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COST EFFICIENCY OF GHANA'S BANKING INDUSTRY: A PANEL DATA ANALYSIS

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ABSTRACT

This study analyzes the efficiency of the banking industry in Ghana over the period of 2001–2010 using the data envelopment analysis. The study investigates the impact of size, capitalization, loan loss provision, inflation rate and GDP growth rate on Ghana's bank efficiency using both static and dynamic panel data models. The static model is estimated by the fixed effects estimator whereas the dynamic mdoel is estimated by the two step system GMM estimator. The results suggest that Ghana banks are inefficient. This study reveals that well-capitalized banks in Ghana are less cost efficient. In addition, bank size has no influence on bank cost efficiency suggesting that larger banks in Ghana have no cost advantages over their smaller counterparts. The findings also exhibit that loan loss provision ratio has no effect on bank efficiency in Ghana. This study finds GDP growth rate negatively influences bank cost efficiency and that lagged cost efficiency tends to persist from year to year.

JEL: E44, E50, E60

KEYWORDS: Data Envelopment Analysis, Bank Efficiency, Cost Efficiency

INTRODUCTION

The banking industry in Ghana has changed considerably since 1988 as a result of the gradual and steady implementation of financial services deregulation, globalisation and the emergence of communication and information technologies. The financial deregulation was undertaken as part of the structural economic adjustment and stabilization program launched in 1983 with the assistance of the International Monetary Fund and World Bank. These financial sector reforms are aimed at increasing banks competitiveness, efficiency and performance in Ghana's banking system that could then contribute in greater measure to stimulate economic growth and ensure financial stability. During the pre-reform era, Ghana banking system was dominated by the state owned banks and totally controlled by the government. Ghana's economic performance declined and its banking system was in distress. Banks were characterised by inadequate capital, insufficient loans loss provisions, high operating costs due to inefficient operations, a large portfolio of nonperforming loans and endured enormous political influence (International Monetary Fund, 1999; World Bank, 1989). The financial system was distorted by interest rate controls and selective credit policies, lack of competition, and weak supervision by the Bank of Ghana (World Bank, 1989).

As a result, financial reforms were undertaken and most restrictions on foreign entry, interest rates and exchange rates were removed. The results have increased the capacity of financial institutions to mobilise domestic savings, enhanced efficiency among banks, and strengthened economic growth. The central bank set up the payments system infrastructure and appropriate measures that facilitate a competitive and efficient banking sector. The Ghana banking sector has shown considerable improvements in communication and computing information technology, as banks modernized their distribution networks and introduced new banking services such as Automated Teller Machines **(**ATMs), telephone banking, mobile banking and internet banking are now prevalent in Ghana. The Ghana banking sector is reasonably efficient, financially innovative, competitive, profitable, and growing quite quickly (Acquah, 2009). The

sector has seen some structural changes with reduced concentration and strong competition for market shares, increase in branch network and provision of various new banking products in Ghana. For example, the number of banks actively operating in Ghana has grown from 7 in 1987 to 27 in 2010. Most of the new entrants were foreign banks. During the same period, the number of foreign banks in Ghana increased from 3 to 15. The bank concentration based on the Herfindahl-Hirschman index (HHI) has dropped considerably from 1,065.9 points in 2000 to 600.0 points in 2010 (Bank of Ghana, February 2009) representing a decrease in market concentration of 30.2 percent, as a result of the increase of the number of banks. During the period 2001 to 2010 the real gross domestic product has grown between 4.5 percent and 8.4 percent (International Monetary Fund, 2011).

Ghana's financial sector reforms policies have long been pursued with great enthusiasm and consistency than in some other African countries. Despite the considerable progress for the past 12 years as a result of the financial reforms, no study has been conducted to evaluate the level and determinants of bank efficiency in Ghana. This paper attempts to fill this gap in literature by providing empirical evidence on efficiency in the Ghana's banking industry. In addition, better understanding of the factors affecting Ghana banks' efficiency is vital to both bank regulators and policy makers because improvements in efficiency in the banking industry are essential prerequisite for providing a more efficient system of asset allocation in the financial system which then facilitates lower cost of capital to firms and accelerates capital accumulation and productivity growth (McKinnon, 1973)..The aim of this study is to determine whether deregulation has improved the level of bank cost efficiency of Ghana's banking sector and examine the determinants of bank cost efficiency using both static and dynamic models.

The rest of the paper is organized as follows. Section 2 discusses the relevant literature on bank efficiency. Section 3 provides the methodology and data employed. Section 4 presents the empirical results; and Section 5 concludes the paper.

LITERATURE REVIEW

Many studies have used various methods to estimate bank efficiency as well as different econometric approaches to determine the factors that affect bank efficiency. Many of the previous studies on bank efficiency have been conducted on developed economies (Pasiouras, 2008 and Delis et al., 2009 on Greek banks; Mukherjee et al., 2001 on US banks; and Girardone et al., 2004 on Italian banks). However, the recent resurgence of economic and financial reforms across the developing countries has also raised the awareness of the importance of bank efficiency (Tecles & Tabak, 2010 on Brazilian banks; Ariff & Can, 2008 on Chinese banks; Altunbas et al., 2007 on banks from 15 European countries and; Ataullah & Le, 2006 on India and Pakistan banks).

Previous studies revealed mixed results regarding the relationship between financial reforms and efficiency. Casu & Molyneux (2003) use a sample of 530 banks from five European Union countries covering the period 1993 to 1997 to investigate the existence of productive efficiency across the European banking markets since the introduction of the Single Internal Market. Their results show an evidence of a small improvement in bank efficiency levels. Similarly, Ataullah & Le (2006) analyze the efficiency of the Indian banking sector during 1992–1998 using the data envelopment analysis (DEA) method and find evidence of efficiency gain in the Indian banking industry during the post-economic reforms era. A recent study by Loukoianova (2008) who uses DEA to investigate the cost and revenue efficiency of Japanese banks from the period 2000-2006 finds enhancement in efficiency for the period between 2001 and 2006. Staub et al. (2010) estimate cost, technical and allocative efficiencies for Brazilian banks for the period 2000–2007 and conclude that banks in Brazil are inefficient.

In assessing the determinants of bank efficiency, the relationship between efficiency, on one hand, and bank size, bank capitalization, loan loss provisions ratio and GDP growth, on the other hand, is

ambiguous. The results of previous studies on the relationship between bank size and bank efficiency are inconsistent. Some previous studies have found that larger banks are more efficient (e.g. Miller & Noulas, 1996; Ataullah & Le, 2006; Tecles & Tabak, 2010). In contrast, Isik & Hassan (2002), Girardone et al. (2004) and Altunbas et al. (2007) studies have documented a significantly negative effect of bank size on bank efficiency. Other studies have observed insignificant influence of bank size on bank efficiency (e.g. Berger & Mester, 1997, Ariff & Can, 2008; Staub et al., 2010).

Some previous studies such as Casu & Girardone (2004) , Ataullah et al.(2004), Staikouras et al. (2008) and Yildirim & Philippatos (2007) reported a negative impact of loan loss provisions ratio on bank efficiency. However, Altunbas et al. (2007) find a positive relationship between loan loss provision and bank efficiency while Staub et al. (2010) observed an insignificant relationship. The relationship between bank capitalization and bank efficiency clearly show mixed results. For example, some studies have reported a positive relationship between bank capitalization and bank efficiency (see Casu & Girardone, 2004; Pasiouras, 2008, Yildirim & Philipatos, 2007; Staikouras et al., 2008). On the other hand, Kwan & Eisenbeis (1997), Altunbas et al. (2004), Altunbas et al. (2007) and Kablan (2010) studies reveal a negative relationship. A negative relationship can be attributed to the fact that financial capital influences costs through its use as a source of financing loans (Berger & Mester, 1997; Ariff & Can, 2008; Staikouras et al., 2008). Thus, raising capital that involves higher costs than taking deposits, for example issuing shares, could generate a negative relationship between bank capitalization and bank efficiency. Others studies such as Ariff & Can (2008), Casu & Molyneux (2003) and Staub et al. (2010) find no significant impact of bank capitalization on bank efficiency.

In regards to the macroeconomic factors on bank efficiency, Maudos et al. (2002) study 10 European Union countries for the period 1993–1996 and report that GDP growth rate has a positive correlation with profit efficiency but a negative correlation with cost efficiency. Yildirim & Philippatos (2007) investigate cost and profit efficiency of 12 transition economies of Central and Eastern Europe (CEE) banks from 1993 to 2000. The authors investigate the determinants of bank efficiency employing the generalized least squares fixed-effects estimators and find that economic growth has a positive relationship with bank cost efficiency but a negative relationship with profit efficiency.

Previous empirical studies on bank efficiency have mostly employed static panel data methods to analyze the determinants of bank efficiency. However, many financial processes exhibit dynamic adjustment over time so failing to incorporate dynamic aspect of the data can lead to serious misspecification biases in the estimation and results. De Jonghe & Vennet (2008) report that most banking studies failed to consider the time it takes for the impacts of bank efficiency to materialize. However, there is gradual awareness of the need to include lagged efficiency such as in the studies of Ataullah & Le (2006), Staub et al. (2010) and Fiordelisi et al. (2011).

METHODOLOGY

Data Envelopment Analysis as Measure of Bank Efficiency

Due to the small number of banks in Ghana, this paper employs the data envelopment analysis to determine efficiency scores of Ghana's banks. This is because DEA works well with small sample size as opposed to parametric methods which require large sample size to generate reliable estimate (Isik & Hassan, 2002; Ariff & Can, 2008). DEA also does not specify any functional form of the underlying production relationship (Berger & Humphrey, 1997). Further, DEA is used extensively in studying the banking industry of developed and developing economies; for individual countries as well as cross-country comparisons (Aly et al., 1990; Chen & Ye, 1998; Sathye, 2001; Casu & Girardone, 2006. Following Aly et al. (1990), Sathye, (2001), Casu & Girardone (2006) and Tecles & Tabak (2010), this study uses variable return to scale (VRS) model (Banker et al., 1984) as constant returns-to-scale

(Charnes et al., 1978) assumption is unlikely to prevail since Ghana banks operate in an imperfect competitive environment and are also subject to financial constraints and regulatory requirements (see Coelli et al., 1998). These factors might compel or cause the banks not to operate at optimal scale. Following Elyasiani & Mehdian (1990), Drake (2001), Goddard et al. (2001) and Berger (2007) studies, this study assumes that bank management has more control over costs rather than over outputs (and with high bank operating costs in Ghana) and adopts an input-orientation approach.

Estimating Bank Cost Efficiency

Cost efficiency measures how close a bank's cost is to the minimal cost (or best practice bank's cost) for producing a certain level of output with given input prices and technology. Consider N banks that employ a vector of input quantities x_i for the *i*-th bank, given the prices of input w_i and the levels of output y_i, the cost efficiency model for bank i can be expressed in a linear programming as follows:

$$\text{Minimize}_{\lambda, x_i^*} \quad w_i' x_i^* \tag{1}$$

$$\begin{aligned} \text{Subject to} \quad & -y_i + Y\lambda \geq 0 \\ & x_i^* - X\lambda \geq 0 \\ & NI'\lambda = I \\ & \lambda \geq 0 \quad i = 1, \ldots N \end{aligned}$$

where x_i^* is the frontier or cost-minimizing vector of input quantities for the *i*-th bank and λ is a Nx1 vector of constants. To estimate cost efficiency the optimal values x_i^* are estimated by solving the linear programming (equation 1), where X and Y are the matrix of observed inputs and outputs for all the banks. The cost efficiency of the *i*-th bank is calculated as the ratio of minimum cost to actual cost:

$$CE = \frac{w_i' x_i^*}{w_i' x_i} \tag{2}$$

The measure of cost efficiency is bounded between zero and one. A cost efficiency score of one represents a fully cost efficient bank and are also known as best practice banks in the sample, whereas inefficient cost banks exhibit a value less than one. However, those inefficient cost banks with a value of zero are considered worst practice banks.

Inputs and Outputs for the DEA

In order to estimate cost efficiency, inputs, input prices and outputs must be calculated. Table 1 shows the description of the variables used in the computation of bank efficiency. The choice of the inputs and outputs is essential for measuring the relative efficiencies in banks. The two most widely used approaches in the banking literature for the selection of bank inputs and outputs are the production and intermediation approaches. This study employs a variation of the intermediation approach originally developed by Sealy & Lindley (1977) which views banks as financial intermediaries, producing intermediation services through the collection of deposits and other liabilities and use them to generate interest-earning assets such as loans, securities and other investments. This study identifies two outputs, namely total loans and other earning assets and three inputs, that is, labour (proxy by personnel expenses), capital-related expenses and deposits. Deposits are the most important input resources for Ghana banks to perform their banking activities such as lending and investing. The choice of labour (personnel expenses) and capital expenses are other input resources used in the production of bank products and services. In the case of output, loans and investments securities (especially government securities) constitute the major activities

Table 1 Variables used in the Computation of Bank Efficiency

Variable	Description
Inputs:	
Deposits	Customers deposits
Labour	Personnel expenses of bank staff such as salaries, wages and benefits
Outputs:	
Loans	Total customers' loans
Other earning assets	Banks' investments in different types of securities (e.g. government securities, bonds, Treasury bill and equity investment)
Input prices:	
Price of deposits	Interest expenses divided by total deposits
Price of labour	Personnel expenses divided by the total assets
Price of capital	Capital-related expenses (operating expenses - personnel expenses) divided by total fixed assets.

(especially government securities) constitute the major activities of the banks that channel their funds into investment or lending for profits. In Ghana, loans and other earning assets account for about two thirds of the bank assets and are important generator of revenues. The inputs prices are estimated as proxies since data on the number of personnel and input prices are not available. The production approach is not considered because it is difficult to obtain detailed bank information relating to transactions and financial documents which are required in the approach.

Determinants of Bank Efficiency

Empirical Model

This study investigates the underlying relationship between the estimated efficiency levels and a variety of bank-specific and macroeconomic factors. In the second stage, both the static and dynamic panel data models are estimated with the DEA cost efficiency scores as the dependent variable and bank-specific and macroeconomic factors as the explanatory variables. Many banking studies have examined the factors that affect the efficiency of banks. In the banking literature some studies investigate only bank-specific factors while others assess both bank-specific and external factors. The widely used bank-specific factors are size, profitability, capitalization, loans to assets, loan loss provision to total loans (see Casu & Molyneux, 2003; Casu & Girardone, 2004; Ataullah & Le, 2006; Ariff & Can, 2008). The inflation and real GDP growth rates are commonly used to control for the macroeconomic conditions (see Salas & Saurina, 2003; Girardone et al., 2004; Yildirim & Philippatos, 2007). In this study, bank size, bank capitalization, loan loss provision to total loans, inflation and real GDP growth rates considered as the factors influencing bank cost efficiency in Ghana.

The static panel data model used to determine the bank-specific and macroeconomic factors that affect bank cost efficiency in Ghana is given as follows:

$$\mathrm{EFF_{it}} = \alpha_1 \mathrm{CAP_{it}} + \alpha_2 \mathrm{SIZE_{it}} + \alpha_3 \mathrm{LLP_{it}} + \alpha_4 \mathrm{INF_{it}} + \alpha_5 \mathrm{GDP_{it}} + + \eta_i + \mu_{it} \quad (3)$$

where i represents the individual bank and t denotes time, α are the parameters to be estimated, η_i is the individual bank specific-effect, $\mathrm{EFF_{it}}$ is cost efficiency scores, $\mathrm{CAP_{it}}$ is bank capitalization, $\mathrm{SIZE_{it}}$ is bank size, $\mathrm{LLP_{it}}$ is loan loss provision ratio representing credit risk, $\mathrm{GDP_{it}}$ is real gross domestic product growth rate, $\mathrm{INF_{it}}$ is inflation rate and μ_{it} is the random error term.

A dynamic panel data model is specified by including one-year lagged efficiency among the explanatory variables to capture the dynamic nature of the efficiency of banks. This study attempts to test whether bank efficiency tends to persist over time in the Ghanaian banking context. According to Staub et al. (2010), banks that are more efficient in a specific year tend to be efficient in the following year. On the

other hand, Ataullah & Le (2006) suggest that the one-year lagged efficiency indicates accumulation of knowledge and technological endowment that may assist banks to produce higher outputs with their inputs or reduce cost by adjusting comparatively quickly to the financial reforms. Ataullah & Le (2006) and Staub et al. (2010) studies find significant and positive relationship between the efficiency of the previous year and that of the current year. Furthermore, early banking studies have confirmed the persistence of efficiency over time (Berger & Humphrey, 1991; Kwan & Eisenbeis, 1997). Following the procedure of Ataullah & Le (2006), Solis & Maudos, (2008) and Staub et al. (2010) the dynamic panel model specification for the determinants of bank cost efficiency in Ghana is given as follows:

$$EFF_{it} = \beta_1 EFF_{it-1} + \beta_2 CAP_{it} + \beta_3 SIZE_{it} + \beta_4 LLP_{it} + \beta_5 INF_{it} + \beta_6 GDP_{it} + \eta_i + \epsilon_{it} \quad (4)$$

where *i* represents the individual bank and *t* denotes time, β are parameters to be estimated, η_i is the individual bank specific-effect, EFF_{it} is cost efficiency scores, $EFF_{i,t-1}$ is one-year lagged cost efficiency, CAP_{it} is bank capitalization, $SIZE_{it}$ is bank size, LLP_{it} is loan loss provision ratio representing credit risk, GDP_{it} is real gross domestic product growth rate, INF_{it} is inflation rate and ϵ_{it} is the random error term.

The logit method has been used in recent studies on bank efficiency (see for example, Ataullah & Le, 2006; Maudos & Fernandez de Guevara, 2007; Solís & Maudos, 2008). Since the estimated values of DEA efficiency (EFF_R) range between 0 to 1, logistic specification is used to transform the efficiency scores into natural log odds ratio as follows:

$$\text{Ln}\left(\frac{EFF_R}{1-EFF_R}\right). \quad (5)$$

However, the transformed efficiency score is undefined when the efficiency score, EFF_R is zero or one. This problem reduces the total observations by the number of undefined efficiency scores, causing some loss of the data. Consequently, as in Cox (1970 p.33), Voos & Mishel (1986), Campbell et al. (2007) and Kader et al. (2010), the logit transformation is modified by adding 1/2N to both numerator and denominator, where N represents the number of observations for the efficiency. The advantage of this modified logit transformation is that there is no reduction or elimination of the observations when the efficiency score is equal to zero or one (Maddala, 1983 p.30). The transformed efficiency score, EFF, is employed as the dependent variable for the evaluation of the determinants of efficiency. DEA-Solver Pro is used to estimate the efficiency scores.

Model Variable Definitions

The variable definitions are presented in Table 2.

Table 2: Definition of Model Variables

Variable	Symbol	Description	Expected Signs
Cost efficiency	EFF	Estimated using data envelopment analysis	
Size	Size	Natural logarithm of total assets	(+/-)
Credit risk	LLP	Loan loss provisions over total loans	(-)
Capitalization	CAP	Total value of shareholders equity over total assets	(+/-)
Macroeconomic Factors:			
Inflation rate	INF	Change in consumer price index	(+)
GDP growth rate	GDPG	GDP growth rate between two consecutive years	(+)

Estimation Techniques

The study employs the fixed effect model to estimate the coefficients in the static equation (3). In terms of the static model, the regression equation for the determinants of bank efficiency assumes exogeneity of the explanatory variables and account for unobservable heterogeneity. The fixed effect model is estimated using robust standard errors (White/Huber (1980) test) to control for potential heteroscedasticity. Under these assumptions, the fixed effect estimator generates efficient parameter estimates and it is considered better than the GMM estimator. However, with a lagged dependent variable and endogenous explanatory variables in the dynamic panel estimation, the GMM estimator is more superior to fixed effect estimator which generates inconsistent estimates (Baltagi, 1995). Following Arellano and Bover (1995) and Blundell and Bond (1998) we developed the system GMM estimator that was designed to overcome potential bias and imprecision associated with first difference GMM estimator when the explanatory variables are persistent (or the sample size is small, as in this study) to estimate the coefficients in equation (4). The first-difference GMM estimator may suffer from the weaknesses of its instruments as the lagged levels of persistent explanatory variables are weak instruments for the equation in first-difference (Blundell & Bond, 1998; Bond, 2002). Particularly, in this study, a two-step system GMM estimator with Windmeijer (2005) corrected standard error is used because it is more efficient and robust to autocorrelation and heteroscedasticity and provides the least bias in small samples. In addition, forward orthogonal deviation is used in place of first-difference as recommended by Roodman (2006 pp. 20, 2009) because first-difference enlarges gaps in unbalanced panel data as it uses only lags variables as observations (Roodman, 2006 pp.19) that can produce biased results especially in small sample. This approach preserves sample size in panels with gaps (Roodman, 2009) . Forward orthogonal deviations approach subtracts the mean of all future available observations of a variable instead of subtracting the past value of observations of a variable.

Based on previous banking studies loan loss provision and bank capitalization are assumed to be endogenous to efficiency is instrumented with their own lags. In this study, the second and third lags of loan loss provision and bank capitalization are used as instruments for the system GMM estimates as well as collapsing instruments (Roodman, 2006, 2009) . The use of these techniques allows us to considerably reduce the number of instrument counts in order to avoid over-fitting of the endogenous variables to have more reliable estimations.

In terms of the static equation (3), the F-test is used to test the null hypothesis that the overall significance of the coefficients of the explanatory variables is jointly equal to zero. This must be rejected to ensure the model is correctly specified. On the other hand, the following tests must be satisfied under the system GMM estimation. First, the Hansen (and difference-in-Hansen) test should not be rejected suggesting that instruments in the system GMM estimation are valid. Second, it is imperative that the second order autocorrelation test under the null hypothesis of no second order autocorrelation is not rejected. This leads to the conclusion that the original error term is serially uncorrelated. The regressions are estimated by employing the Hansen and second order autocorrelation tests to select an appropriate set of instruments for estimation.

Data

The study covers Ghana banks during the period 2001 to 2010. The data used in this study depend on the amount of information available for each bank involved. The data exclude banks which have less than three years of operation during the study period. There were very few mergers and acquisitions and exit during the study period. The data were analyzed for inconsistencies, reporting errors, and outliers. In addition, the years with zero or missing values on input and output variables are omitted. With these restrictions, the sample data for this study is an unbalanced panel data of 25 banks with 211 annual observations, which accounts for more than 99% of bank assets in the time period under consideration.

The choice of an unbalanced panel is due mostly to entry during the study period. The number of banks in each year varied between 14 and 25. The data are based on balance sheets and income statements of the banks' annual reports. The data are obtained from PricewaterhouseCoopers. The macroeconomic variables are obtained from International Monetary Fund's World Economic Outlook. The 25 banks consist of 4 state-owned banks, 8 domestic private banks, and 13 foreign-owned banks. A bank is identified as foreign-owned in Ghana if the foreign ownership share in its assets exceeds 50%.

EMPIRICAL RESULTS

Descriptive Statistics and Correlation Analysis

Table 3 shows large variation across banks shown by the minimum and maximum values of the factors during the study period 2001 to 2010. The rate of inflation depicts a minimum figure of 10.2 percent and a maximum of 32.9 percent with an average of 16.4 percent from 2001 to 2010. The loan loss provision ratio exhibits a worrying trend. On average, 8.8 percent of the total loans in Ghana's banking industry exhibits a minimum of zero percent and a maximum of 64 percent.

Table 3: Summary Statistics of the Determinant Factors

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
size	211	11,935	1,388	7,910	14,560
inf	211	0.164	0.067	0.102	0.329
llp	211	0.088	0.084	0.000	0.640
gdpg	211	0.057	0.012	0.045	0.084
cap	211	0.136	0.113	-0.150	0.980

This table presents the descriptive statistics including the sample size, mean, standard deviation, minimum and maximum values for the 25 banks used in this study. inf, llp, gdpg and cap are in ratios size is in million cedis.

The range is overwhelmingly substantial during the study period. Even though the loan loss provision ratio has been decreasing steadily, it is still considered relatively high. However, Ghana banks are well-capitalized. The average bank in the sample has a capital ratio of 13.6 percent. There are also noticeable differences in bank size during the study period. The average GDP growth is 5.7 percent during the study period. The Ghanaian economy has enjoyed a sustained economic growth from 2001 to 2010. However, the inflation rate continues to be high despite the economic and financial reforms.

Table 4 presents summary statistic of the bank specific factors exhibiting yearly values of mean and standard from 2001 to 2010. The dispersion of bank specific factors (measured by standard deviation) is high, indicating that the factors are dispersed around the average. This suggests that Ghana's banks are heterogeneous. The introduction of universal banks policy in 2003 in Ghana could reduce the heterogeneity across banks.

In order to avoid multicollinearity problems in the determinant factors of bank efficiency, pairwise correlations of the explanatory variables used in the regressions are examined. Table 5 reports the results of the correlation matrix of the factors. The result shows low correlation among the variables and allays the fear of multicollinearity problems. This suggests that there is no significant correlation between the explanatory variables.

Table 4**:** Summary Statistic of Bank Specific Factors (2001-2010)

	Size		llp		Cap	
Year	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**	**Mean**	**Standard Deviation**
2001	10.486	1.474	0.1	0.094	0.134	0.073
2002	10.859	1.29	0.122	0.111	0.104	0.075
2003	11.268	1.179	0.116	0.088	0.097	0.074
2004	11.563	1.085	0.097	0.063	0.119	0.043
2005	11.502	1.248	0.086	0.063	0.192	0.232
2006	11.835	1.124	0.067	0.046	0.14	0.076
2007	12.287	0.995	0.066	0.067	0.103	0.045
2008	12.479	1.218	0.059	0.058	0.143	0.153
2009	12.797	1.117	0.082	0.071	0.152	0.11
2010	13.152	0.858	0.106	0.13	0.158	0.091

This table presents the descriptive statistics showing the mean and standard deviation of the bank specific factors for the period under study. llp and cap are in ratios size is in million cedis.

Table 5: Correlation Coefficients of Determinants of Bank Efficiency

Variable	**size**	**inf**	**llp**	**gdpg**	**cap**
size	1.0000				
inf	-0.3089	1.0000			
llp	-0.0149	0.0821	1.0000		
gdpg	0.2117	-0.2290	-0.1298	1.0000	
cap	-0.2362	-0.0347	-0.1229	0.0336	1.0000

This table presents correlation coefficients of determinants of bank efficiency. inf, llp, gdpg and cap are in ratios and size is in million cedis.

Bank Efficiency in Ghana

Average Bank Efficiency Scores by Year

Table 6 presents the results of the yearly and overall efficiency of Ghana's banking system over the period 2001 to 2010. The results show that the overall average cost efficiency score for Ghana's banking industry is 0.505. This implies that Ghana's banks wasted 49.5 percent (half) of its costs relative to the "best-practice" banks. In other words, on average, the industry could reduce their cost by 49.5 percent and still produce the same amount of output. The results suggest Ghanaian bank managers did not use their inputs efficiently over the study period. Overall, the results show relatively low average efficiency scores during the study period, which suggests that Ghana banks are operating far from the efficiency frontier. On the contrary, Fang et al. (2011) in their study reported a relatively higher efficiency score of 76.95 percent for the Croatian banking sector over the period 1998 to 2008. Similarly, Ariff & Can (2008) and Maudos & Pastor (2003) studies reported an average cost efficiency score of 79 percent for the Chinese banking industry during the period 1995-2004 and 87.1 percent for the Spanish banking sector during 1985-1996. However, high levels of inefficiency in some emerging countries such as India, Turkey and Brazil have also been reported (Das & Ghosh, 2006; Denizer et al., 2007; Tescles & Tabak, 2010).

In terms of yearly results, the cost efficiency of Ghana's banking industry improved considerably from 0.452 in 2001 to 0.661 in 2010, an increase of 46.2 percent. In early years, from 2002 to 2005, cost efficiency increases from 0.416 in 2002 to 0.486 in 2005, showing improvement in input utilization, but then declines to 0.469 in 2006 and eventually starts to show a steady improvement in input utilization from 2007 to 2010. The trend in cost efficiency from 2007 to 2010 suggests that banks managers in Ghana have begun to use their inputs more efficiently that is, the managers are able to control the underutilization or wastage of valuable input resources. Nevertheless, more effort is still required. The high interest rates in the Ghana confirm the high financial costs of the capital, and high non-performing loan problems which result in low cost efficiency of the banks. Casu & Girardone (2009) in their study of five European countries banking sector report an increase in input waste from 2000-2001 onwards leading

to lower average bank efficiencies. They attribute the input waste to reduction in costs facilitated by bank deregulation and increased competition leading to many mergers and acquisitions that may have increased bank costs leading to a decline in their cost efficiency. The authors further explain that decreases in bank efficiency can be the cause of bank consolidation which allows managers to exploit market power.

Table 6: Average Efficiency Scores of Ghana's Banking Industry (2001-2010)

Year	Number of Banks	Ce	
		Mean	Standard Deviation
2001	17	0.452	0.263
2002	18	0.416	0.253
2003	18	0.451	0.201
2004	18	0.484	0.188
2005	20	0.486	0.174
2006	22	0.469	0.201
2007	23	0.453	0.196
2008	25	0.526	0.206
2009	25	0.577	0.250
2010	25	0.661	0.276
Mean		0.505	0.231

This table provides the average efficiency scores. The table shows the number of banks, mean and standard deviation scores, Ce represents cost efficiency.

Our results show bank cost efficiency is relatively unstable over the study period. The results also show the low level of the efficiency scores in Ghana's banks. However, since 2007 there has been a remarkable improvement in the efficiency scores in Ghana's banks. For instance, the average cost efficiency score increased from 0.577 in 2009 to 0.661 in 2010 representing a yearly increase of 14.6 percent, also the biggest during the study period.

Composition of Efficient Frontier Banks

Table 7 describes the composition of the Ghana's bank efficiency frontier, which is the input and output combination of the 'best-practice' banks in Ghana. The data in Table 7 shows a total of 62 of the 211 bank observations are regarded cost efficient over the study period. Based on individual years, only 7 out of 25 banks are on the cost efficiency frontier in 2010.

Table 7: Number of Efficient Frontier Banks (2001-2010)

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
All Banks	3	5	5	6	7	7	9	7	6	7	62
Number of banks	17	18	18	18	20	22	23	25	25	25	

This table shows the number of efficient frontier banks for the period 2001-2010. All banks indicate the banks under study. Ce represents cost efficiency

With the exception of 2001 and 2007, the rest of the study period indicates a fairly distributed cost efficiency frontiers. The results indicate that 36 of the 62 efficient observations are recorded from 2006 to 2010 representing 58 percent. This shows the weakness of Ghana's banks in regards to cost efficiency. The low bank cost efficiency apparently reflects the high operating and financial costs of managing a bank in Ghana. Even though the financial reforms have improved the bank efficiency in Ghana in comparison to pre-reforms period, there is more room for improvement, especially in terms of bank cost efficiency.

Determinants of Bank Cost Efficiency

Table 8 presents the result of the determinants of cost efficiency in Ghana banks. The F-test is statistically significant at 1 percent level for all the explanatory variables. This indicates that the factors used are relevant in explaining the cost efficiency. The results indicate that bank size and bank capitalization are the most important factors in determining bank cost efficiency in Ghana. The analysis of the residuals indicates the presence of heteroskedasticity and as a result White/Huber robust standard error is applied. In terms of the system GMM, the p-value of Arellano-Bond test statistics AR(1) is 0.042 which shows that AR(1) test rejects the null hypothesis of no existence of first-order serial autocorrelation. However, the Arellano-Bond test statistics for the second order serial correlation AR (2) in the residuals do not reject the specification of the error term, since the p-value of AR (2) is 0.948. Thus, there is no second order serial correlation in the error term. The p-value of the Hansen test is 0.881. Accordingly, the Hansen test of over-identification reports that the instruments used in the system GMM estimation are valid. The difference-in-Hansen test of exogeneity indicates that the instruments used for the equation in levels are exogenous which strengthens the validity of instruments employed in the system GMM estimation. There is no evidence of correlation between the instruments and error terms. Hence, the dynamic cost efficiency equation is correctly specified. In addition, since the loan loss provision and bank capitalization are endogenous variables, the results in this study are based on the two-step system GMM instead of the static fixed effect estimator.

Impact of Bank Specific Factors on Bank Cost Efficiency

The system GMM results in Table 8 show that lagged cost efficiency, GDP growth rate and bank capitalization are the important factors in determining bank cost efficiency in Ghana. The lagged cost efficiency is significant and has a positive effect on the bank efficiency in the current year. This implies that bank cost efficiency tends to persist from year to year. This suggests that an increase in lagged cost efficiency could help increase the current year's cost efficiency. The positive lagged cost efficiency may constitute some accumulated knowledge and technologies that may help banks to reduce their costs (see Ataullah & Le, 2006). This implies that the financial services in Ghana's banking industry have encouraged banks to improve their cost efficiency. The result is consistent with the study of Staub et al. (2010) and Manlagnit (2011) which reveal lagged cost efficiency to have positive and significant effect on the current year efficiency.

Table 8 shows that bank size is positive but has no significant impact on cost efficiency. This result implies that larger banks in Ghana have no cost advantages over their smaller counterparts. Similarly, some previous studies did not observe any significant efficiency advantage for large banks. For instance, Girardone et al. (2004) study on the Italian banking sector indicates no evidence of correlation between size and bank efficiency suggesting that larger banks are not more cost efficient than the smaller banks. Similarly, Staub et al. (2010) study on the Brazilian banking system in the period 2000 to 2007 find that bank size is not an important factor in determining bank cost efficiency.

The bank capitalization coefficient is negative and statistically significant at 10 percent level. Ghana banks have been recapitalized by the Bank of Ghana, first in 2003 and then in 2009. This result suggests that well-capitalized banks are less cost efficient in Ghana. This could be due to a higher shareholders' leverage which forces banks to sacrifice costs in exchange for achieving better results. This finding is similar to the results reported by Tabak et al. (2011) on 495 Latin American banks operating in 17 countries over the period 2001-2008, Sufian (2009) on Malaysian banks from 1995 to 1999 and Ariff & Can (2008) on 28 Chinese commercial banks from 1995 to 2004. Based on the results, bank cost efficiency decreases with increases in the level of bank capitalization. This suggests that well-capitalized banks incur higher costs in providing banking products and services due to high level of non-performing

loans and higher cost of capital resulting from the increase in minimum regulatory capital requirement (PricewaterhouseCoopers, 2011).

Financial capital affects costs through its use as a source of financing loans (Berger & Mester, 1997; Ariff & Can, 2008, Manlagnit, 2011). However, raising equity capital involves higher costs than raising deposits leading to increase in financial costs and may lead to decrease cost efficiency. In addition, bank capitalization may likely increase moral hazard incentives and is more likely to increase costs (Ariff & Can, 2008; Fiordelisi et al, 2011). This may reduce cost efficiency. Thus, bank capitalization, on the one hand may reduce bank capital risk, but on the other hand, may increase moral hazard incentives leading to increase in costs and therefore decline in cost efficiency (Ariff & Can, 2008).. The culture of risk management is not well-developed in Ghana's banking industry (Amissah-Arthur, 2010). Intuitively, the level of bank capitalization may not be adequate to cover increases in bank risk taking that may contribute to bank insolvency which could lead to reduction in bank efficiency (Soedarmono et al., 2011).

Table 8**:** Determinants of Bank Cost Efficiency

Variable Ce	**Fixed Effect Model Estimates**	**System GMM Estimates**
Ce_{t-1}	-	0.269*
		(1.85)
size	0.511**	0.033
	(2.42)	(0.07)
inf	1.722	0.794
	(1.33)	(0.38)
llp	0.916	-5.445
	(0.34)	(-1.03)
gdpg	-8.665	-42.910*
	(-1.30)	(-1.97)
cap	3.501**	-28.743*
	(2.18)	(-1.81)
Trend		0.356
		(1.36)
Constant	-6.138	3.815
	(-2.49)**	(0.59)
R-squared	0.109	
F-Statistic (p-value)	0.000	0.004
Wald Test Heteroscedasticity (p-value)	0.000	
Number of observations	211	186
Number of banks	25	25
Number of instruments		14
Hansen J test (p-value)		0.881
Arellano-Bond test:		
AR(1) *p*-value		0.042
AR(2) *p*-value		0.948
Difference-in-Hansen test (p-values):		
GMM instruments for levels		0.784

This table presents the regression estimates of the static equation: $EFF_{it} = \alpha_1 CAP_{it} + \alpha_2 SIZE_{it} + \alpha_3 LLP_{it} + \alpha_4 INF_{it} + \alpha_5 GDP_{it} + \eta_i + \mu_{it}$ *using fixed effect estimator and the dynamic equation:* $EFF_{it} = \beta_1 EFF_{it-1} + \beta_2 CAP_{it} + \beta_3 SIZE_{it} + \beta_4 LLP_{it} + \beta_5 INF_{it} + \beta_6 GDP_{it} + \eta_i + \epsilon_{it}$ *applying two-step system GMM estimator. t-statistics are in parentheses below the estimates. *, ** and *** indicate level of significance at 10%, 5% and 1% respectively. The first column shows the variables entered into the equations. Ce represents cost efficiency.*

The loan loss provision coefficient has a negative effect but does not appear to have a significant influence on bank cost efficiency in Ghana during the study period. This result supports the finding of Yildirim & Philippatos (2007) and Brissimis et al. (2008) who find loan loss provision to be negatively related to bank cost efficiency. In addition, Staikouras et al. (2008) assess the cost efficiency of banks operating in six emerging South Eastern European countries and finds a negative relationship.

Furthermore, Staub et al. (2010) study on the Brazilian banking system in the period 2000 to 2007 show that loan loss provision ratio has a negative and insignificant impact on cost efficiency.

Impact of Macroeconomic Factors on Cost Efficiency

The GDP growth rate has a negative and significant effect on bank cost efficiency. This shows that economic growth reduces the banks' cost efficiency. This finding is consistent with the studies of Fries & Taci (2005) and Chan & Karim (2010) on the Middle Eastern/North African banks, but opposite to the findings of Maudos et al. (2002) on 10 European countries' banks, Grigorian & Manole (2006) on 17 Eastern European countries' banks and Lozano-Vivas & Pasiouras (2010) on 87 countries' banks, where real GDP growth rate is positively related to bank cost efficiency. On the contrary, it is hypothesized that economic growth will positively influence cost efficiency in Ghana's banks. One possible explanation is that during higher economic growth (and therefore increased demand for bank financing) the banks lower their operating standards, such as relax evaluation of borrowers and monitoring of credit (reduce their capital ratio through aggressive lending resulting in higher costs) and thereby become less cost efficient. Thus, higher economic growth leads to greater risk taking (in less competitive banking markets) resulting in reduction in bank efficiency (Soedarmono et al., 2011).

Generally an increase in inflation rate leads to increase in bad debts which reduces bank cost efficiency because the banks incur more costs in managing bad debts indicating a negative relationship between inflation rate and cost efficiency. Contrary to our expectation, the results show that the inflation coefficient is positive but statistically insignificant, implying that inflation has a weak influence on efficiency. In other words, the evidence suggests that high inflation in Ghana does not contribute to bank cost efficiency. The positive relationship revealed in this study indicates that Ghana's banks are able to charge higher rates in a high inflationary environment to compensate for their returns (see Chan & Karim, 2010). This finding supports the study of Kasman &Yildirim (2006) who find no relationship between inflation and cost efficiency.

The cost inefficiency in Ghana's banking industry reflects the higher cost of operation mainly due to inadequate credit monitoring (and hence high non-performing loans) and inefficient control of operating expenses particularly high staff cost and cost of funds. This implies that banks operating in a less competitive banking market such as Ghana are able to charge higher prices and surprisingly, are not under any pressure to control their costs (see Maudos et al, 2002) and therefore become less cost efficient. In general, banks encounter problems of adverse selection and moral hazard caused by asymmetric information between the bank and its customers. Banks can reduce adverse selection by screening and monitoring borrowers to reduce moral hazard behavior (Vennet, 2002) in order to reduce bad debts (non-performing loans) and therefore total costs leading to increase in cost efficiency.

CONCLUSIONS

Ghana banking industry has undergone considerably transformation over the last 20 years. Using 25 banks over the period 2001-2010, this paper examines the cost efficiency of banks in Ghana using the DEA. In addition, fixed effect and two-step system GMM estimators are to investigate the determinants of bank cost efficiency. The findings reveal relatively low average efficiency scores for Ghana's banks during the study period, suggesting that Ghana banks are operating far from the efficiency frontier. This finding is attributed to underutilization or waste of input resources. The cost efficiency scores show variance over time. The findings reveal that bank capitalization has negative and significant effect on bank cost efficiency suggesting that well-capitalized banks are less cost efficient. Similarly, GDP growth rate negatively impacts bank cost efficiency. The findings also show that lagged cost efficiency is an important factor in determining bank cost efficiency in Ghana. The level of bank cost efficiency is low in

Ghana, but it persists from year to year. Loan loss provision ratio, bank size and rate of inflation, however, are not important factors in influencing bank cost efficiency in Ghana.

The findings of this study offer important implications for bank regulation, policy decisions and bank management in Ghana. The results indicate that GDP growth negatively influences bank cost efficiency. This suggests that banks lower their evaluation standards of borrowers or reduce their monitoring of loan performance during the boom period. Therefore, regulators and policymakers should pay attention to risk management and control procedures of Ghana banks (e.g., loan review, collateral appraisal). Bank of Ghana has twice increased the minimum capital requirement in 2003 and 2009, but the findings indicate that bank capitalization reduces cost efficiency. The bank cost efficiency in Ghana persist from year to year which indicates bank management ability and quality (knowledge) and technologies assist the banks to lower costs (see Ataullah & Le, 2006). The persistent cost efficiency should encourage banks to focus on reducing cost efficiency in order to reduce financial and operating costs which would help increase the bank's profits.

The small number of Ghana banks prevents this study from employing more determinant factors such as bank profitability, liquidity, interest rate, market share and bank concentration (measured by the HHI) for both bank efficiency and competition for the dynamic system GMM estimations. This is because increasing the determinant factors will increase the number of instruments in the system GMM estimation which may invalidate the system GMM results. The increase in the number of instruments could become large relative to the number of banks in the regression. This could generate too many instruments (over-fitting endogenous variables) in the system GMM estimations which will weaken the specification tests and bias the results (Roodman, 2007, 2009). Thus, when the instrument count is high, the Hansen test of validity of the instruments weakens (Roodman, 2009). This could mean accepting a model as valid when the problem of endogeneity is partially solved.

Recommendations for Further Research

Profit efficiency essentially captures the efficiencies (or inefficiencies) using both input and output variables, unlike cost efficiency which involves only input variables. Computing profit efficiency, therefore, constitutes a more important source of information for bank management. Therefore, investigating the profit efficiency of Ghana banks in future research would enrich the banking literature. This study only examines Ghana's banking industry and we suggest that future research could use cross-country studies including other African states such as Nigeria, Kenya, Zambia, Tanzania and Uganda which have also undertaken similar financial reforms. Such a study may provide useful information about cross-country comparison of bank efficiency and competition in other countries with banks in Ghana.

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