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The determinants of scale economies in the Ghanaian banking industry

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Abstract: The study analyses the presence and determinants of economies of scale in Ghana's Banking sector, using 366 unbalanced annual panel data observations from 29 banks in Ghana from 2007 to 2023. A stochastic cost function was used to estimate scale economies, while the determinants of scale economies were estimated using panel regression. The study found that scale economies and technological progress are widespread across various banking groups, with an average scale elasticity of 1.15, indicating that a 100% increase in output quantities results in an average rise in total cost of only 85%, and that Ghanaian banks, on average, recorded a cost reduction of about 3.3% over the sample period due to technological progress. The results also show that factors such as net interest margin and technological progress have a positive influence on scale economies. In contrast, investment banking activities have a negative impact, while capitalisation has a non-linear inverted U-shape relationship with scale economies. The study concludes that the consolidation that occurred in Ghana's banking sector may have led to stronger banks that allow them to enjoy larger economies of scale. Nevertheless, the non-linear relationship between capitalisation and scale economies suggests that policymakers must be mindful that excessive capitalisation may eventually lower scale economies. Policymakers should also pursue policies that will encourage and facilitate the adoption of new banking technologies to improve business processes and the delivery of banking services.

Keywords: economies of scale, determinants, technological progress, banks, Ghana

JEL Classification: C33, C36, E58, G21, G28

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1. Introduction

The Ghanaian banking industry has witnessed some solvency and liquidity challenges in recent years, resulting in some actions by the Bank of Ghana (BOG), especially in 2017/2018, to ensure the safety of depositors' funds and to stabilise the sector generally. Among these actions were the increase in the minimum capital requirement and the withdrawal of the licenses of 9 banks. The actions of the BOG also led to the consolidation of the industry through some mergers and acquisitions, which have heightened the policy debate on bank size, risk, bank performance, and scale economies (Bank of Ghana, 2020; Ayagre et al., 2024).

A merger refers to the combination of two or more banks, while an acquisition refers to the takeover of one or more banks by one stronger bank. Recent mergers and acquisitions in Ghana, include the merger of seven banks to create Consolidated Bank Limited in 2018, the merger of First Atlantic bank with Energy Bank, the merger of Omni Bank and Sahel Sahara Bank to form OmniBSIC Bank, and the merger between First National Bank Ghana and GHL Bank, while two banks were taken over by GCB Bank earlier in 2017, reducing the number of banks from 34 to 23 by the end of 2018. It is argued that the banking industry, which typically has high fixed costs, can potentially

reduce costs through the exploitation of scale and scope economies, mainly by consolidation (Das & Das, 2007). The industry has also witnessed rapid technological changes in the past decade, especially in the form of digital banking systems such as mobile and internet banking, which have altered bank business models and widened bank product and service offerings to customers.

Ghana's banking landscape has undergone significant changes since the introduction of financial sector reforms in the late 1980s. The pre-reform period was marked by severe distress in the banking sector, illiquidity and insolvency, interest rate controls, and credit rationing. The reforms resulted in a more market-based regime characterised by increased competition among banks(Acquah, 2006). Before the 1990s, Ghana's banking sector was largely driven by the deliberate effort of the government, especially in the establishment of banks, where capital was provided directly by the central government or public institutions such as the Bank of Ghana (BOG), the Social Security and National Insurance Trust (SSNIT), and the State Insurance Company (SIC). In the late 1980s, Ghana began the implementation of financial sector reforms as part of the then Economic Recovery Programme (ERP). This led to the introduction of capital adequacy requirements by Legislative Instrument (LI 1329) in 1988 and the eventual replacement of the Banking Act (1970) with the Banking Law (1989) (Antwi-Asare & Addison, 2000) A key component of the reforms was the Financial Sector Adjustment Programme (FINSAP), which was launched in 1989 to, among other objectives, restructure distressed banks, reform the prudential regulatory and supervisory system, allow the entry of new public and private financial institutions, and develop both the money and capital markets of Ghana.

Ghanaian banks have responded by improving and expanding their product offerings, such as zero-balance savings accounts, bill payments, debit and credit cards, telephone, and internet banking (Isshaq & Bokpin, 2012). The financial sector reforms led to significant improvement in the performance of the Ghanaian banking sector, particularly in the areas of access, financial depth, and competition, as shown in Table 1. However, efficiency, measured by the cost-to-income ratio, and stability, as measured by the z-score, saw a deterioration trend, especially from 2015. This may have contributed to the crisis in the banking sector in 2017, when several banks faced serious liquidity challenges and were unable to meet the capital adequacy requirement of the BOG. The key motivation for the banking sector clean-up was to strengthen the sector to minimise systemic failure. However, some contend that the consolidation, which led to some mergers and acquisitions, reducing the number of banks from 34 to 23, has increased market power and reduced competition but improved the banking sector's stability (Cantah et al., 2023). Other recent studies (Musah et al., 2020; George et al., 2021) found an inclusive and insignificant impact of mergers and acquisitions in Ghana's banking sector. Nevertheless, the literature and policy debate have overlooked that the larger banks resulting from the consolidation can produce positive externalities through efficient financial intermediation in the form of economies of scale (Beccalli et al., 2015).

The purpose of this paper therefore, is to investigate the evidence of scale economies in the Ghanaian banking sector and to examine how the orientation of a bank's business model, specific bank characteristics, the utilisation of technology, among other factors, influence scale economies, which may be helpful in the formulation of policies, particularly regarding mergers and acquisitions to enhance policy focus. Specifically, this study sought to answer the following research questions. First, to what extent have the recent regulatory and industry changes influenced the realisation of scale economies in the Ghanaian banking industry? Secondly, to what extent have banks exploited different business models and technological changes to enhance scale economies?

The paper makes the following contributions to the extant literature on the banking industry of Ghana. First, even though many studies have analysed scale economies and technological change in banking, most of these have focused on advanced economies. This paper provides a developing-country context in which the dynamics of the financial system differ from those in the developed world. Secondly, the study goes beyond the

mere inclusion of scale economies in general bank efficiency analysis (see Akoena et al., 2012; Alhassan et al., 2016; and Alhassan & Tetteh, 2017) to investigate the key determinants of scale economies, such as regulatory changes and the effects of the banking-sector clean-up, to enhance policy focus. These changes have implications for mergers and acquisitions and, hence, bank size and the exploitation of scale economies. Finally, the integration of scale economies with technological progress would add depth to the banking literature as well as suggest targeted policies, especially on mergers and acquisitions and technological innovation, that are applicable in Ghana. For instance, the integrated approach would highlight how larger and more resource-rich banks may be better equipped to adopt new banking technologies to enjoy economies of scale, while smaller banks may also utilize technology to expand their services in niche markets.

The rest of the paper is organised as follows: Section 2 reviews relevant literature. Section 3 describes the methodology and data. Section 4 presents the empirical results and discussions of the same, while Section 5 concludes the study.

Table 1. Basic Characteristics of Ghana's Banking Industry

Year	Access	Depth	Efficiency			Stability	Competition
			ROA	ROE	Cost/income		
2007	217.53	19.84	3.45	31.25	62.91	10.81	61.71
2008	244.01	22.64	2.27	21.50	63.43	9.61	53.89
2009	267.81	24.92	1.38	12.07	63.02	10.52	50.08
2010	278.52	25.81	2.55	19.61	57.44	12.13	41.92
2011	340.58	26.83	2.30	17.31	61.71	11.81	40.07
2012	447.63	26.61	3.62	26.60	52.93	13.40	39.08
2013	448.25	20.21	4.51	31.22	47.78	14.69	35.78
2014	491.93	22.20	3.96	27.76	47.62	13.39	32.52
2015	583.91	24.33	3.11	22.25	50.88	13.37	29.31
2016	543.57	25.26	2.70	19.31	52.55	12.63	29.11
2017	614.09	24.89	3.19	21.97	52.20	13.94	34.72
2018	725.21	24.34	2.91	19.03	52.68	13.92	32.39
2019	766.70	24.33	3.16	20.51	51.00	14.13	31.70
2020	762.37	27.26	3.23	20.96	48.05	14.16	32.70
2021		23.93	3.21	21.06	45.45	13.92	32.84

Source: World Bank (2022). *Access:* Measured by the Number of depositors with banks per 1000 adults (15+). *Depth:* Total Banking System Deposits to GDP (%). *Efficiency:* Measured by Return on Total Assets, Return on Equity, and Bank cost to income ratio (%). *Stability:* Measured by Bank Z-score (the probability of default of the banking system). *Competition:* Measured by the 3-Bank concentration ratio (%) (lower figures indicate higher competition and vice versa)

2. Literature Review

Economies of scale exist when a proportionate increase in the levels of output results in a smaller proportional increase in a bank's cost of production. On the other hand, technological progress captures the cost savings arising from the adoption of new technologies over time. The theoretical link between economies of scale and technological progress may be traced to both the Solow Growth Model (Solow, 1957) and modern endogenous growth theories (Romer, 1986). According to the Romer Growth Model (1986), technological innovations in the form of new ideas (knowledge) and objects (e.g., equipment and software), acquired through research and development (R&D), are non-rivalrous. That is, once a bank develops a new technology, though at a high initial fixed cost, it can be used repeatedly at a lower marginal cost, which helps the bank enjoy increasing returns to scale. Thus, technological progress can enhance scale economies in banks by reducing their marginal cost, while economies of scale can promote

technological progress by enabling banks to acquire new technologies and provide more innovative services.

Earlier empirical studies show an inverted-U-shaped relationship between economies of scale and bank size, indicating that economies of scale first increase with size but are exhausted beyond a certain size threshold (McAllister & McManus, 1993; Hughes et al., 2001). However, later evidence, such as Feng & Serlities (2010), Wheelock & Willson (2012), among others, shows the existence of economies of scale even in larger banks. The continued existence of economies of scale even among larger banks may be attributed to the adoption of information technology (IT) in banking activities (Marinč et al., 2013). Berger (2003) argues that technological progress in banking can enhance economies of scale in four ways. First, the adoption of information technology may facilitate the creation of new services that offer greater economies of scale than traditional services. Secondly, technological progress may enable better delivery of existing banking services, which may create larger economies of scale compared with traditional delivery methods. Thirdly, technological progress can enhance scale economies by facilitating and improving the risk management systems of large banks. And fourthly, technological progress may reduce managerial diseconomies of scale. Marinč et al. (2013) also argue that IT enhances scale economies by improving business processes in both transaction banking and relationship banking. The study further contends that IT improves scale economies by facilitating the scalability of transaction banking activities and increasing the geographical reach of banks.

Empirical studies abound on the link between economies of scale and technological progress in banking, but only a few studies focus on sub-Saharan Africa. Studies such as Kasman (2002), Carbo et al. (2002), Margono & Sharma (2004), Tadesse (2006), and Beccalli et al. (2015) have found evidence of the existence of widespread scale economies and technological change among Turkish banks, European savings banks, Indonesian banks, Japanese banks, and European listed banks, respectively. Empirical evidence on the presence of scale economies in bank efficiency analysis is very limited in Africa. A literature review shows only very few studies, such as Simpasa (2010) on Zambian banks and Asongu & Odhiambo (2019) on 162 African banks. The findings of Asongu & Odhiambo (2019), for instance, suggest an inverted U-shaped nexus in the relationship between bank size and inefficiency, and that market power and economies of scale do not increase or decrease interest rate margins of African banks significantly over the period 2001 – 2011.

Regarding Ghana, the literature indicates that a few studies, such as Akoena et al. (2012); Alhassan et al. (2016); Alhassan & Ohene-Asare (2016); and Alhassan & Tetteh (2017), have only included scale economies in general bank efficiency analysis. For instance, Akoena et al. (2012) found higher returns to scale among smaller banks compared with bigger banks, while Alhassan & Tetteh (2017) only indicate the percentage of banks that operated at constant returns to scale, increasing returns to scale, and decreasing returns to scale. No attempt was made in these studies to comprehensively examine evidence of scale economies and technological progress in Ghana's banking sector using different banking business models and characteristics.

Therefore, the objective of this paper is to analyse the evidence of scale economies in the Ghanaian banking sector, as well as investigate how different banking business models and bank-specific characteristics, such as size, risks, ownership, and technological change, among others, as well as the macroeconomic environment, influence scale economies. This is particularly important in light of the recent consolidation that occurred in the Ghanaian banking industry, and the potential scale efficiency gains through the creation of larger and stronger banks.

3. Data and Methods

3.1. Data and Description of Variables

This study employed 366 unbalanced annual panel data observations extracted from the annual financial statements of 29 out of a total of 34 universal banks operating in Ghana from 2007 to 2023. The five banks exempted include four new banks that were licensed in 2015/2016, but their licences were revoked by 2027/2018, and hence did not have full-year financial information. The fifth bank excluded from the sample is an old bank that did not provide information on employees on their annual reports and has not published annual financial statements since 2015. This data was sourced from publicly available, audited annual reports of the banks, obtained through their websites or direct contact with various banks. The panel employed in this study is unbalanced because the number of banks in the sample has varied over the sample period due to new entrants, especially from 2007 to 2017, and the consolidation that occurred after the banking sector clean-up from 2018 (see Table 2). The sample period was chosen because of the regulatory changes in the Ghanaian banking industry, as well as the mixed macroeconomic performance of the Ghanaian economy, which may have affected the behaviour of banks in terms of their business models and resource allocation, and thus the evolution of scale economies of banks over the study period.

This study adopts the intermediation approach, proposed by Sealey and Lindley (1997). This approach, which has been widely used in the literature on bank efficiency studies (Das & Das, 2007; Alhassan and Ohene-Asare, 2016; Moyo, 2018; Blankson et al., 2022), treats bank deposits as inputs. The intermediation approach sees banks primarily as financial intermediaries channelling funds from surplus spending units (savers) to deficit spending units (investors) and therefore treats deposits primarily as inputs. Hence, bank deposits are raw material (inputs) used to create bank assets such as loans and investments.

The study employed three inputs namely physical capital (x1), measured as the net book value of fixed assets including plant, machinery, equipment, fixtures and fittings; labour (x2), measured as the average number of permanent employees on payroll for the year; and financial capital (x3), measured as all customer deposits including demand deposits, savings and time deposits, fixed deposits as well as other borrowed funds. The price of input 1 (w1), is the ratio of depreciation expenses to the net book value of fixed assets; that of input 2 (w2), is defined as all staff cost divided by average number of employees during the year; while that of input 3 (w3), is defined as all interest expenses divided by customer deposits and other borrowed funds. The study also employed three outputs, which include interbank loans (y1), measured as all placements and fixtures with other banks; customer loans (y2), defined as all net outstanding term loans and overdrafts granted to individuals and businesses; and investments in securities (y3), made up of all short-term investments such as government treasury bills, medium-term investments such as treasury notes and long-term investments like treasury and other bonds and equities. Total cost (C) is made up of all interest and non-interest expenses.

The determinants of economies of scale include two key factors that capture a bank's business model: the net interest margin (NIM), measured as net interest income divided by total loans, and the securities-to-total-assets ratio (SECTA). A higher SECTA indicates a business model that is more focused on investment banking activities than on commercial banking. The rest of the determinants are technological progress (TP); capital adequacy ratio (CAR), measured as the ratio of total regulatory capital to total risk-weighted assets of a bank; credit risk (CR), represented by the ratio of loans loss provisions to gross loans; funding risk (FR), measured as the ratio of bank deposits to loans and is included to capture banks' exposure to the use of deposits to finance bank assets relative to equity capital; size of bank (SIZE), measured by total assets; and age of bank (AGE), measured as number of years in operation in Ghana. Also included are dummies for the banking sector clean-up (BCLEAN), majority locally owned (LOCFOR), and majority

publicly owned (PUBPRIV). The definitions of variables, descriptive statistics for the variables, and the correlation matrix of the determinants are presented in Tables 3, 4, 5, and 6, respectively.

Table 2. Banks in Ghana Before and After the Banking Sector Clean-up

S/N	Before Banking Sector Clean-Up	After Banking Sector Clean-Up	Majority Ownership
1	Access Bank (Ghana) Plc	Access Bank (Ghana) Plc	Foreign
2	Agricultural Development Bank Limited	Agricultural Development Bank Limited	Local
3	Barclays Bank of Ghana Limited	Barclays Bank of Ghana Limited	Foreign
4	Bank of Africa Ghana Limited	Bank of Africa Ghana Limited	Foreign
5	CAL Bank Limited	CAL Bank Limited	Local
6	Construction Bank Limited	Consolidated Bank Ghana Limited	Local
7	Beige Bank Limited		
8	Heritage Bank Limited		
9	Premium Bank Limited		
10	Royal Bank Limited		
11	UniBank Limited		
12	Sovereign Bank		
13	Ecobank Ghana Limited	Ecobank Ghana Limited	Foreign
14	FBNBank (Ghana) Limited	FBNBank (Ghana) Limited	Foreign
15	Fidelity Bank Ghana Limited	Fidelity Bank Ghana Limited	Local
16	Energy Bank Ghana Limited	First Atlantic Bank Limited	Foreign
17	First Atlantic Bank Limited		
18	First National Bank (Ghana) Limited	First National Bank (Ghana) Limited	Foreign
19	GHL Bank Limited		
20	GCB Bank Limited	GCB Bank Limited	Local
21	Capital Bank Limited		
22	UT Bank Limited		
23	Guaranty Trust Bank (Ghana) Limited	Guaranty Trust Bank (Ghana) Limited	Foreign
24	National Investment Bank Limited	National Investment Bank Limited	Local
25	OmniBSIC Bank Ghana Limited	OmniBSIC Bank Ghana Limited	Local
26	Sahel Sahara Bank Ghana Limited (BSIC)		
27	Prudential Bank Limited	Prudential Bank Limited	Local
28	Republic Bank (Ghana) Limited	Republic Bank (Ghana) Limited	Foreign
29	Societe General (Ghana) Limited	Societe General (Ghana) Limited	Foreign
30	Stanbic Bank Ghana Limited	Stanbic Bank Ghana Limited	Foreign
31	Standard Chartered Bank (Ghana) Limited	Standard Chartered Bank (Ghana) Limited	Foreign
32	United Bank for Africa (Ghana) Limited	United Bank for Africa (Ghana) Limited	Foreign
33	Universal Merchant Bank Limited	UMB Bank Limited	Local
34	Zenith Bank (Ghana) Limited	Zenith Bank (Ghana) Limited	Foreign

Source: Author's own compilation, 2025.

.1.1. Ethical Considerations

The study used secondary data, which is publicly available and was sourced mainly from the websites of Ghanaian banks, the Bank of Ghana, the Ghana Statistical Service, the Ghana Stock Exchange, the World Bank, and the IMF. Furthermore, this study does

not involve human subjects, and the dataset does not contain any personal information or identifiers.

Table 3. Description of Inputs and Outputs

Variable	Description	Used by Similar Studies
Total Cost (C)	Made up of all interest and non-interest expenses	Standard in the empirical literature
	Inputs	
Physical capital (x1)	The net book value of fixed assets, including plant, machinery, equipment, fixtures, and fittings	Das & Das (2007); Alhassan and Ohene-Asare (2016); (Moyo, 2018)
Labour (x2)	The average number of permanent employees on payroll for the year	
Financial capital (x3)	All customer deposits, including demand deposits, savings and time deposits, fixed deposits, and other borrowed funds	
	Outputs	
Interbank loans (y1)	All placements and fixtures with other banks	Standard in literature, but studies such as Simpasa (2010) and Moyo (2018) combined all three into a single output
Customer loans (y2)	All outstanding term loans and overdraft facilities granted to businesses and individuals have less provision for bad or doubtful debts or impairment losses.	
Investments in securities (y3)	All short-term investments, such as government treasury bills, medium-term investments, such as treasury notes, and long-term investments, like treasury and other bonds and equities	
	Input Prices	
Price of physical capital input (w1)	The ratio of depreciation expenses to the net book value of fixed assets is defined	Standard in the literature, but in the absence of information on the number of employees, some have defined the price of labor as the ratio of personnel expenses to total assets.
Price of labor (w2)	Staff or personnel expenses, including wages and salaries, social security and provident fund contributions, training, and other staff costs, are all divided by the number of employees during the year.	
price of the financial capital (w3)	All interest expenses are divided by customer deposits and other borrowed funds	

Source: Author's own compilation, 2025.

3.2. Computing Economies of Scale and Technological Progress

Economies of scale and technological progress can be measured using the following multi-product translog cost frontier with three outputs, three input prices, and non-neutral technology:

$$\mathrm{InC_{it}} = \beta_0 + \sum_{q=0}^{3} \beta_q \ln y_{qit} + \sum_{j=1}^{3} \beta_j \ln w_{jit} + \frac{1}{2}\sum_{q=1}^{3}\sum_{k=1}^{3} \beta_{qk} \ln y_{qit} \ln y_{kit} + \frac{1}{2}\sum_{j=1}^{3}\sum_{c=1}^{3} \beta_{jc} \ln w_{jit} \ln w_{cit}, \quad (1)$$

where C_{it} is the total operating cost for the i-th bank at time, t; yqit measures the q-th output of bank i at time t; w_{jit} is the price of the j-th input of bank i at time t; T denotes the time trend common to all banks, and is intended to measure technical progress over time; and β is an unknown parameter to be estimated. The error term ε_{it} comprises two components (v_{it} and u_{it}), where v_{it} is the symmetrical random error, assumed to be i.i.d., with $N(0,\sigma^2_v)$ and independent of the explanatory variables, while the distribution of the one-sided inefficiency term u_{it} is assumed to be truncated at zero, with $N(\mu_{it},\sigma^2_\mu)$ and independent of the error term vit.

Table 4. Description of the Exogenous Variables (Determinants)

Variable	Description	Used by Similar Studies
Capital Adequacy Ratio (CAR)	The ratio of total regulatory capital to total risk-weighted assets of a bank. A proxy for the capital strength of a bank.	Simpasa (2010); Beccalli et al. (2015)
Net interest margin (NIM)	Measured as net interest income divided by total loans, and a proxy for the bank business model (higher values indicate that a bank is more oriented to traditional lending activities rather than to investment banking activities)	Beccalli et al. (2015)
Securities to total assets ratio (SECTA).	Measured as total investment in securities divided by total assets and a proxy for the bank business model (higher values indicate that a bank is more oriented to investment banking activities rather than to commercial banking activities)	Beccalli et al. (2015)
Technological progress (TP)	Estimated from eqn (3) as the negative of the rate of change of total cost with respect to time.	Das & Das (2007); Simpasa (2010)
Bank size (SIZE)	Measured by the natural logarithm of total assets.	Standard in literature
Credit Risk (CR)	Represented by the ratio of loan loss provisions to gross loans. Higher values indicate higher credit risk	Simpasa (2010); Das Gupta et al. (2021)
Funding Risk (FR)	Measured as the ratio of bank deposits to loans, and is included to capture banks' exposure to the use of deposits to finance bank assets relative to equity capital	Simpasa (2010)
Bank Age (AGE)	The number of years the bank has been in operation in Ghana as of the end of the sample period.	Alber (2015); Moyo (2018)
Banking sector clean-up (BCLEAN)	A dummy variable to capture the impact of the banking sector clean-up. Takes 1 for the period after the bank sector cleanup and 0 before the clean-up	
Ownership (LOCFOR)	Takes 1 if the bank is 50%+ locally owned and 0 otherwise	
Ownership (PUBPRIV)	Takes 1 if the bank is 50%+ publicly owned and 0 otherwise	

Source: Author's own compilation, 2025

The translog cost function is employed for a number of reasons. First, it accommodates multiple outputs, which is typical of the banking industry. Second, it is a flexible functional form compared with other functional forms, such as the Cobb-Douglas, which assumes constant returns to scale, and the CES, which assumes constant elasticity of substitution of inputs. Thirdly, it allows the direct estimation of economies of scale as the cost elasticity with respect to output. Finally, it accommodates technological change and hence allows the direct estimation of technological progress.

From the Translog cost function in (3), the level of economies of scale (ES) is estimated as the inverse of the rate of change of total cost with respect to proportional changes in all outputs, holding input prices constant, as follows:

$$ES = \sum \left[\frac{\partial \ln C_{it}}{\partial \ln y_{it}}\right]^{-1} = \left[\sum_{q=1}^{3} \beta_q + \sum_{j=1}^{3}\sum_{k=1}^{3} \beta_{jk} \ln y_k + \sum_{q=1}^{3}\sum_{j=1}^{3} \beta_{qj} \ln w_j + \sum_{q=1}^{3} \beta_{tq} T\right]^{-1} (2)$$

where ES>1 implies economies of scale, which indicates that equi-proportional increases in all outputs result in a less than proportional increase in total cost, signifying decreasing long-run total average cost. On the other hand, ES=1 implies constant returns to scale, where proportional increases in outputs lead to the same proportional increase in total cost, while ES<1 implies diseconomies of scale, which means increasing output results in a greater proportional increase in total cost, signifying rising long-run total average cost. Knowledge of scale economies enables us to understand the structural changes that have occurred in the Ghanaian banking industry over the study period, which could form the basis for regulatory policies on consolidation.

Table 5. Descriptive Statistics of Variables

Variable	No. of Obs	Mean	Std. Dev.	Min.	Max.
Total Cost (C) (in GHS)	366	364,972,835	442,210,747	2,123,595	3,053,566,000
Inputs					
Physical capital (x1) (in GHS)	366	108,569,379	153,037,188	59,111	1,321,232,000
Labour (x2)	366	757	535	19	2,582
Financial capital (x3) (in GHS)	366	3,111,154,247	4,028,412,826	1,464,000	28,801,661,000
Outputs					
Interbank Loans (y1) (in GHS)	366	332,958,015	478,429,329	0	4,250,328,000
Customer Loans (y2) (in GHS)	366	1,148,910,777	1,355,172,416	1,365,000	9,444,131,000
Investments in securities (y3)	366	1,365,669,557	2,050,215,879	61,000	12,153,990,000
Input Prices					
Price of physical capital (w1)	366	0.1810	0.1651	0.0215	2.1336
Price of labour (w2) (in GHS)	366	127,855.89	138,261.82	7,268.65	1,481,433.63
Price of financial capital (w3)	366	0.0582	0.0331	0.0068	0.2223
Dependent Variable					
Economies of Scale (ES)	366	1.1055	0.3197	0.6899	3.1834
Determinants					
Net Interest Margin (NIM)	366	0.3968	1.9168	-0.0669	34.40
Securities to Total Assets (SECTA)	366	0.3014	0.1658	0.0003	0.9443
Technological Progress (TP)	366	-0.0333	0.0172	-01339	0.0117
Capital adequacy ratio (CAR)	366	0.2681	0.3529	-0.3790	3.3400
Credit risk (CR)	366	0.0983	0.1045	0.0000	0.8570
Funding risk (FR)	366	6.4414	81.1841	0.3348	1554.52
Size (SIZE) (in GHS)	366	3,800,754,993	4,790,344,754	1,397,1170	33,520,636,000
Age (AGE)	366	28	31	1	127
Inflation rate (INF)	366	0.1566	0.1057	0.0790	0.5410
Dummy-banking sector clean-up (BCLEAN)	366	.3606	0.4808	0.0000	1.0000
Dummy for Local-Foreign (LOCFOR)	366	0.3606	0.4808	0.0000	1.0000
Dummy for Public-Private (PUBRIV)	366	0.1093	0.3124	0.0000	1.0000

Source: Author's own computation based on the Financial Information of Ghanaian Banks, 2025. *Note:* GHS-Ghana Cedis, Obs.- Observation, Std.Dev.-Standard deviation, Min-Minimum, Max.-Maximum.

Technological progress, on the other hand, is measured as the negative of the rate of change of total cost with respect to time. Again, from the translog cost function in equation (3), technological progress (TP) can be defined as follows:

$$TP = -\sum \frac{\partial \ln C_{it}}{\partial T} = -\left[\sum_{q=1}^{3} \beta_{tq} \ln y_{qit} + \sum_{j=1}^{3} \beta_{tj} \ln w_{jit} + \beta_t + \beta_{it} T\right], \quad (3)$$

where TP<0 implies technological progress, which means that technological advancement results in a reduction in total cost over time, while TP>0 indicates technological regress, meaning the adoption of new technologies results in increased total cost over time. TP can be broken into three components, namely pure technological change, represented by the sum of the last two terms in equation (5); input-biased (non-neutral) technological change, represented by the second term; and scale-augmenting technological change, represented by the first term (Tadesse, 2006). Pure technological change refers to the rate of cost reduction independent of the shares of inputs in the total cost build-up and efficient scale of production. However, technological change can be biased with respect to both inputs and the scale of production(Tadesse, 2006). Technological progress allows the same or more output to be produced using lower amounts of inputs at a lower cost.

Table 6. Correlation Matrix of the Determinants

	SIZE	CR	FR	LOC-FOR	PUB-PRIV	AGE	CAR	NIM	SECTA	INF	BCLEAN	TP
SIZE	1											
CR	-0.12	1										
FR	-0.1	-0.19	1									
LOC-FOR	-0.06	-0.28	0	1								
PUB-PRIV	0.28	0.02	0.18	0.57*	1							
AGE	0.57*	-0.03	-0.13	0.04	(0.44) .	1						
CAR	-0.38	0.38	0.06	(-0.57)*	-0.29	(-0.43) .	1					
NIM	-0.17	-0.13	0.97***	-0.13	0.12	-0.22	0.29	1				
SECTA	0.31	0.4	0.23	-0.38	0.21	0.05	0.51*	0.36	1			
INF	0.58*	-0.12	-0.24	-0.09	-0.03	0.21	-0.32	-0.28	-0.03	1		
BCLEAN	0.84***	0	-0.05	-0.17	0.13	0.34	-0.2	-0.08	0.51*	0.52*	1	
TP	0.22	-0.4	-0.19	0.57*	0.09	0.29	(-0.9)***	(-0.41) .	(-0.6)***	0.18	0.04	1

Source: Author's own computation, 2025. *Significance Level:* *, p<0.1; **, p<0.05; ***, p<0.01

3.3. Determinants of Scale Economies

The determinants of scale economies (ES) are defined as follows:

$$ES = \delta_0 + \delta_1 NIM_{it} + \delta_2 SECTA_{it} + \delta_3 TP_{it} + \delta_4 CAR_{it} + \delta_5 CR_{it} + \delta_6 FR_{it} + \delta_7 SIZE_{it} + \delta_8 AGE_{it} + \delta_9 INF_t + \delta_{10} BCLEAN_i + \delta_{11} LOCFOR_i + \delta_{12} PUBPRIV_i + e_{it} \ , \quad (4)$$

where *i* is a subscript for bank, *t* denotes the year, and eit is a random error term that captures statistical noise. All other variables are defined in Table 4.

3.3.1. Potential Endogeneity Issues and Robustness Checks

As is typical of most panel data, potential endogeneity issues may arise, leading to biased and inconsistent estimates of the coefficients of the determinants of scale economies, especially if OLS regression is applied. For instance, endogeneity may arise from omitted variables or unobserved heterogeneity resulting from bank-specific characteristics, such as differences in management quality, risk management practices, and reputation, among others. Also, endogeneity may arise due to the simultaneity or reverse causality between the dependent variable, scale economies, and any of the determinants. For instance, technological progress can enhance scale economies in banks by reducing their marginal cost. Economies of scale, on the other hand, can promote technological progress by enabling banks to acquire new technologies that enable them to provide more innovative services. Also, larger banks may enjoy economies of scale due to their size, while scale economies may enable banks to grow faster to become larger banks. Because of these potential endogeneity issues, the study employs panel data models such as the Fixed Effects (FE), the Random Effects (RE), and the Instrumental Variable (IV) regressions as a robustness check on the pooled OLS regression results. The FE and RE regressions, especially the True FE and True RE models, were proposed by Greene (2005) to deal with the problem of unobserved heterogeneity, while the IV regression is better at handling omitted variables and simultaneity issues.

4. Results

4.1. Bank Characteristics, Scale Economies, and Technological Progress

This section presents annual indices of economies of scale and technological progress (based on various bank characteristics) to show how various banking groups in Ghana differ in levels of scale economies and technological progress. The upper part of Table 7 shows annual average economies of scale, where figures greater than, equal to, or less than 1 suggest the presence of economies of scale, constant returns to scale, or diseconomies of scale, respectively. It can be observed from Table 7 that, although there are significant differences in the levels of economies of scale among various banking groups, the indices generally show the existence of global scale economies in the Ghanaian banking industry over the study period. The average scale elasticity of the banking industry as a whole over the study period is approximately 1.15, indicating that a 100% increase in output quantities results in an average rise in total cost of only 85%. Regarding the various banking groups, smaller, younger, and private banks recorded slightly higher average scale economies than larger, older, and public banks. The evidence of higher average economies of scale among smaller banks compared with larger banks in the present study is consistent with Akoena (2012) on Ghanaian banks, and Simpasa (2010), who found similar evidence among Zambian banks, but is inconsistent with Beccalli et al. (2015), who found that economies of scale are larger among the biggest European banks.

The middle part of Table 7 shows technological progress or otherwise, where negative figures indicate technological progress (i.e., the reduction in banking costs due to technological advancement). In contrast, positive figures imply technological regress (i.e., the increase in banking costs following the adoption of new technologies). The indices indicate that Ghanaian banks, on average, recorded a cost reduction of about 3.3% over the sample period due to technological progress. The results in Table 7 also show that smaller and younger banks recorded higher cost reduction due to technological progress compared with their larger and older counterparts, respectively, over the sample period. In terms of ownership, foreign and private banks recorded higher cost gains, while local banks recorded the lowest cost gains due to technological progress over the study period. This suggests that smaller, younger, foreign and private banks in Ghana adapted faster to new technologies in the banking industry, probably because they were more capitalised (especially in the case of foreign banks) and therefore were able to acquire and utilise new technologies such as Automated Teller Machines (ATMs), electronic banking among others to provide diversified products and services, which contributed to cost savings for such banking groups compared with their counterparts.

In terms of the business model of banks, NIM returns a positive and significant (at the 1% level) relationship with economies of scale, suggesting that banks with greater profitability from traditional lending activities tend to experience larger economies of scale compared with banks with lower profitability from traditional lending. The positive coefficients of 0.13 and 0.18 for the base and reduced models, respectively, imply that a 1% increase in NIM will result in 13% and 18% increases in scale economies, respectively, holding other factors constant. On the other hand, there is a positive but insignificant relationship between SECTA (investment banking activity) and economies of scale, suggesting that investment banking is not an essential determinant of economies of scale in Ghana over the study period. Regarding technological progress, the results in Table 5 indicate a negative and significant (at the 1% level) relationship with scale economies, suggesting that banks experiencing greater cost reductions due to technological advancements have larger scale economies. This is because more negative values of TP indicate a larger reduction in cost due to technological progress, and hence the negative relationship implies that banks that experience a larger reduction in cost due to technological advancement have larger scale economies.

Table 7. Bank Characteristics, Economies of Scale, and Technological Progress

	2007-2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2007-2023
Economies of Scale											
All	1.081	1.182	1.365	1.200	1.149	1.094	1.072	1.080	1.093	1.127	1.145
Small	1.269	1.437	1.768	1.421	1.308	1.211	1.173	1.165	1.163	1.265	1.318
Large	0.876	0.926	0.962	0.980	0.991	0.977	0.970	0.995	1.024	0.988	0.969
Young	1.228	1.418	1.735	1.350	1.258	1.204	1.145	1.178	1.146	1.181	1.284
Old	0.904	0.945	0.995	1.050	1.041	0.984	0.998	0.982	1.040	1.072	1.001
Local	1.036	1.200	1.230	1.247	1.219	1.150	1.115	1.173	1.175	1.242	1.179
Foreign	1.107	1.172	1.437	1.179	1.109	1.062	1.047	1.027	1.047	1.061	1.125
Public	0.808	0.902	0.922	0.932	1.041	1.110	1.016	1.058	1.006	1.010	0.981
Private	1.115	1.205	1.402	1.227	1.166	1.091	1.080	1.084	1.107	1.145	1.162
Technological Progress											
All	-0.034	-0.033	-0.033	-0.035	-0.035	-0.033	-0.032	-0.033	-0.031	-0.034	-0.033
small	-0.040	-0.043	-0.042	-0.039	-0.038	-0.035	-0.032	-0.033	-0.030	-0.033	-0.037
Large	-0.027	-0.023	-0.024	-0.030	-0.032	-0.031	-0.032	-0.033	-0.031	-0.034	-0.030
Young	-0.036	-0.040	-0.036	-0.037	-0.038	-0.035	-0.032	-0.031	-0.029	-0.032	-0.035
Old	-0.032	-0.026	-0.029	-0.032	-0.031	-0.031	-0.032	-0.035	-0.032	-0.035	-0.032
Local	-0.024	-0.018	-0.019	-0.026	-0.029	-0.028	-0.029	-0.029	-0.025	-0.030	-0.026
Foreign	-0.039	-0.041	-0.040	-0.039	-0.038	-0.036	-0.034	-0.035	-0.034	-0.036	-0.037
Public	-0.033	-0.032	-0.038	-0.034	-0.037	-0.033	-0.034	-0.032	-0.027	-0.029	-0.033
Private	-0.034	-0.033	-0.032	-0.035	-0.034	-0.033	-0.032	-0.033	-0.031	-0.034	-0.034
Number of Banks											
All	25	26	26	22	22	22	22	22	22	22	22
small	13	13	13	11	11	11	11	11	11	11	11
Large	12	13	13	11	11	11	11	11	11	11	11
Young	13	13	13	11	11	11	11	11	11	11	11
Old	12	13	13	11	11	11	11	11	11	11	10
Local	9	9	9	7	8	8	8	8	8	8	8
Foreign	16	17	17	15	14	14	14	14	14	14	14
Public	2	2	2	2	3	3	3	3	3	3	3
Private	23	24	24	20	19	19	19	19	19	19	19

Source: Author's own computation, 2025. *Note:* The medians of bank size and bank age have been used to divide the banks into large/small and old/young banks, respectively. Local banks - Over 50% locally-owned; Foreign banks – Over 50% foreign-owned. Public banks – Over 50% government-owned; Private banks – Over 50% privately-owned.

The economic significance of the TP coefficients of -2.4 and -3.7 for the base and reduced models, respectively imply that a 1% increase in investment in new technology will result in cost reductions of 24% and 37%, respectively. The relationship between funding risk (FR) and economies of scale is negative and significant at the 1% level. This suggests that Ghanaian banks that rely more on deposits to finance their loan assets relative to equity enjoy less scale economies than their counterparts. On the other hand, the relationship between credit risk (CR) and scale economies is positive and significant at the 5% level. Although it is expected that a higher credit risk will increase a bank's cost of doing business and hence should have a negative effect on economies of scale, some factors may explain the positive relationship between credit risk and economies of scale. First, to attain economies of scale, banks may aggressively expand lending, often lowering credit standards and hence increasing credit risk. Secondly, when a bank expands more quickly than its prudential risk management processes can keep pace, economies of scale and credit risk may exhibit a positive correlation.

Regarding the relationship between capital strength and economies of scale, the evidence in Table 8 suggests that capitalisation increases economies of scale up to a point,

but further increases in capitalisation subsequently decrease economies of scale. This is because CAR's coefficient is positive, while the coefficient of the square of CAR (CARsq) is negative and significant, both at the 1% level, suggesting a non-linear, inverted-U-shape relationship between CAR and economies of scale. The coefficients of 0.35 and -0.11 for CAR and CARsq, respectively, suggest that, all other things being equal, an increase in capitalisation initially will lead to an increase in scale economies by 35%, but further increases in capitalisation will eventually lower scale economies by 11%.

Table 8. Determinants of Economies of Scale

Variable	Base Model			Reduced Model		
	Coef.	Std. errs.	P-Value	Coef.	Std. errs.	P-Value
NIM	0.1302***	0.0195	0.0000	0.0178***	0.0066	0.0072
SECTA	0.1160	0.0980	0.2375			
TP	-2.3518**	1.0681	0.0283	-3.6924***	1.1123	0.0010
CR	0.2892**	0.1178	0.0145	0.2538**	0.1266	0.0458
FR	-0.0029***	0.0004	0.0000			
CAR	0.0898	0.1049	0.3925	0.3511***	0.1087	0.0014
CARsq	-0.0710**	0.0331	0.0327	-0.1119***	0.0357	0.0019
ln(SIZE)	-0.1140***	0.0165	0.0000	-0.1446***	0.0140	0.0000
ln(AGE)	-0.0880***	0.0134	0.0000			
INF	0.2675**	0.1208	0.0275	0.3705***	0.1201	0.0022
BCLEAN	0.2059***	0.0392	0.0000	0.2394***	0.0356	0.0000
LOCFOR	0.1605***	0.0298	0.0000	0.2172***	0.0330	0.0000
PUBPRIV	-0.1646***	0.0442	0.0002	-0.2356***	0.0481	0.0000
Constant	Yes	Yes	Yes	Yes	Yes	Yes
F-Statistic	40.14		0.0000	36.02		0.0000
No. of obs.	366			366		
No of Banks	29			29		

Source: Authors' own computation using R Version 4.5.0, 2025.. *Significance Level:* *, p<0.1; **, p<0.05; ***, p<0.01. *Note:* NIM – Net interest margin, SECTA - Investments in securities to total assets ratio, TP - Technological progress, CR – Credit risk, FR – Funding risk, CAR – Capital adequacy ratio, CARsq – Square of capital adequacy ratio, INF – Inflation Rate, BCLEAN – Dummy for the Banking sector clean-up, LOCFOR – Dummy for local vs foreign banks, PUBPRIV – Dummy for public vs private banks, Coef. - Coefficient, Std.errs - Standard errors.

Regarding size, the results in Table 8 show a negative and statistically significant (at the 1% level) relationship between economies of scale and bank size, suggesting that larger banks have less scale economies than smaller banks, which is consistent with the univariate analysis in Table 7. Also, the results show a negative and statistically significant (at the 1% level) relationship between bank age and economies of scale, suggesting that older banks have less scale economies than younger banks. Again, this is consistent with the univariate analysis in Table 7. The coefficients of -0.11 and -0.09 for bank size and age, respectively, suggest that increases in both size and age by 1% will result in a decrease in scale economies by 11% and 9%, respectively, holding other factors constant. With regards to the variable BCLEAN, the results show a positive and significant (at the 1% level) relationship with economies of scale, suggesting that the banking sector clean-up, which resulted in some mergers and acquisitions and an increase in capitalization, may have led to an improvement in economies of scale. The results in Table 8 suggest that in both the base and the reduced models, the banking sector clean-up contributes over 20% to increases in scale economies among Ghanaian banks. Finally, the two ownership variables

(LOCFOR and PUBPRIV) return positively significant and negatively significant coefficients, respectively, suggesting that local and private banks have larger scale economies than their foreign and public counterparts. The positive relationship between local banks and scale economies may be explained by the fact that the consolidation that occurred in the banking industry in 2017/2018, which appears to have a positive impact on economies of scale, was mainly among local banks.

4.2. Robustness Test

To address potential unobserved heterogeneity, the study performed both random-effects and fixed-effects panel regressions and conducted the Haussmann test to determine the most appropriate model. The Haussmann test rejects the random-effects in favour of the fixed-effects at the 5% level of significance. To further assess the robustness of the results and address potential endogeneity issues, the study performed an instrumental variables (IV) regression, using the first lags of economies of scale, size, and age as instruments. For instance, a problem of simultaneity bias may arise where a two-way relationship exists between bank size and other variables such as age or profitability. These instruments need to be correlated with the endogenous variables but uncorrelated with the error term to be considered valid. Since the p-value (0.65) of the Sargan-Hansen statistic of overidentification is greater than conventional significance levels (0.01, 0.05, and 0.10), the study fails to reject the null hypothesis that all instruments are valid. Hence, the chosen instruments are considered valid. The results of both the fixed effects and the IV regressions, as presented in Table 9, generally confirm those of the pooled OLS.

4.3. Discussion of Key Findings and Policy Implications

First, the finding of an insignificant association between investment banking and economies of scale as well as a positive and significant relationship between net interest margin and economies of scale are inconsistent with Beccalli et al. (2015), who found a positive and significant link between investment banking and economies of scale; and a positive but insignificant link between profitability from traditional lending and economies of scale among European banks. The results in the present study may be explained by the fact that, unlike Europe, where banks have the opportunity to invest in a variety of investment banking products in both equity and debt markets, in Ghana, the investment banking sub-sector is not yet well developed. For instance, the number of listed companies on the Ghana Stock Exchange totalled just 36, with an average annual market capitalisation of GHS49.43 billion (USD15.24 billion) and an average yearly value of shares traded of just GHS467.10 million (about USD129.27 million) over the study period (Ghana Stock Exchange, 2023). This may also indicate a low free-float. Hence, capital market investment opportunities are mainly in Government debt securities, which provide relatively lower yields than traditional core lending activities. The managerial implication of this finding is that Ghanaian banks can experience larger-scale economies by engaging more in traditional lending activities and implementing measures that will minimise the cost of funds to improve net interest margins. The financial regulatory authorities, such as the Bank of Ghana and particularly the Securities and Exchange Commission, should pursue deliberate policies to expand the capital market (such as more listing of shares and bonds on the stock exchange) to provide banks with a variety of capital market investment products.

Table 9. Fixed Effects and Instrumental Variables (IV) Regressions

Variable	Fixed Effects			Instrumental Variables (IV)		
	Coef.	Std. errs.	P-Value	Coef.	Std. errs.	P-Value
NIM	0.0930***	0.0168	0.0000	0.0912	0.0692	0.1881
SECTA	0.1688	0.0999	0.1920	-0.2736**	0.1335	0.0412
TP	-2.8866**	1.3285	0.0305	-7.1425***	2.0492	0.0006
CR	0.1069	0.0907	0.2394	0.4405**	0.2137	0.0400
FR	-0.0022***	0.0004	0.0000	-0.0022	0.0015	0.1410
CAR	0.0857	0.0856	0.3174	0.2113	0.1595	0.1861
CARsq	-0.0115	0.0261	0.6579	-0.0942**	0.0455	0.0390
ln(SIZE)	-0.0372**	0.0179	0.0385	0.0413	0.0394	0.2954
ln(AGE)	-0.0644	0.0333	0.0542	-0.1605***	0.0240	0.0000
INF	0.1972**	0.0865	0.0233	0.0706	0.1002	0.4816
BCLEAN	0.1058***	0.0301	0.0005	0.0353	0.0591	0.5506
LOCFOR				0.2133***	0.0390	0.0000
PUBPRIV				-0.2011***	0.0407	0.0000
Constant	No	No	No	Yes	Yes	Yes
F-Statistic/Chisq	18.74		0.0000	20.58		0.0000
Sargan-Hansen statistic				0.87		0.6480
No. of obs.	366			366		
No of Banks	29			29		

Source: Authors' own computation using R Version 4.5.0, 2025. *Significance Level:* *, p<0.1; **, p<0.05; ***, p<0.01. *Note:* NIM – Net interest margin, SECTA - Investments in securities to total assets ratio, TP - Technological progress, CR – Credit risk, FR – Funding risk, CAR – Capital adequacy ratio, CARsq – Square of capital adequacy ratio, INF – Inflation Rate, BCLEAN – Dummy for the Banking sector clean-up, LOCFOR – Dummy for local vs foreign banks, PUBPRIV – Dummy for public vs private banks, Coef. - Coefficient, Std.errs - Standard errors.

Secondly, the relationship between capital strength and economies of scale is non-linear, inverted U-shaped, suggesting that increases in capitalisation will eventually reduce scale economies. This finding is consistent with that of Beccalli et al. (2015), who also found a similar relationship between capital strength and scale economies among European banks. The implication of this finding for policymakers, particularly the Bank of Ghana, is that the regulatory authority must be mindful of increases in the minimum capital requirements for banks, since excessive capitalisation may eventually reduce scale economies in the banking industry.

Finally, the finding in this study, which suggests that technological progress improves scale economies, is consistent with studies such as Berger (2003) and Marinč et al. (2013), who also found that technological progress enhances scale economies by facilitating the creation of new products and services, enabling better delivery of existing services, improving risk management, and improving business processes in transaction and relationship banking. Regulatory policies should therefore promote and enable the adoption of new technologies such as digital and mobile banking, artificial intelligence, among others, to enhance the expansion and delivery of banking products and services.

5. Conclusion

The main objective of this paper was to analyse the evidence of economies of scale and technological progress, as well as to investigate the determinants of scale economies in Ghana's banking sector, to enhance policy focus. First, the study discovered that scale economies are widespread across different banking groups, with an average scale

elasticity of the banking industry as a whole, over the study period of about 1.15, suggesting that a 100% increase in output quantities leads to a rise in total cost on average by only 85%. Second, the study finds that Ghanaian banks recorded, on average, a cost reduction of about 3.3% over the study period due to technological progress, and that this cost reduction was widespread across various banking groups, with foreign and private banks recording larger cost reductions.

Regarding the determinants of scale economies, the study found that Ghanaian banks that are more oriented towards traditional lending relative to investment banking experience larger economies of scale over the study period. Also, the study found that banks that experience more cost reductions due to technological advancement have larger scale economies. Furthermore, the study found that although capitalisation has a positive influence on economies of scale, there is a non-linear relationship between capital strength and economies of scale, which implies that capitalisation increases economies of scale up to a point, but further increases in capitalisation lead to an eventual decrease in economies of scale. Finally, the results indicate that the banking sector clean-up improved economies of scale, and that local banks that were mainly affected by the clean-up experienced larger economies of scale, compared with their foreign counterparts over the study period.

In conclusion, regarding the first research question, the results confirm that recent regulatory actions of the Bank of Ghana, particularly the banking sector clean-up, have a positive influence on scale economies. This means that the capitalization and consolidation that occurred through some mergers and acquisitions may have led to stronger banks that allow them to enjoy larger economies of scale. However, the non-linear relationship between capitalisation and scale economies suggests that policymakers must be mindful in the implementation of capital adequacy policies in the industry, as excessive capitalisation may eventually lower scale economies. Furthermore, regarding the second research question, the results show that Ghanaian banks exploited different banking models, particularly traditional lending, as well as employed technology to operate at a more optimal scale and to enjoy larger economies of scale. Policymakers should therefore pursue policies that will encourage and facilitate the adoption of new banking technologies to improve business processes and the delivery of banking services.

The main limitation of this study is its focus on Ghana, which may limit its generalisability. Therefore, future research on the analysis of determinants of economies of scale in the banking industry should explore the application of cross-country datasets, particularly a sample of sub-Saharan African countries, since many of these economies also went through financial sector reforms similar to what happened in Ghana. This will allow for the analysis of scale economies across various banking groups in different banking systems under different regulatory environments.

Supplementary Materials: Please refer to any additional supplementary material available online: online appendices, datasets, codes, etc.

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