RESEARCH ARTICLE

Asset-Liability Management and bank profitability: Statistical cost accounting analysis from an emerging market

Freeman Brobbey Owusu[1] | Abdul Latif Alhassan[2]

[1]Department of Accounting and Finance, Sheffield Business School, Sheffield Hallam University, Sheffield, UK

[2]Development Finance Centre (DEFIC), Graduate School of Business, University of Cape Town, Cape Town, South Africa

Correspondence
Freeman B. Owusu, Department of Accounting and Finance, Sheffield Hallam University, Sheffield, UK.
Email: f.b.owusu@shu.ac.uk

Abstract

This paper employs the Statistical Cost Accounting (SCA) model to examine the relationship between profit and Asset-Liability Management (ALM) structure of 27 banks in Ghana over the period 2007–2015. The findings confirm the central hypothesis of the SCA model and provide evidence that profitability is linked to balance sheet items in Ghana. It also documents evidence that domestic banks have higher rate of return on assets than foreign banks over the study period. In addition, high profit banks were observed to have higher rate of return on assets as well as higher rate of cost on liabilities than low profit banks. These findings provide useful insights to bank management through the identification of the assets items that generate highest return on bank profitability.

KEYWORDS

Asset and Liability Management, banking, Profitability, Statistical Cost Accounting

1 | INTRODUCTION

The economic growth of every country is influenced greatly by the activities of banks. Thus, a sound banking system is essential for the economic development of every nation (Ayadi, Arbak, Naceur, & De Groen, 2015; Goodhart, 2004). For most African countries with thin and illiquid stock markets (see Allen, Otchere, & Senbet, 2011), the banking industry remains the main financial intermediary through which funds are transferred from surplus units to deficit units for productive use. Hence, failure of the banking system will generate serious negative externalities for the rest of the economy (Morris & Turner, 1996). Banking crises and failures in developing economies far outweigh those in developed economies (Caprio & Klingebiel, 1996). According to

Morris and Turner (1996), banking problems in the developing economies have dire consequences for the domestic economies and rippling effect on other countries as a result of the integration of financial markets globally.

Through prudent management of assets and liabilities, banks are able to ensure going concern. Poor Asset and Liability Management (ALM) has been identified as one of the root causes of bank failures (Daumont, Le Gall, & Leroux, 2004; Kapur, Hadjimichael, Hilber, & Szymczak, 1991). ALM involves the strategic management of the assets and liabilities of an institution (bank) to optimize profitability, improve liquidity, and to protect it against various bank risks (Brick, 2014). It is an indispensable part of risk management, which is at the very core of financial management of banks. ALM goes

beyond managing individual assets and liabilities but adopts an integrated approach of managing the two sides of the balance sheet of a bank simultaneously (Gup & Brooks, 1993). The core function of banks is to accept deposits (liability) and make loans (assets) (Fama, 1980). They incur costs on their liabilities (deposits) and earn income on their assets (loans). This implies that to maximize banks' profit, efficient ALM is essential (Tektas, Nur Ozkan-Gunay & Gunay, 2005).

While several studies (see Asiri, 2007; Chatterjee & Dutta, 2016; Hester & Zoellner, 1966; Kosmidou, Pasiouras, & Floropoulos, 2004; Kwast & Rose, 1982; Vasiliou, 1996) have examined the ALM from different context in developed economies, empirical evidence from emerging African economies appear parsimonious. This study, therefore, seeks to provide empirical evidence from the Ghanaian context. In order to achieve this objective, the paper applies the Statistical Cost Accounting (SCA) model on annual data of 27 banks from 2007 to 2015 to examine the relationship between components of banks' assets and liabilities on profitability measured as Net Interest Income (NII) and Net Income (NI). In addition, further robustness analysis is undertaken by estimating the model for sub-samples of foreign versus domestic and high-profit versus low-profit banks.

This current empirical investigation is motivated by the recent worrying trends in the Ghanaian banking sector. The sector has come under intense pressure in recent times following the collapse of two domestic banks (UT Bank Ghana Limited and Capital Bank Limited) (PWC, 2019). These two banks were identified by the Central bank as insolvent after Asset Quality Review (AQR) exercise which led to revocation of their licenses under a purchase and assumption agreement which allowed the biggest domestic bank (GCB Bank Limited) to take over the affected banks' selected assets and deposits (BOG, 2017). A year after the revocation of these licenses, five other domestic banks also had their licenses revoked for insolvency, breach of cash reserve requirement and negative capital adequacy ratio (BOG, 2018; PWC, 2019).These banks were combined into one newly created state-run bank called "Consolidated Bank" and the government had to issue USD 1.2 billion in bonds to clear their debt. These happenings in the banking sector have largely been attributed to mismanagement of the assets and liabilities of these banks (BOG, 2018). The susceptibility of the banking industry to such alleged mismanagement makes it worthy to analyse the situation to assess the link between ALM and bank profitability.

This paper makes two major contributions to the literature on bank performance in Ghana (Africa). First, it is the only empirical study to apply the SCA approach to examine the linkages between Asset-Liability (AL) composition and bank profitability in the Ghanaian context, as far as the authors are concerned. Secondly, this study is the first to use Net Interest Income (NII) as a dependent variable to examine the link between ALM composition and bank profitability. This paper is also a response to the call by Hester and Zoellner (1966) for different dependent variables to be used to test the efficiency of the SCA model since the model is very sensitive to the choice of dependent variable.

The remaining part of this paper is organized as follows: Section 2 presents a brief outlook of Ghanaian banking sector while Section 3 reviews the relevant empirical literature on ALM, Statistical Cost Accounting and Bank profitability. Section 4 describes the data and methodology adopted for the purposes of the study whilst Section 5 delineates the concluding remarks and recommendation for further research.

2 | OVERVIEW OF THE GHANAIAN BANKING SECTOR

The banking industry in Ghana over the last decades has seen tremendous reforms and transformations leading to phenomenal growth in the sector. The creation of an enabling environment and enactment of policies and laws by the government and Bank of Ghana have had enormous impact on the sector. The enactment of the banking law (PNDC Law 225) in 1989 set the pace for major reforms in the banking industry to commence in Ghana. Through these reforms, the banking sector witnessed the emergence of a number of domestic banks (Antwi-Asare & Addison, 2000).

The Divestiture of Interests Law of 1993 through Divestiture Program implemented in the early 1990s by the government of Ghana, led to the privatization of some of the state-owned banks which led to financial liberalization (Adei, 2006; Isshaq, Bokpin, & Amoah, 2012). This led to the influx of more local and international banks into Ghana's banking sector (Acheampong, 2013), a phenomenon which is normally associated with deepened competition and efficiency (Beck, Demirgüç-Kunt, & Levine, 2006; Boldrin & Levine, 2009; Demirgüç-Kunt & Levine, 2008). Additionally, to align the banking sector with global standards, a new Banking Act called the Banking Act 2004 Act 673 promulgated which was later amended in 2007 by the Banking Amendment Act, 2007 (Act 738).

In 2016, the Banks and Specialized Deposit-Taking Institutions Act, 2016 (Act 930) and the Ghana Deposit Protection Act 2016 (Act 931) were introduced. The Deposit Protection Act was later amended by the Ghana Deposit Protection (Amendment) Act 2018 (Act 968). All

these reforms were done to enhance monitory and further stabilize and strengthen the banking industry in Ghana (PWC, 2018).

Following the collapse of some local banks within a space of 1 year, the Central bank in its quest to further strengthen and stabilize the banking sector, in 2017, introduced a new policy that led to a temporary freeze on the issuance of license to new banks and other financial institutions. According to the central bank, this was done to tighten supervision and ensure the existing banks are efficient in their operations.

Over the years, the minimum capital requirements has undergone several changes with the most recent change occurring in September 2017. It was increased from GHS 120 million to GHS 400 million and banks were required to meet this new quota by December 2018 (PWC, 2019). The sharp increase in minimum capital requirement brought intense pressure on local banks leading to a number of mergers and acquisitions within the sector.

2.1 | Stylized fact about Ghanaian banks

The Ghanaian Banking Industry has witnessed a significant growth in Assets over the past decade. With total assets of GHS 7.7 billion in 2007, the industry as at 2017 had total assets of GHS 93.6 billion. The growth in assets was funded mainly by deposits which also increased astronomically over the period (BOG, 2017). From Table 1a, the return on equity (ROE) of the banking industry dwindled over the periods with the highest ROE recorded in 2014.The ROE fell steeply from 33.1% in 2014 to 22.2% in 2015 and farther to 17.3% in 2016. It however rose slightly to 18.7% in 2017. Return on asset (ROA), on the other hand was relatively stable over the period. After recording the highest ROA in 2014, ROA declined to 3.6% as at 2017. Net Interest Margin(NIM) declined over the period with the Industry's highest NIM of 13.8% recorded in 2015. The year 2016 saw the NIM falling by 80 basis points to 13% and fallen further to 11% in 2017. The overall profitability of Ghanaian Banking industry has witnessed a downward trend since 2014 with key financial indicators declining. The reduction in profitability has partly been blamed on poor management of assets and liabilities of banks (see Alhassan, Kyereboah-Coleman, & Andoh, 2014; Daumont et al., 2004; Kapur et al., 1991).

Table 1b presents the common size analysis of the balance sheet of Deposit Mobilizing Banks in Ghana from 2012 to 2015. It shows that among the assets, loans and advances form the largest proportion of the banks earning assets with an average of 43%. This is followed by the banks' investment in securities which is predominately government treasury instruments. It is observed that among DMBs, a relatively smaller proportion of their total assets (average of 5.75%) is invested in other assets and fixed assets. Among the liabilities of the banks, a larger proportion (approximately 66%) comes from deposits. This goes to confirm the notion that deposit remains one of the main sources of funding to banks.

2.2 | Review of literature

ALM is defined as a proactive process which involves the management of assets and liabilities simultaneously to ensure proper management of a firm's exposure to various risks (Gup & Brooks, 1993). Empirically, the SCA has been employed to examine the linkages between

TABLE 1a Key profitability indicators of the Ghanaian Banking Sector

Year	Return on equity (ROE)	Return on assets (ROA)	Net interest margin
2008	23.70%	3.20%	10.10%
2009	17.50%	2.80%	10.80%
2010	20.40%	3.80%	12.40%
2011	19.70%	3.90%	10.20%
2012	25.80%	4.90%	10.90%
2013	30.90%	6.20%	12.60%
2014	33.10%	6.60%	13.40%
2015	22.20%	4.60%	13.80%
2016	17.30%	3.80%	13.00%
2017	18.70%	3.60%	11.00%

Note: Source: (Bank of Ghana (2009; 2013; 2015; 2016; 2017; 2007).

TABLE 1b Common size analysis of the balance sheet of DMBs in Ghana

	Industry			
	2012	**2013**	**2014**	**2015**
Cash and bank balances	24%	22%	27%	27%
Investment	28%	30%	23%	23%
Loans and advances	43%	43%	43%	43%
Other assets and PPE	5%	5%	6%	7%
Total assets	**100%**	**100%**	**99%**	**100%**
Deposits	72%	64%	63%	65%
Borrowings and other liabilities	13%	21%	23%	20%
Equity	15%	15%	14%	15%
Total liabilities and equity	**100%**	**100%**	**100%**	**100%**

Note: Source: Authors' calculation from BOG data.

profitability on one hand and balance sheet asset and liability items on the other hand. From the model, differences arising from balance sheet composition drive interbank differences in profitability.

In the existing literature, ALM has received considerable attention from several scholars (Asiri, 2007; Haslem, Scheraga, & Bedingfield, 1999; Hester & Zoellner, 1966; Kosmidou et al., 2004; Kwast & Rose, 1982; Vasiliou, 1996). Some of the early studies include Hester and Zoellner (1966) who used SCA method to study the association between bank portfolio and earnings in United States. The authors reported that ALM has significant relationship on different profit constructs which were operating income, income before taxes and income after taxes. They concluded that the marginal rate of returns became smaller when the independent variables were regressed on net income after taxes because of the tax effect. Kwast and Rose (1982) extended the traditional SCA to account for differences in market structure, regional demand and supply conditions as well as macro-economics factors. Unlike Hester and Zoellner (1966) who used net operating income, net profit before tax and net profit after tax as dependent variables and placed emphasis on net operating income, Kwast and Rose (1982) used total operating income (gross income), net operating income and net income after tax as dependent variables. They found no evidence of differential operating efficiency between high-profit and low-profit banks. Korhonen (1987) used two-stage goal programming model in examining ALM whilst Giokas and Vassiloglou (1991) discussed the goal programming model that considers essential institutional, financial, legal and bank policy .

Vasiliou (1996) using sample from Greece employed SCA method to examine the difference in profitability between high-profit and low-profit banks and found that

assets management rather than liability management plays a role in explaining interbank differences. On the contrary, Kosmidou et al. (2004), using banks from United Kingdom, found that liability management rather contributes more to profitability of banks than asset management. Oğ̆uzsoy and Gu̇ven (1997) developed a stochastic linear model whilst Gu̇ven and Persentili (1997) developed a linear programming model in studying ALM. Haslem et al. (1999) using canonical analysis examined the framework of asset-liability management. Haslem et al. (1999) established that for very large banks, the larger the proportion of foreign loans used, the less profitable the banks become and the smaller proportion of foreign loans used the more profitable they become. Sayeed, Edirisuriya, and Haque (2012) in their study using banks in Bangladesh established that high-profit banks enjoy higher returns on assets and lower returns on their liabilities than low-profit banks. Studies by Tektas et al. (2005) and Das, Lu, Papaioannou, and Petrova (2012) examined the ALM during financial crisis. The summary of the literature is presented in Table 2.1.

The application of the SCA model has been limited to banking markets in the United States, United Kingdom, Indian, Greek, Bangladesh and Italian banks (Chatterjee & Dutta, 2016; Hester & Pierce, 1975; Hester & Zoellner, 1966; Kwast & Rose, 1982; Vasiliou, 1996, Pouw & Kakes, 2013). In the context of banking markets in Africa, empirical evidence appears non-existent. Within the Ghanaian banking context, several studies (Aboagye, Akoena, Antwi-Asare, & Gockel, 2008; Alhassan, Tetteh, & Owusu, 2016; Aryeetey, Hettige, Nissanke, & Steel, 1997; Boadi, Leo Paul Dana, Mertens, & Mensah, 2017) have examined the different aspects of bank profitability. However, the linkage between banks AL composition and profitability has not received much attention as far as the authors are concerned.

TABLE 2.1 Summary of the ALM literature in banking

Authors	Countries	ALM approach	Profitability indicator	Major findings
Hester and Zoellner (1966)	USA	Statistical cost accounting model	Net current operating income, net profit after taxes and net profit before income taxes	The rates of return on assets and cost were found to be sensitive to the different proxies for profitability.
Kwast and Rose (1982)	USA	Expanded statistical cost accounting techniques	Net operating income, gross operating income and net income	Banks with high earnings recorded lower operating cost with reference to some liabilities. However, the opposite is true with reference to asset items selected.
Vasiliou (1996)	Greece	Statistical cost accounting techniques	Income before income taxes as dependent variable.	On the rates of return, the study concludes that high-profit banks recorded higher returns on asset than low-profit banks. On the other hand, lower rates of cost on liabilities was recorded by banks with high earnings than compared to banks with low earnings.
Kosmidou et al. (2004)	UK	Statistical cost accounting method	Operating profit	Lower cost of liabilities was observed across banks with high profit for most sources of funding than compared to banks with low profit. The return on operating profits of domestic banks was observed to be higher for loans and fixed assets while that of foreign owned banks was higher for all assets.
Pouw and Kakes (2013)	28 countries	Statistical cost accounting method	Net income after tax	The highest rates of return were observed for private sector lending and interbank deposits while the highest marginal costs were associated with interbank and customer deposits.
Chatterjee and Dutta (2016)	India	Statistical cost accounting method	Earnings before interest and tax (EBIT)	Low-profit banks generate higher rates of return on loans, investments and fixed assets compared with high-profit banks. In addition, profitability for private banks was generated by loans and placings with other banks while public banks profitability was generated from all assets.

This paper therefore seeks to fill the gap in literature by using the Statistical Cost Accounting (SCA) model to examine the link between AL compositions and profits in the Ghanaian banking sector. This study differs from previous studies in the sense that earlier ones have employed gross operating profit, net operating profit and either Profit before taxes or profit after tax as proxies for profitability. But this study employs two income

measures which are Net Income (NI) and Net Interest Income (NII), a new income measure. The NI which is quite popular and widely used in the ALM literature is referred to as "the broad definition of profit" in this study. It represents a bank's bottom-line profit out of which dividends are paid. It is computed as net operating income plus securities gains (losses) and extraordinary credits (charges) less income taxes. Kwast and Rose (1982) indicated that changes in NI reflect the assumed profit-maximization behaviour of a bank. The second income measure which is NII is referred to as the "narrow definition of profit" for a bank and defined as the difference between interest income and interest expense. Given that, the core mandate of banks is to accept deposits and grant loans and these two activities, by far distinguish banks from other financial institutions, a profit measure which reflects these activities is the NII. NII helps to assess how effective banks have performed at their core mandate. This choice of NII as the second income measure is supported by Saksonova (2014) who indicated that the NII is the most fitting proxy for measuring the effectiveness and stability of banks' core operation because it shows how effectively banks manage their interest bearing assets and liabilities.

3 | DATA AND EMPIRICAL METHODOLOGY

3.1 | Data

The study used a panel data of 27 banks in Ghana consisting of 12 domestic and 15 foreign owned banks for the period of 2007 to 2015. Table 2 documents the growth in the total number of banks in the country as categorized into domestic and foreign banks. The Ghanaian banking industry has been dominated by foreign banks with an average of 54% of the total number of banks being foreign and 46% being domestic. This phenomenon has increased competition in the industry to the advantage of customers but in terms of competition among the banks, the domestic banks are at a disadvantage because the foreign banks come in with advanced banking technology, huge capital base and enjoy some intergroup benefits which domestic banks are not privy to.

The sample selected out of the population is illustrated in Table 2. For most of the study periods, more than 50% of the banks in the country were included in the sample. Availability of data influenced the choice of study periods. In selecting the study sample, banks were included based on them meeting the following conditions. First of all, the bank should be classified as major Deposit Mobilizing Bank (DMB) by the Central Bank of

Ghana. This study included only DMBS to avoid possible comparisons among the different types of deposit accepting institutions (such as rural banks, savings and loans, microfinance institutions etc.). Secondly, the banks should have available financial statements for the study periods. The data on assets, liabilities and income were obtained from the Bankscope Database whilst data on the number of DMBs were obtained from Bank of Ghana.

3.2 | Empirical model

In order to examine the link between ALM and banks' profitability, the SCA model is used as described by Hester and Zoellner (1966) and Kwast and Rose (1982). The SCA model documents the rates of return on earning assets to be positive and varied across different assets with the rates of cost on liabilities being negative and also varied across liabilities (Hester & Pierce, 1975). Hence the SCA model in year t for a bank employed in our study is outlined below;

$$Y_{lt} = \alpha_1 + \sum \alpha_{2i} A_{ilt} + \sum \alpha_{3j} L_{jlt} + e_{lt} \qquad (1)$$

Y represents the **profit** of a bank (dependent variable).

$$A_i \text{ is the } i\text{th asset}, i = 1, 2, \ldots m$$

$$L_j \text{ is the } j\text{th liability}, j = 1, 2, \ldots n$$

$$l \text{ represents the number of banks}, l = 1, 2, \ldots k$$

t is the time period, $t = 1, 2, \ldots, T$.

α_{2i} is the rates of return and shows the variations in the bank's profit by replacing one unit of cash with one unit of the ith asset and is expected to be positive (non-negative).

α_{3j} denotes the rate of cost of liabilities and indicates the changes in the bank's profit by adding one unit of cash and one unit of jth liability and is expected to be negative (non-positive).

α_1 is a constant term indicating the existence of income that is unrelated to banks' portfolio structure.

e_{it} is a stochastic (error) term accounting for stochastic differences among individual banks.

The explanation and definition of the above assets and liabilities parameters are general and subject to change when the dependent variable changes. Specifically, the study uses two income measures which are NII and NI as dependent variables for the purposes of the

TABLE 2 Growth in Deposit Mobilizing Banks (DMBS) in Ghana

	Industry			Sample		
	Domestic	**Foreign**	**Total**	**Domestic**	**Foreign**	**Total**
2007	10	13	23	7	10	17
2008	12	13	25	8	11	19
2009	13	13	26	8	13	21
2010	12	14	26	8	14	22
2011	12	15	27	8	15	23
2012	11	15	26	9	14	23
2013	12	15	27	12	14	26
2014	13	15	28	11	12	23
2015	12	17	29	5	9	14

Note: Source: Authors' estimate from research data.

study. The NII is defined as the difference between total interest income and total interest expense whilst the NI is computed as net operating income plus securities gains (losses) and extraordinary credits (charges) less income taxes. Table 3 presents a brief description of the variables employed in the study.

3.3 | Estimation strategy

Using Equation (1), we estimate the different rates of return for (a) High-profit bank and Low-profit banks; and (b) domestic and foreign banks. Grouping banks according to their ownership status was quite straightforward unlike according to their profitability level. In grouping banks according to the profit level, we initially compute the ROA for the sampled banks, rank them and find the median ROA value. The first group which we call the high-profit banks include banks with ROA higher than the median ROA and the second group which is the low-profit banks have ROA values to be less than the median ROA for all the sample banks. Apart from comparing the coefficients among regressions using different measures of dependent variable, this study also seeks to compare coefficient estimates between the banks with high profit and low profit margins as well as domestic and foreign banks. The comparison of coefficient estimates provides fascinating results into the link between profits and ALM for different bank sets.

In the estimation of the model (1) for full sample and the sub-samples of ownership and profitability levels, the fixed effects (FE) and random effects (RE) techniques were considered. The choice between the FE model and RE model was determined by Hausman specification test while the Breusch-Pagan Cook-Weisberg test was employed to test to for the presence of heteroskedasticity.

All the estimations and analysis were undertaken using STATA13.

4 | EMPIRICAL RESULTS

4.1 | Summary statistics

Table 4.1 presents the summary statistics of the key variables. The table shows the two income measures and the various assets and liabilities included in this study. For the study period, the mean NII for the sample banks is 1,395 with a standard deviation of 6,403. Net interest income ranges from a minimum of 1 to a maximum of 42,090, it can be deduced that the banks were profitable in at least generating profit from their core business of accepting deposits and granting of loans though there are wide variations among net interest income. NI, on the other hand, has mean value of 264 and a standard deviation of 1,321.In terms of NI, some of the sample banks recorded losses with minimum value of 5,255. Net income is also widely dispersed around the mean. We also report the descriptive statistics of the banks' assets and liabilities. In terms of the balance sheet items, loans to customers (A1) has the highest mean value of 6,404 considering all the assets whilst demand deposit (L1) has the highest mean value of 7,197 among all the liabilities. This goes to confirm the fact that deposit mobilization and granting of loans remain the main roles of banks in Ghana.

4.2 | Regression results: ALM And profitability

Table 4.2 reports the regression results on the relationship between AL compositions and bank profitability

TABLE 3 Variables

Variables	Description	Expected signs
Profitability		
NII	Net interest income	
NI	Net income	
Assets		
A1	Loans to customers	Positive (+)
A2	Loans and advances to banks	Positive (+)
A3	Cash and equivalents	Positive (+)
A4	Total securities	Positive (+)
A5	Fixed assets	Positive (+)
A6	Other assets	Positive (+)
Liabilities		
L1	Demand deposit/current a/c	Negative (−)
L2	Savings deposits	Negative (−)
L3	Fixed deposits (terms)	Negative (−)
L4	Deposit from banks	Negative (−)
L5	Other short-term fund	Negative (−)
L6	Total long-term funding	Negative (−)
L7	Other liabilities	Negative (−)

proxied by net interest income (NII) and net income (NI) for the whole sample. The diagnostics of results show that AL composition significantly explains bank profitability at 1% and they account for 99.91% of variations in NII and NI. Most importantly the significance of the *F*-test at 5% indicates that the null hypothesis of no relationship between AL variables and bank profitability (NII and NI) is rejected to support the SCA method. Using the Hausman (1978) specification test, the null hypothesis of random effects was rejected at 1%, hence the fixed effects technique becomes the most efficient estimator of the regression model. Before proceeding with the FEM estimation, using the Breusch-Pagan Cook-Weisberg test, we test for the presence of heteroscedasticity. The test results also presented in Table 4.2 indicates that the null hypothesis of homoskedasticity cannot be rejected.

From Table 4.2, it is observed that twelve out of the thirteen coefficients in the NII model are statistically significant whilst ten out of the thirteen coefficients are significant in the NI model. The signs of estimated coefficients of the AL variables are generally consistent with the expectations as outlined in Table 3. In the NI model, all the rates of return on assets (A1 to A6) were positive and significant whilst six rates of cost on liabilities negative and significant as expected. For the net income, there seems to be a slight difference in the sense that, five out of six rates of return on assets are positive and significant whereas five of seven rates of cost on

liabilities are negative and significant. Notably, the coefficients for assets were observed to be higher in the NII model compared to the NI model and this suggests that higher returns are generated on the bank assets for their core intermediation activities compared with the return on the comprehensive income.

The coefficient of fixed asset (A5) has the highest rate of return on NII while cash and cash equivalents (A3) generated the highest return on NI. With respect to the liability side, saving deposit (L2) and Fixed deposits (L3) were observed to generate the lowest marginal rate of cost among the significant variables in the NII and NI models respectively. This confirms the notion that deposit remains one of the cheapest sources of funding to a bank. This result is consistent with the findings of Berlin and Mester (1999).

Comparing the coefficients in the NII model to the NI model, it can be observed that the rates of return are relatively higher in the NII regression. This result is similar to that of Hester and Zoellner (1966) who identified that the coefficients in the net profit after tax regression were lower than the coefficients from the other income measures. This is understandable in the sense that, unlike NII which is arrived at by only deducting interest expense NI is derived by deducting all expenses from total revenue of the banks. And as reported in Table 4.1, the mean value for NII is higher than that of NI. The intercepts of both regressions are negative and insignificant. As expounded earlier, the coefficients are approximate estimates of rates of return or costs realized by banks for holding unto various assets and liabilities including interest expenses for net interest income and including all expenses for net income.

4.3 | Robustness analysis

4.3.1 | Profitability and ALM: Bank ownership

Table 4.3 reports the regression results when we split the banks' observations according to ownership status, thus domestic banks and foreign banks. Consistent with the full sample estimations in Table 4.2, the model diagnostics confirms the appropriateness of the fixed effects without heteroskedastic errors across both the foreign-owned and the domestic owned-bank sample. In both sub-samples, approximately 99% of the variations in profitability are explained by the AL composition.

In the NII model, the SCA methodology is strongly supported by results from both domestic and foreign banks. Twelve out of thirteen coefficients are statistically significant. We find that rates of return on assets are

TABLE 4.1 Summary statistics

Variables	Mean	Median	*SD*	Min	Max	Count
NII	1,395	62	6,403	1	42,090	188
NI	264	17	1,321	−5,255	9,301	188
A1	6,404	411	34,596	0	290,993	188
A2	3,183	73	16,736	0	126,692	188
A3	1,096	91	4,897	0	42,177	188
A4	5,127	175	26,872	0	261,997	188
A5	798	19	4,728	0	55,554	188
A6	1,123	25	6,051	−11	53,729	188
L1	7,197	324	38,177	0	331,700	188
L2	443	54	1914	0	16,332	188
L3	2,383	124	15,759	0	177,876	188
L4	764	16	5,968	0	70,049	188
L5	2,403	0	19,866	0	241,773	188
L6	296	5	2,251	0	24,063	188
L7	494	32	3,059	0	38,160	188

Note: NII, net interest income; NI, net income; A1, Loans to customers; A2, Loans and advances to banks; A3, cash and equivalents; A4, total securities; A5, fixed assets; A6, other assets; L1, demand deposit/current a/c; L2, savings deposits; L3, fixed deposits (terms); L4, deposit from banks; L5, other short term fund; L6, total long term funding; L7, other liabilities. Figures are in millions of GH.

significant and positive for both domestic and foreign samples, except for fixed assets in the domestic sample which is not significant. For liabilities, all the rates of cost are negative and significant as expected. This finding that profit of foreign banks was generated by all assets is consistent with that of Kosmidou et al. (2004).

For all the assets with significant coefficients, the estimated coefficients were observed to be higher for domestic banks compared with foreign banks. This suggests that rates of return of domestic banks are higher than those of foreign banks. The only exception is fixed assets (A5), where foreign banks generated significantly higher coefficient compared to domestic banks (NII model). This finding contradicts evidence from the UK banking system where Kosmidou et al. (2004) found evidence of higher rates of return on assets for foreign banks compared to domestic banks. Among domestic banks, the coefficients indicate that they generate higher rate of returns from Cash and equivalents (A3) and other assets (A6) in both NII and NI Models. With respect to foreign banks, they generate the highest rate of return on NII from fixed assets (A5) while the highest rate of return on NI is generated from other assets (A6). The lowest rate of return generated on NII and NI is Loans to customers (A1) for domestic banks. For foreign banks, Cash and equivalents (A3) generate the lowest rate of return for NII while loans and advances to banks (A2) generate the lowest return on NI.

These findings reveal some interesting happenings in the Ghanaian banking sector. Domestic banks earn more returns on their cash and equivalents, which implies having enough cash at hand, local banks are able to lend them out on the interbank market to cash in returns at relatively low risk. They also gain reasonable returns from holding government securities such as treasury bills. But foreign banks earn high returns on fixed assets and other assets. Surprisingly, loans to customers happen to earn domestic banks the lowest returns, which explain why most domestic banks, in recent times, hesitate in granting consumer loans.

On the liabilities side, the coefficients of rates of cost are generally observed to be lower for foreign banks compared to domestic banks with few exceptions. This indicates that foreign banks have lower cost of funding compared to domestic banks. Specifically, domestic banks experience the lowest rate of cost on savings deposit (L2) for both NII and NI models whilst demand deposit (L1) has the lowest rate of cost among foreign banks' liabilities on NII and savings deposit (L2) on NI model. The highest costs of funding for both domestic banks are from deposits from banks (L4) for NII and demand deposit (L1) for NI. The highest cost of funding for foreign banks was other short funds (L5) for both NII and NI. The findings imply that, for domestic banks in Ghana, their cheapest source of funding comes from saving deposit whilst that of foreign banks is from both demand deposit

TABLE 4.2 Profitability and ALM

Dependent variables	Net interest income Coef.	Net income Coef.
Constant	−120.827 (100.287)	−81.117 (89.260)
A1	0.179*** (0.031)	0.096*** (0.028)
A2	0.293*** (0.038)	0.143*** (0.034)
A3	0.315*** (0.045)	0.208*** (0.040)
A4	0.261*** (0.029)	0.070*** (0.026)
A5	0.436*** (0.093)	−0.140* (0.083)
A6	0.186*** (0.048)	0.170*** (0.042)
L1	−0.193*** (0.040)	−0.114*** (0.036)
L2	−0.092** (0.043)	0.057 (0.038)
L3	−0.194*** (0.038)	−0.077** (0.034)
L4	−0.145*** (0.033)	−0.024 (0.029)
L5	−0.316*** (0.027)	−0.149*** (0.024)
L6	−0.158** (0.061)	−0.124** (0.054)
L7	0.021 (0.091)	0.003 (0.081)
$F_{(13,148)}$	12,905.58	13,238.51
Prob > F	0.000	0.000
R-squared	0.9991	0.9991
Robust Hausman χ^2	2,857.996	300.196
Prob > χ^2	0.000	0.000
BP-CW Hettest χ^2	1.91	0.97
Prob > χ^2	0.1671	0.3235
Banks	27	27
Observations	188	188

Note: A1, loans to customers; A2, loans and advances to banks; A3, cash and equivalents; A4, total securities; A5, fixed assets; A6, other assets; L1, demand deposit/current a/c; L2, savings deposits; L3, fixed deposits (terms); L4, deposit from banks; L5, other short term fund; L6, total long term funding; L7, other liabilities: BP-C, Breusch-Pagan Cook-Weisberg test of heteroskedasticity. *SEs* in parentheses; ***, ** and * denotes significance at 1, 5 and 10% respectively.

and savings deposit. A better mobilization of funds from these two sources can help banks reduce drastically their cost of funding and subsequently increase their profitability.

4.3.2 | Profitability and ALM: Low versus high profitable banks

Table 4.4 shows results obtained from the regression model when we divide the total of banks' observations into groups using profitability levels, thus banks with high profit margins and banks with low profit margins. Consistent with the full sample estimations in Table 4.2, the model diagnostics confirm the appropriateness of the fixed effects without heteroskedastic errors across both High-profit banks and Low-profit banks. In Low-profit banks, approximately 99% of the variations in profitability are explained by the AL composition whilst approximately 96% of the variations are explained for High-profit banks.

In the NII model, the results for High-profit banks and Low-profit banks strongly support the Statistical Cost Accounting method. For both High-profit and Low-profit banks, all the rates of return on assets are positive and statistically significant except for fixed assets for Low-profit banks which are not significant. Comparatively, High-profit banks generate higher rates of returns on all assets compared to Low-profit banks, except loans and advances to banks (A2), which generated significant higher rate of return for Low-profit banks. This suggests that consistent with findings Vasiliou (1996), return on asset is higher for banks with high profit levels than for banks with low profit levels. While this is inconsistent with the findings of Kwast and Rose (1982) and Kosmidou et al. (2004), the observations are consistent with evidence by Chatterjee and Dutta (2016) in the Indian banking sector. Loans to customer (A1) are the highest earning assets for Low-profit banks whilst other assets (A6) earn the highest rate of returns for High-profit banks. Cash & equivalents (A3) and loans & advances to banks (A2) have the lowest rate of return among assets for Low profit and High-profit banks respectively.

With respect to the liabilities of the two classes of banks, negative (rates of cost) and significant coefficients are observed except for Savings deposit (L2) and other liabilities (L7) for Low profit banks which were not significant. Specifically, demand deposit (L1) has the lowest rate of cost for Low-profit banks whilst long term liabilities (L6) have the lowest cost for High-profit banks. Highest rate of cost on liabilities are recorded on other short-term funds (L5) for Low-profit banks and deposits from banks (L4) for High-profit banks. Comparing the rates of cost on liabilities between the two banks, it can be observed that, High-profit banks experienced higher

TABLE 4.3 Profitability and ALM: bank ownership

	Net interest income		Net income	
	Domestic Coef.	Foreign Coef.	Domestic Coef.	Foreign Coef.
Constant	378.721 (271.677)	−494.688*** (77.014)	−244.656 (231.687)	−212.648*** (78.035)
A1	0.387*** (0.067)	0.275*** (0.051)	0.267*** (0.057)	0.256*** (0.052)
A2	0.400*** (0.071)	0.290*** (0.045)	0.276*** (0.060)	0.207*** (0.045)
A3	0.633*** (0.109)	0.246*** (0.045)	0.404*** (0.093)	0.211*** (0.045)
A4	0.404*** (0.071)	0.304*** (0.047)	0.269*** (0.061)	0.215*** (0.048)
A5	0.238 (0.171)	0.709*** (0.152)	−0.189 (0.145)	−0.066 (0.154)
A6	0.491*** (0.121)	0.354*** (0.069)	0.670*** (0.103)	0.337*** (0.069)
L1	−0.442*** (0.093)	−0.235*** (0.053)	−0.416*** (0.079)	−0.236*** (0.054)
L2	−0.247*** (0.089)	−0.258*** (0.064)	−0.142* (0.076)	−0.114* (0.064)
L3	−0.332*** (0.072)	−0.254*** (0.057)	−0.189*** (0.061)	−0.235*** (0.058)
L4	−0.535*** (0.110)	−0.254*** (0.055)	−0.275*** (0.093)	−0.201*** (0.055)
L5	−0.394*** (0.069)	−0.309*** (0.063)	−0.189*** (0.059)	−0.279*** (0.064)
L6	−0.432*** (0.111)	−0.261*** (0.061)	−0.315*** (0.094)	−0.211*** (0.062)
L7	−0.387** (0.148)	−0.064 (0.131)	−0.404*** (0.126)	−0.210 (0.132)
$F_{(13,51)}$	9,868.59	6,831.75	13,590.2	750.72
Prob > F	0.0000	0.000	0.000	0.000
R-squared	0.9996	0.9991	0.9997	0.9915
Robust Hausman χ^2	50.94	34.80	24.71	61.46
Prob > χ^2	0.0000	0.0009	0.0252	0.0000
BP-CW Hettest χ^2	2.78	0.48	1.31	0.68
Prob > χ^2	0.0957	0.4896	0.2529	0.4108
Banks	12	15	12	15
Observations	76	112	76	112

Note: A1, loans to customers; A2, loans and advances to banks; A3, cash and equivalents; A4, total securities; A5, fixed assets; A6, other assets; L1, demand deposit/current a/c; L2, savings deposits; L3, fixed deposits (terms); L4, deposit from banks; L5, other short term fund; L6, total long term funding; L7, other liabilities: BP-C, Breusch-Pagan Cook-Weisberg test of heteroskedasticity; *SEs* in parentheses. D-F, differences between coeffects of domestic and foreign banks; ***, ** and * denotes significance at 1, 5 and 10% respectively.

cost on demand deposit (L1), Savings deposit (L2), deposits from banks (L4) and other liabilities (L7) compared to Low-profit banks. On the contrary, Lower-profit banks are observed to experience higher cost on fixed deposits (L3), other short-term funds (L5) and long-term liabilities (L6). While similar results were reported by

TABLE 4.4 Profitability and ALM: low versus high profitable banks

	Net interest income		Net income	
	Low profit Coef.	**High profit Coef.**	**Low profit Coef.**	**High profit Coef.**
Constant	−220.968	−241.803**	588.638	−268.283***
	(507.036)	(117.942)	(388.998)	(60.639)
A1	0.372***	0.407***	0.061	0.218***
	(0.105)	(0.062)	(0.081)	(0.032)
A2	0.497***	0.313***	0.039	0.218***
	(0.130)	(0.064)	(0.100)	(0.033)
A3	0.337**	0.365***	−0.085	0.281***
	(0.166)	(0.068)	(0.128)	(0.035)
A4	0.375***	0.448***	0.048	0.222***
	(0.113)	(0.062)	(0.087)	(0.032)
A5	0.019	0.520**	−0.596***	−0.112
	(0.203)	(0.223)	(0.156)	(0.114)
A6	0.369*	0.566***	0.047	0.334***
	(0.206)	(0.091)	(0.158)	(0.047)
L1	−0.324**	−0.361***	−0.029	−0.221***
	(0.141)	(0.069)	(0.108)	(0.036)
L2	−0.198	−0.381***	0.001	−0.208***
	(0.126)	(0.086)	(0.097)	(0.044)
L3	−0.368***	−0.363***	0.024	−0.229***
	(0.115)	(0.076)	(0.088)	(0.039)
L4	−0.371***	−0.452***	−0.075	−0.212***
	(0.131)	(0.071)	(0.100)	(0.036)
L5	−0.510***	−0.442***	−0.131	−0.165***
	(0.106)	(0.072)	(0.082)	(0.037)
L6	−0.416***	−0.182**	−0.106	−0.196***
	(0.117)	(0.086)	(0.090)	(0.044)
L7	−0.043	−0.309*	0.268	−0.060
	(0.220)	(0.161)	(0.169)	(0.083)
$F(13,56)$	7,317.67	126.81	2028.21	121.93
Prob > F	0.000	0.000	0.0000	0.000
R-squared	0.9994	0.9666	0.9979	0.9653
Robust Hausman χ^2	25.58	11.01	-	46.793
Prob > χ^2	0.0194	0.6096	-	0.000
BP-CW Hettest χ^2	2.36	1.01	1.27	0.90
Prob > χ^2	0.1246	0.3144	0.2599	0.3439
Banks	25	24	25	24
Observations	94	94	94	94

Note: A1, loans to customers; A2, loans and advances to banks; A3, cash and equivalents; A4, total securities; A5, fixed assets; A6, other assets; L1, demand deposit /current a/c; L2, savings deposits; L3, fixed deposits (Terms); L4, deposit from banks; L5, other short term fund; L6, total long term funding; L7, other liabilities: BP-C, Breusch-Pagan Cook-Weisberg test of heteroskedasticity; *SEs* in parentheses. H-L, differences between coeffects of High profit and Low profit banks. ***, ** and * denotes significance at 1, 5 and 10% respectively.

Chatterjee and Dutta (2016), this finding contradicts Vasiliou (1996) and Kosmidou et al. (2004) who reported lower cost of funding for high-profit banks.

Table 4.4 also presents the results of the regression with net income (NI) as the dependent variable under Low-profit banks and High-profit banks. Contrary to the

NII model results, all the coefficients of the asset compositions for Low-profit banks are insignificant except for fixed assets (A5) which has a negative sign and is significant at 1%. All the assets of High-profit banks have positive coefficients and are significant except for fixed asset (A5) which is negative and insignificant. Among the assets of the high profit banks, other assets (A6) have the highest rate of return whilst loans to customers and loans and advance to banks have the lowest rates of return. None of the coefficients of the liabilities for Low-profit banks is significant but for the High-profit banks, all the coefficients are negative and significant with the exception of other liabilities (L7). In terms of cost of funding, other liabilities (L5) had the lowest cost and fixed deposits (L3) have the highest cost for high profit banks.

5 | CONCLUSION

In this study, we employed Statistical Cost Accounting model to investigate the link between asset-liability compositions and profitability of banks in Ghana from 2007 to 2015. Using six categories of assets and seven categories of bank liabilities, the paper tested the effect of ALM on bank profitability measures by net interest income and net income. It further examined the differences in ALM-profitability relationship across different categories according to ownership status (Domestic and Foreign banks) and profit levels (High-profit banks and Low-profit banks).

Overall, the central hypothesis of the statistical cost accounting model is confirmed by this paper since we found most of the estimated rates of return on assets (liabilities) to be positive (negative) and vary across assets (liabilities). There is also evidence that profitability is linked to balance sheet items since most of the asset and liability compositions were statistically significant when regressed on the two income measures. This implies that proper asset-liability management has direct impact on the overall performance of banks. In examining the difference between domestic banks and foreign banks, this study found that domestic banks have higher rate of return on assets than foreign banks over the study period. The domestic banks equally recorded higher rate of cost on liabilities than foreign banks. Cash and equivalent and other assets are among the high earning assets of domestic banks whilst fixed assets and other assets are the high earning assets for foreign banks. Saving deposits are the cheapest source of funding for domestic banks whilst demand deposits are for foreign banks.

With respect to bank profit levels, this paper concludes that High-profit banks generate higher rate of return on assets compared to Low-profit. Demand deposits are the cheapest cost of funding for Low-profit banks whilst long term liabilities and other short tern funds are the cheapest for High-profit banks.

The findings have the following implications for bank management and regulators in Ghana and other emerging markets. First, for bank manager, this study informs them different assets and liabilities contribute differently to profitability of their banks and for that matter there is need to identify assets with higher returns and liabilities with lower cost in order to increase their profitability. Efficient management of these assets and liabilities will help banks to maximize profit and create value for shareholders. And for policymakers, the study has revealed that the rate of return on loans to customers are very low which implies if banks decide to cut down their lending to household and business, this will affect credit creation in the economy which can stifle economy growth. There is, therefore, the need for policies to stimulate credit to the private sector and also to boost returns from these loan assets. In addition, the study highlights that policies on ALM can have dire consequence on profitability of banks in the country so thorough review of policies should be made before they are rolled out.

For future studies, we recommend the inclusion of other variables as in the case of Kwast and Rose (1982) and since this study was limited to only major Deposit Mobilizing Banks (DBMs), future studies can consider the other banks and deposit accepting institutions (like rural bank, saving and loans and microfinance institutions) which were excluded from this study.

DATA AVAILABILITY STATEMENT
Data available on request from the authors: The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID
Freeman Brobbey Owusu https://orcid.org/0000-0002-6633-4922

REFERENCES
Aboagye, A. Q. Q., Akoena, S. K., Antwi-Asare, T. O., & Gockel, F. A. (2008). Explaining interest rate spreads in Ghana. *African Development Review*, *20*(3), 378–399.

Acheampong, N. K. (2013). The effects of foreign Bank entry on financial performance of domestic-owned banks in Ghana (2013). *The International Journal of Business and Finance*

Research, 7(3), 93–104 Retrieved from SRN https://ssrn.com/abstract=2149814

Adei, S. (2006). Governance, state-ownership and divestiture: The Ghanaian experience. *African Journal of Public Administration and Administration*, 17(2), 11–28.

Alhassan, A. L., Kyereboah-Coleman, A., & Andoh, C. (2014). Asset quality in a crisis period: An empirical examination of Ghanaian banks. *Review of Development Finance*, 4(1), 50–62.

Alhassan, A. L., Tetteh, M. L., & Owusu, F. B. (2016). Market power, efficiency and bank profitability: Evidence from Ghana. *Economic Change and Restructuring*, 49(1), 71–93.

Allen, F., Otchere, I., & Senbet, L. W. (2011). African financial systems: A review. *Review of Development Finance*, 1(2011), 79–113.

Antwi-Asare, T. O., & Addison, E. K. Y. (2000). *Financial Sector Reforms and bank Performance in Ghana*. London, England: Overseas Development Institute.

Aryeetey, E., Hettige, H., Nissanke, M., & Steel, W. (1997). Financial markets fragmentation and reforms in Ghana, Malawi, Nigeria and Tanzania. *World Bank Economic Review*, 11(2), 95–218. https://doi.org/10.1093/wber/11.2.195

Asiri, B. K. (2007). Assets-liabilities management in bank - a case of Kuwait. *Indian Journal of Economics and Business*, 6(1), 103–115.

Ayadi, R., Arbak, E., Naceur, S. B., & De Groen, W. P. (2015). Financial Development, Bank Efficiency, and Economic Growth across the Mediterranean. In Ayadi, R., Dabrowski, M., & De Wulf, L. (eds), Economic and Social Development of the Southern and Eastern Mediterranean Countries (pp. 219–233). Cham: Springer.

Bank of Ghana (2009). Annual report. Retrieved from https://www.bog.gov.gh/wp-content/uploads/2019/07/AnnRep-2009.pdf

Bank of Ghana (2012). Annual report. Retrieved from https://www.bog.gov.gh/wp-content/uploads/2019/07/AnnRep-2012.pdf

Bank of Ghana (2013). Annual report. Retrieved from https://www.bog.gov.gh/wp-content/uploads/2019/07/AnnRep-2013.pdf

Bank of Ghana (2015). Annual report. Retrieved from https://www.bog.gov.gh/wp-content/uploads/2019/07/AnnRep-2015.pdf

Bank of Ghana (2016). Annual report. Retrieved from https://www.bog.gov.gh/wp-content/uploads/2019/07/AnnRep-2016.pdf

Bank of Ghana (2017). Annual report. Retrieved from https://www.bog.gov.gh/wp-content/uploads/2019/07/AnnRep-2017.pdf

Bank of Ghana (2017). *Press release: GCB bank takes over UT bank and Capital bank*. Retrieved from http://www.annualreportsghana.com/Home/Documents/GSE-Filings/2017/BOG_FAQ.aspx.

Bank of Ghana (2018). *Press release: Government establishes new indigenous bank*. Retrieved from https://www.bog.gov.gh/wp-content/uploads/2019/07/PRESS-RELEASE-Grand-Final-August-2018.pdf.

Beck, T., Demirgüç-Kunt, A., & Levine, R. (2006). Bank concentration, competition, and crises: First results. *Journal of Banking & Finance*, 30(5), 1581–1603.

Berlin, M., & Mester, L. J. (1999). Deposits and relationship lending. *The Review of Financial Studies, Fall*, 12(3), 579–607.

Boadi, I., Leo Paul Dana, L. P., Mertens, G., & Mensah, L. (2017). SMEs' financing and banks' profitability: A "good date" for banks in Ghana. *Journal of African Business*, 18(2), 257–277.

Boldrin, M., & Levine, D. K. (2009). Market size and intellectual property protection. *International Economic Review*, 50(3), 855–881.

Brick, J. R. (2014). *Asset-liability management: Theory, practice, implementation, and the role of judgment*, EE.UU, Madison, WI: . Filene Research Institute.

Caprio, G. J., & Klingebiel, D. (1996). *Bank insolvencies: Cross-country experience. Policy research working paper, no. 1620*. Washington, DC: World Bank.

Chatterjee, C., & Dutta, P. (2016). Exploring the linkage between profits and asset–liability management. *Paradigm*, 20(2), 131–142. https://doi.org/10.1177/0971890716670707

Das, U.S., Lu, Y, Papaioannou, M.G., & Petrova, I. (2012). *Sovereign risk and asset and liability management – Conceptual issues. IMF Working Paper No. WP/12/241* .Washington, D.C.: IMF.

Daumont, R., Le Gall, F., & Leroux, F., (2004). Banking in Sub-Saharan Africa: What Went Wrong? IMF working paper, 04/55. Retrieved from www.imf.org/external/pubs/ft/wp/2004/wp0455.pdf.

Demirgüç-Kunt, A., & Levine, R. (2008). *Finance, financial sector policies, and long-run growth. (World Bank Policy Research Paper 4469)*. Washington, DC: World Bank Retrieved September 23, 2011, from http://papers.ssrn.com/

Fama, E. F. (1980). Banking in the theory of finance. *Journal of Monetary Economics*, 6, 39–57.

Giokas, D., & Vassiloglou, M. (1991). A goal programming model for bank assets and liabilities management. *European Journal of Operational Research*, 50(1), 48–60.

Goodhart, C. (Ed.). (2004). *Financial development and economic growth: Explaining the links*, London: . Palgrave Macmillan.

Gu¨ven, S., & Persentili, E. (1997). A linear programming model for bank balance-sheet management. *Omega*, 25(4), 449–459.

Gup, B. E., & Brooks, R. (1993). *Interest rate risk management*. Burr Ridge, IL: Irwin Professional Publishing.

Haslem, J. A., Scheraga, C. A., & Bedingfield, J. P. (1999). DEA efficiency profiles of U.S. banks operating internationally. *International Review of Economics & Finance*, 8(2), 165–182.

Hausman, J. A. (1978). Specification tests in econometrics. *Econometrica: Journal of the Econometric Society*, 1251–1271.

Hester, D. D., & Pierce, J. L. (1975). *Bank management and portfolio behavior*. New Haven, CT: Yale University Press.

Hester, D. D., & Zoellner, J. F. (1966). The relation between bank portfolios and earnings: An econometric analysis. *Review of Economics and Statistics*, 48, 372–386.

Isshaq, Z., Bokpin, G. A., & Amoah, B. (2012). K. Menyah & J. Abor Efficiency and Risk-Taking Behaviour of Ghanaian Banks. *Finance and Development in Africa (Research in Accounting in Emerging Economies, Vol. 12 Part B)* (pp. 53–74). Bingley: Emerald Group Publishing Limited.

Kapur, I., Hadjimichael, M. T., Hilber, P., & Szymczak, P. (1991). *Ghana: Adjustment and growth, 1983–1991. IMF occasional paper, no 86*. Washington, DC.International Monetary Fund.

Korhonen, A. (1987). A dynamic bank portfolio planning model with multiple scenarios, multiple goals and changing priorities. *European Journal of Operational Research*, 30, 13–23.

Kosmidou, K., Pasiouras, F., & Floropoulos, J. (2004). Linking profits to asset liability management of domestic and foreign banks in the UK. *Applied Financial Economics*, 14(18), 1319–1324.

Kwast, M. L., & Rose, J. T. (1982). Pricing, operating, efficiency, and profitability among large commercial banks. *Journal of Banking and Finance*, *6*, 233–254.

Morris, G., & Turner, P. (1996). *Banking crises in emerging economies: Origins and policy options. BIS Economic Paper. No. 46.* Basel, Switzerland: Bank for International Settlements.

Og̃uzsoy, C. B., & Gũven, S. (1997). Bank asset-liability management under uncertainty. *European Journal of Operational Research*, *102*, 575–600.

Pouw, L., & Kakes, J. (2013). What drives bank earnings? Evidence for 28 banking sectors. *Applied Economics Letters*, *20*(11), 1062–1066.

PwC (2018). *2018 Ghana Banking Survey*, Accra: PWC.. Retrieved from https://www.pwc.com/gh/en/assets/pdf/2018-gh-banking-survey.pdf

PwC (2019). 2019 Ghana Banking Survey. Banking reforms so far: Topmost issues on the minds of bank CEOs. Accra: PWC. Retrieved from https://www.pwc.com/gh/en/assets/pdf/ghana-banking-survey-2019.pdf

Saksonova, S. (2014). The role of net interest margin in improving banks' asset structure and assessing the stability and efficiency of their operations. *Procedia – Social and Behavioral Sciences*, *150*, 132–141.

Sayeed, M. A., Edirisuriya, P., & Haque, M. (2012). Bank profitability: The case of Bangladesh. *International Review of Business Research Papers*, *8*(4), 157–176.

Tektas, A., Nur Ozkan-Gunay, E., & Gunay, G. (2005). Asset and liability management in financial crisis. *The Journal of Risk Finance*, *6*(2), 135–149.

Vasiliou, D. (1996). Linking profits to Greek bank production management. *International Journal of Production Economics*, *43*, 67–73.