiency estimates range between 63.46 and 73.53%, with an average of 67.84%, thereby showing average inefficiency of approximately 32%. The results show that the profit efficiency estimates present greater variability than profit efficiency estimates. It can also be seen that cost efficiency estimates are greater than profit efficiency estimates. The overall trend for the efficiency estimates is not constant but there seems to be some improvements over the years considered. The rank order correlation between the cost and profit efficiency estimates is estimated at 0.41.

The panel is estimated with the Arellano and Bover (1995) system GMM estimator and opts for optimal lag length of one year. Prior to the estimation, we have to determine the optimal lag order of the independent variables in the system of equations. We employ the moment selection criteria and downward testing procedures developed by Andrews and Lu (2001). Based on the Hansen test statistics, the optimal lag is found to be one year. In order to test for autocorrelation additional lag was added. The Sargan test show that for lag order one, we cannot reject the null hypothesis. The exogenous variables and the difference of the lagged dependent variable are used as instruments in the level equation, whiles the lagged dependent variable is the instrument in the first- difference equation. Then, each regressor appears in the instrument matrix. We also perform normality test for the residuals, opting for the Shapiro-Wilk test. The test shows a value greater than 0.05, indicating that the data is normal.

The parameter estimates of the system of equations for efficiency (cost and profit), bank specific variables,

Table 1. The main descriptive statistics of bank specific variables, industry specific variables, macroeconomic and the input and output variables of cost and profit functions.

Variable	Mean	Maximum	Minimum	Std. deviation	Coeff. variation
Loans and advances Q1)	778,335,053	2,524,530,000	223,801,885	518,893,178.71	0.666670705
O I E assets (Q2)	696,556,315	1,982,269,000	72,028,186	637,737,895.39	0.915558271
Price of labour (P1)	0.042373743	0.092394723	0.020838024	0.017729024	0.418396456
Price of deposits (P2)	0.054360551	0.160315374	0.009523156	0.037693888	0.693405188
Price of equity (P3)	1.128600867	2.573696145	0.543011123	0.547614418	0.485215309
Total Cost (TC)	121,759,195	291,740,000	19,969,664	92,813,982.75	0.762274939
Total profit (TP)	103,378,657	488,399,000	7,725,040	119,029,695.02	1.151395253
Equity/Total Assets	0.15107157	0.216669797	0.072355957	0.038127502	0.25
GDP	5.44	8.6	3.9	2.098332671	0.385722918
Inflation	14.528	17.67	9.1	3.43320113	0.236316157
NPL	13	13.7	12.2	0.640312424	0.049254802
Concentration	0.05366222	0.058479	0.049977	0.004282509	0.079804908
Cost/Income	0.39367365	0.649184512	0.053488085	0.114822518	0.29
LN TA	20.98430345	22.35798273	19.36957579	0.908273186	0.04
Total Assets	1,870,031,888	5,128,006,000	258,285,415	1529800287	0.81806107

Table 2. Average cost efficiency scores over the period 2010 to 2016.

Year	Mean	Std. deviation	Coeff. variation
2010	79.547	9.904	0.125
2011	77.396	10.639	0.137
2012	76.924	10.247	0.133
2013	82.274	11.789	0.143
2014	80.247	12.217	0.152
2015	81.563	9.756	0.120
2016	82.759	10.059	0.122

Table 3. Average profit efficiency scores over the period 2010-2016.

Year	Mean	Std. deviation	Coeff. variation
2010	63.784	11.524	0.181
2011	64.273	10.937	0.170
2012	63.455	10.487	0.165
2013	64.076	14.726	0.230
2014	72.272	13.734	0.190
2015	73.466	16.532	0.225
2016	73.527	12.787	0.174

industry specific variables and macroeconomic variables, based on the estimation of system GMM are presented in Table 4. The lagged dependent variable is significant for all two dependent variables. The joint significance of the independent variables is confirmed by the F-test, whiles the Hansen test is insignificant as shown by the p-values, indicating that the model does not suffer from over identification (Table 4).

The coefficient on capital structure (CAS) is positive for both cost and profit efficiency estimates but is insignificant in all cases. Theoretically, increase in ratio of equity capital to total assets lowers banks' deposit ratio, leading to increase in cost of capital and thereby decreasing both cost and profit efficiency. The results seem to suggest that increase in equity capital does not significantly influence banks' cost of capital and efficiency

Table 4. Regression results.

Independent variables	Cost efficiency coefficient	Profit efficiency coefficient
	0.187	0.139
Constant	(0.240)	(0.201)
	[0.78]	[0.69]
	0.574	0.822
Lt-1	(0.197)	(0.311)
	[2.91]	[2.64]
	0.014	0.006
CAS	(0.067)	(0.010)
	[0.21]	[0.59]
	0.009	0.025
OPC	(0.004)	(0.019)
	[2.23]	[1.34]
	0.018	0.021
NPL	(0.011)	(0.012)
	[1.67]	[1.73]
	0.002	0.037
Size	(0.001)	(0.061)
	[1.43]	[0.61]
	0.011	0.004
CONC	(0.041)	(0.006)
	[0.27]	[0.72]
	0.025	0.094
INFLt-1	(0.045)	(0.324)
	[0.56]	[0.29]
	0.016	0.033
GDPt-1	(0.022)	(0.069)
	[0.73]	[0.48]
F test	25.03	31.47
Hansen test	28.34	29.03
AR(1)	-2.74	-2.61
AR(2)	-0.73	-0.24

Values in parenthesis ( ) are standard error and brackets [ ] are t-values.

in the Ghanaian banking industry.

Operational cost (OPC) is negative and statistically significant for both efficiencies, indicating that better management of productive operations, which lowers production cost, also leads to improvements in cost and profit efficiency. This is in consonance with most of the empirical results of previous studies. It is however contrary to Chen (2005), who argued that higher interest income and other fees could be associated with a less than proportionate increase in operational cost, thereby leading to increased profits.

Credit risk (NPL) also has statistically significant negative impact on both efficiency estimates, implying that higher non-performing loans are associated with deteriorations in cost and profit efficiency. This confirms that banks with higher non-performing loans are less cost efficient. The negative impact on cost efficiency is due to the fall in economic activity, which is followed by a rise in

bankruptcy probability. The findings in relation to profit efficiency seem to contradict El Moussawi and Obeid (2011), who argue that higher non-performing loans resulting from increased loan output might lead to increased profit, thereby improving profit efficiency.

The coefficient on 'size' is positively signed for both efficiency estimates but is significant for cost efficiency and insignificant for profit efficiency. The results seem to suggest that large banks benefit from the decrement in per unit costs that result from the increment of size of scale of operations, thereby making them cost efficient. The shocking discovery is that, contrary to most of the empirical results of previous studies, the influence of 'size' on profit efficiency is only mild. The estimated coefficient of concentration (CONC) is statistically insignificant for both efficiency estimates, indicating that market concentration is not a significant determinant of banks' cost and profit efficiencies.

With regards to the macroeconomic factors, the coefficient of GDP growth (GDP_{t-1}) and inflation ($INFLT_{t-1}$) both lagged by a year, are positively and negatively sign, respectively but are insignificant in all cases. The insignificant impact of inflation on both cost and profit efficiency estimates suggest that the usage of interest rates in controlling inflation by the monetary policy committee of Bank of Ghana (2013) has not significantly influenced non-performing loans, which are known to influence efficiency. The greater demand for bank products coupled with a lower risk of default on loans in periods of real GDP growth should result in significant impact on both efficiency estimates. This might have been offset by costly advertising and promotional activities because of high concentration in the industry, resulting in the insignificant impact.

Conclusion

The twin forces of technological advancement and deregulation have led to financial integration and increased competition in the Ghanaian banking industry. This situation requires an extensive study into efficiency and its determinants in the Ghanaian banking sector, if Ghanaian banks are to survive and compete effectively in the global financial system.

This study employs the Arellano and Bover (1995) system GMM estimator to evaluate the determinants of efficiency by regressing micro and macroeconomic variables on two dimensions of bank efficiency: cost and profit efficiency. The cost efficiency estimates are greater than profit efficiency estimates, and profit efficiency estimates present greater variability than profit efficiency estimates. Even though the overall trend for the efficiency estimates is not constant, there seems to be some improvements over the years considered.

The results indicate that operational cost, credit risk and bank size are the main determinant of cost efficiency in the Ghanaian banking industry, whereas profit efficiency is significantly influenced by only operational cost and credit risk. Operational cost has significant negative relationship with both cost and profit efficiency, indicating that better management of productive operations, which lowers production cost, also leads to improvements in cost and profit efficiency.

Credit risk also exerts significant negative influence on both cost and profit efficiency. Hence, implying that banks' cost and profit efficiencies could be ameliorated when sound risk management mechanisms and practices are put in place. Bank size exerts significant influence on cost efficiency but has insignificant impact on profit efficiency. This implies that banks can engage in healthy acquisitions mergers in order to benefit from the decrement in per unit costs that result from the increment of size of scale of operations, thereby making them cost efficient. However, there is weaker evidence on the impact of capital structure and concentration on both cost and profit efficiencies. Inflation and real GDP growth also register insignificant effects.

The evaluation of efficiency and its determinants in Ghana has important implications for banks' management and regulatory authorities. To increase efficiency, banks should enhance the quality of assets owned by improving their risk management processes, in order to reduce the level of non-performing loans and employ effective cost control measures. For policy makers, the results stress the benefits of large bank size. Subsequent reforms should incorporate incentives that encourage mergers and acquisitions.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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