

Banking Sector Stability in Sierra Leone: An Econometric Analysis

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Abstract

This study assesses banking sector stability in Sierra Leone using quarterly data over the period 2009-2019 of the fourteen banks in the sector. The study is carried out in the context of Johansen Cointegration estimation technique, and it is found out that in the long run, total bank assets, gross loans positively influence banking sector stability whilst exchange rate had negative effect on banking sector stability. In the short run, total-banking assets is also found to have a positive and statistically significant relationship on banking sector stability. To safeguard soundness and stability of the banking sector, policies that strengthen banking sector, boost capital adequacy level, deepen financial markets in the sector, should be pursued by the monetary authority. This in turn will facilitate smooth banking operations and fortify public confidence in the banking sector.

Keywords: Banking Sector, Sierra Leone, Financial Stability, Johansen Cointegration, Herfindahl Hirschman Index

JEL Code: C4, C6, G3.

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1. Introduction

In the international arena, drivers of growth and development are multifarious; the stability of the banking sector is viewed as a catalyst to strengthen financial stability. In particular, the banking sector is a significant part of the financial sector, and it channels resources from deficit to surplus units via financial intermediation. This in turn translates to boosting economic growth via gainful employment opportunities and launches the economy on a sustainable trajectory.

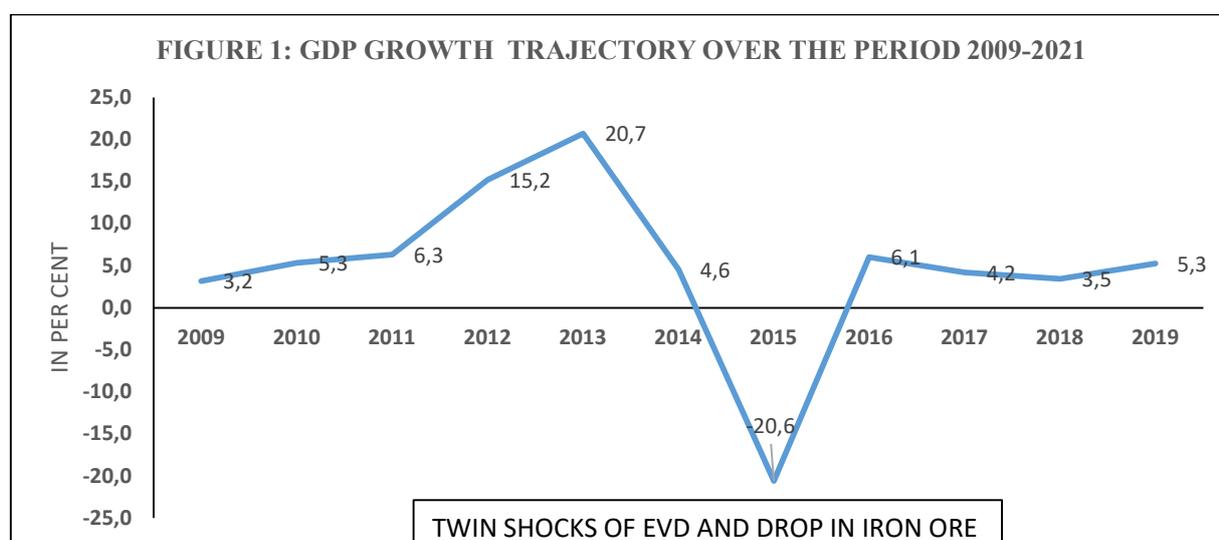
Banking sector stability refers to the ability of the banking sector to withstand shocks and continue its function smoothly whilst improving the public confidence Schinasi (2004). This means that the banking sector serves as a shock absorber to both internal and external vulnerabilities. The banking sector is a focal lever in the financial system dynamics, as it intermediates surplus and deficit units; manages risks (financial & economic). It also facilitates the creation of employment opportunities via intermediation of funds and a key vehicle for monetary stability in the monetary policy dynamics. Banks are the main channels that connect lenders and savers in the economy, and this spurs private sector growth, which together with government spending are the prime movers of economies. The international banking sector has faced crises; in particular, the 2008/2009 Global Financial Crises shook the international landscape tremendously. This prompted regulators to rethink and recast the Basel II Capital Framework to a more standardized Basel III framework that addresses the shortcomings of the international banking sector under Basel III capital framework. In that regard, the banking sector's resilience has been further strengthened.

On a regional bloc, the economic outlook for Africa (AEO) in 2019 portended that the economy of Africa has the growth potentials that are sustainable regardless of the challenges faced in the region. The banking sector is the catalyst that spurs this growth trajectory that is facilitated by financial intermediation (connection between lenders and savers of funds) which is also an impetus. The financial system in Sierra Leone comprises of the banking sector and the non-bank sectors. The banking sector embodies the fulcrum of the financial sector which comprises of about 80 per cent of the assets in the financial sector. This means that for the financial sector to be resilient, the banking sector has to be fortified. Furthermore, the banking system is composed of fourteen (14) Commercial Banks; two (2) state owned banks, two (2) domestic private owned banks and ten (10) foreign owned subsidiaries mainly from Nigeria, all regulated under the Banking Act 2019. The fact that the banking sector is the primary player in the cash markets,

elicits a structural stance that prompts the need to evaluate the banking sector's stability in Sierra Leone.

1.1 Research issue

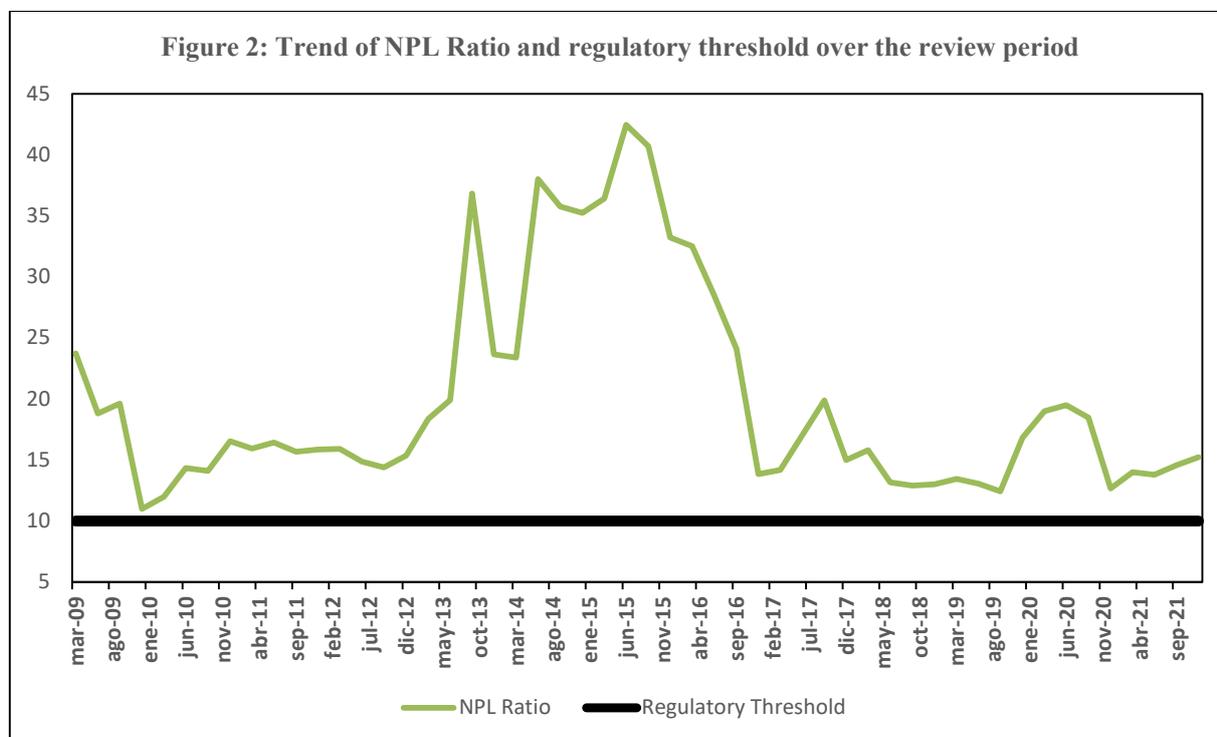
The economic trajectory of Sierra Leone has been one with vicissitudes marked by internal and external shocks. On average, Sierra Leone's economy has continued to grow by 4.2 per cent since 2009.



Source: World Bank's WDI

Banks' efficiency has improved not only on a micro-perspective, but also on more so on a macro-perspective, albeit some prudential measures have been deployed to safeguard the banking sector. The need to strengthen banking sector stability despite some financial skirmishes, and confronted with internal and external pressures, are catalysts of the BSL's crucial and comprehensive policy measures. The BSL has deployed far-reaching prudential and regulatory safeguards during the life-cycle of the banks. These include revised Acts, Guidelines and Regulations. Banking sector stability has focused on ensuring a safe, sound, stable and profitable banking sector. This embeds the protection of depositors' funds that is paramount and the alignment of boosting shareholders' equity. The banking sector in Sierra Leone has been resilient in the midst of a taxonomy of risks. These include credit risk (that loans those banks made will not be repaid.), market risk (that assets will become worthless due to changes in market prices). Additionally, operational risk (that internal processes including governance, control systems, amongst others will fail); and liquidity risk that it will be hard for banks to meet short-

term obligations, leading to fire sales of assets and interest rate risks amongst others. Other measures employed by the central bank of Sierra Leone were directed at putting the banking sector on a firmer footing.



Source: BSL

Despite the channel toward a germane macroeconomic outlook, risks are still present in the banking sector including liquidity risks, market risks and operational risks. These are often coupled with panic or bank run in which there is a call on deposits from banks. Beyond these concerns, the matter of banking sector stability is key because as complexities and diversities of the banking sector dynamics have increased in the past the likelihood effect of banking sector instability on the economy has also increased. With non-performing loans ratio on the high side since 2009 averaging 20.39 per cent amidst a regulatory threshold of 10 per cent, the resultant increase in loan risk has burdened monetary policy and more so financial stability policy as shown in figure 2. Against a background of an already high cost of operations by banks, further increase in NPLs ratio on the main would dampen confidence, reliability thus becoming deleterious and inimical to growth and further development of the banking sector in particular, and the financial system in general. A disintegration of the NPLs revealed that the substandard, doubtful and loss categories are exacerbating the NPLs ratio. This means that these three (3) keys elements are the drivers for these the decline in asset qualities.

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Stress testing exercises conducted by the central bank reflect that the banking sector is resilient and stable. Furthermore, the banking sector was still experiencing deficit in terms of corporate governance issues (weak governance structures amongst others). These shortcomings or weaknesses amongst others prompted the central bank to increase banks minimum capital levels from Le30bn to Le85bn in 2021 over a three-year period in tranches. Given the different measures that Bank of Sierra Leone has brought to bear on the prudential and regulatory perimeter of the banking sector, with attendant asset quality issues raising, the question still persists: How stable is the banking sector of Sierra Leone? how concentrated is the banking sector of Sierra Leone.? Therefore, this study unravels the stability and concentration of the banking sector of Sierra Leone. In that regard, the objective of the study is to first assess the banking sector's stability and secondly is to explore the concentration level of the banking sector.

Banking sector stability and concentration is of paramount focus to economists, policy makers and other stakeholders. Economists and other policy makers amongst others have elicited this core interest. The interest had been enshrined on the debate of entering a variable in elucidating growth and development of a country, had been contributed to by Bretton woods institutions and other researchers. It is astonishing that few studies have been done on financial stability in Sierra Leone. For instance, Jackson and Tamuke (2022) assessed the credit risk management and the financial performance of domiciled banks in Sierra Leone using unbalanced panel data methodology using quarterly data over the period 2008-2018 with only eight banks. Their findings is that weaknesses of the banking sector stems from NPLs ratio. They also provide evidence that a low productive base in the domestic economy influences the state of high NPLs in the banking system.

From a more focused point, the astonishment of few studies being done on banking sector stability and diversity also emanates from the fact that the banking sector of Sierra Leone accounts for about 80 per cent of the assets in the financial system, which makes it very significant in determining the stability and diversity of the financial sector. This study supersedes that done by Jackson and Tamuke (2022) because it takes a macro-prudential dimension of the entire banking sector comprising of fourteen banks and more so employs the standardized Financial Soundness Indicators (FSIs) portended by the IMF to allow for comparable amongst country financial landscapes. It is the first empirical research to the best of the researcher's knowledge to focus on the banking sector stability by encapsulating all fourteen banks in the Sierra Leone jurisdiction.

Concerning methodology, plethora of methods are available in the literature for empirical analysis. Employing any of these methodologies depends on the country specific factors that may have various effects of the estimates generated. Three key facets come to the fore, including variable measurement, estimation techniques and scope. However, the method put forward by the authors –the unbalanced panel fixed effects suffer from some limitations, including a culture of omission, low statistical power, limited external validity, restricted time periods, measurement error, time invariance, undefined variables, unobserved heterogeneity, erroneous causal inferences, imprecise interpretations of coefficients, imprudent comparisons with cross-sectional models, and questionable contributions vis-à-vis previous work.

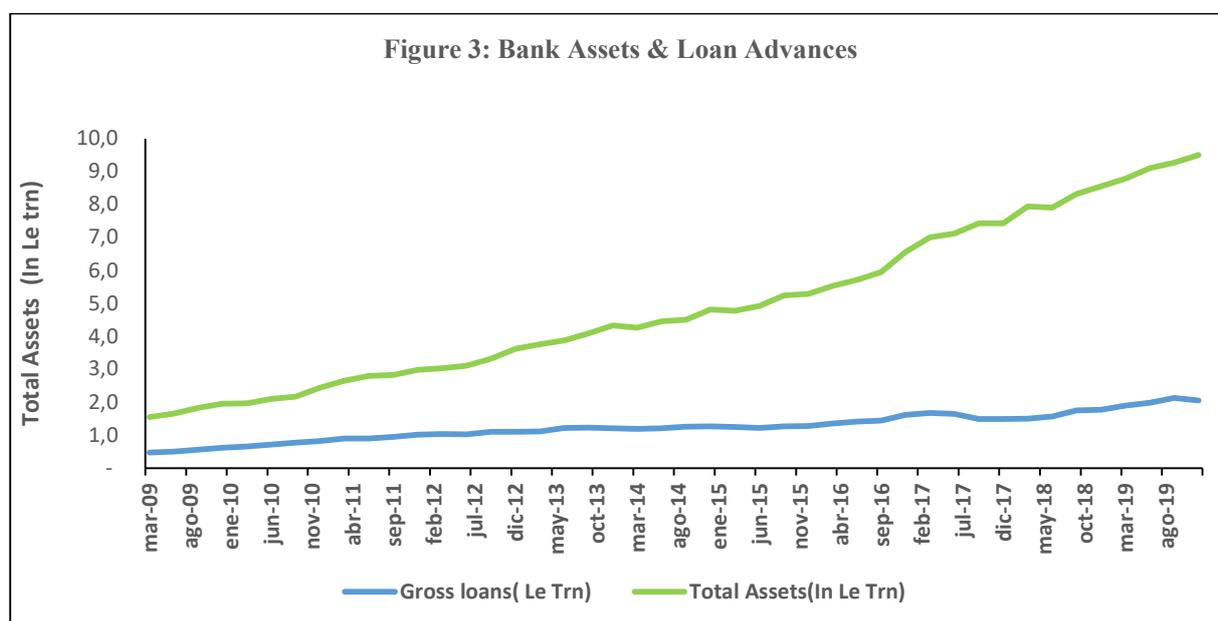
Therefore, to overcome these shortfalls in fixed effects methodology, this study examines the stability of the banking sector using relevant econometric analysis in the context of Johansen Cointegration technique that encapsulates the long run relationship amongst the variables of interest. The banking sector diversity is explored in the context of Herfindahl Hirschman Index (HHI). The findings of this study would provide a fresh comprehension of stability and diversity of the banking sector in Sierra Leone and offer a platform to keep policy makers more informed and portend prescriptive policies that will boost the sector performance in Sierra Leone.

2. Synopsis of Sierra Leone's Banking Sector

Indeed, banks are key as they lend to finance and boost growth and development in the country. Primary amongst their functions include accepting of deposits, granting credits and transfer of funds on customers' behalf. The banking sector is a crucial mechanism for transmitting economic policies of government especially via the monetary policy transmission by the central bank, which regulates the cost and availability of credit in the economy.

Given their substantial role, sensitive features, and the focal point that banks' capacity affect economic growth largely depending on their efficiency, the central bank has continued to adopt a comprehensive nest of policies that put the banks on a firmed footing by improving banks' safety and soundness.

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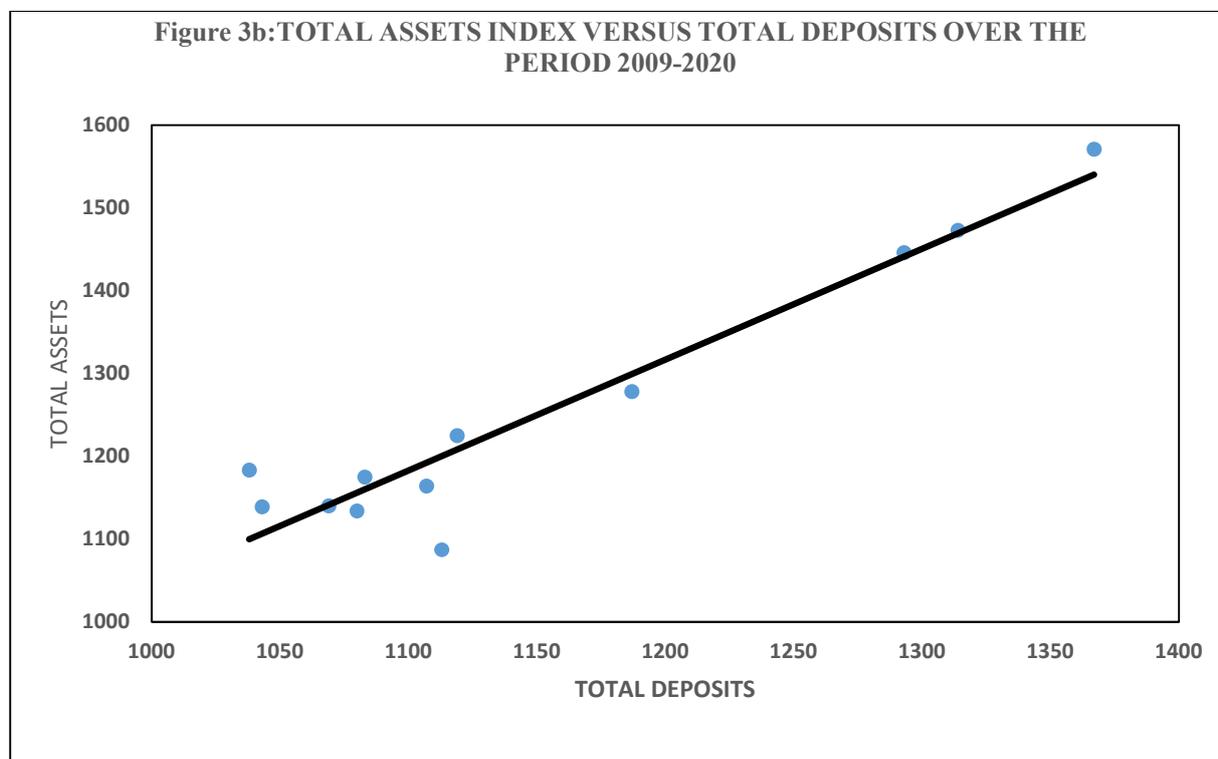
Source: BSL

The banking sector diffusion has been such that the paid-up capital was increased due to the new regulatory directive which required all commercial banks to increase their minimum paid up capital from Le30bn to Le45bn in 2019, but further increased to Le85bn in 2021. Due to the regulatory tsunami of policies rolled-out by the central bank, the effects have translated into influencing macro-economic conditions in the banking sector via the increase in total assets of banks, loans and advances have increased but NPL ratio on the average has increased. On structural basis, this permeation has also improved the banking sector.

2.1 Stylized Facts

This sub-section deals with stylized facts to assess the diversity of the banking sector by mirroring the total assets against the total deposits in the banking sector over the period 2009-2020. This is illustrated in figure 3b that reflects concentration and diversification index of the banking sector in Sierra Leone using *Herfindahl Hirschman Index* (HHI). In this analysis, concentration is shown as stylized facts in terms of total assets and total liabilities in the banking sector. Concerning total deposits for 2019, the read-out 1134 which is below, the threshold of 1500 and reflects a competitive banking sector. With respect to total assets for 2019 the read out is 1080 that is also below the threshold of 1500 and confirms a competitive banking sector in Sierra Leone. The key message is that there is high correlation between the squares of deposits

and assets of the banking sector have positive correlation reflecting the competitiveness of the banking sector in Sierra Leone. Taken together, the HHI confirms that the banking sector is competitive as reflective of the diversity level of the banking sector.



Source: BSL

3. Review of the Relevant Literature

On the global scene, a myriad of studies has unraveled the stability and diversity of the financial sector in Africa but very few in Sierra Leone. This article conducts empirical analysis to select a suitable technique to employ as well as seeing how estimated findings support theoretical discourse on the variables of interest. It further delineates the literature review based on selected studies done outside Africa and studies done within Africa. In addition, studies done in Sierra Leone.

Ntarmah et “al” (2019) averred the impact of banking system stability and economic sustainability on some selected developing countries using a panel data methodology of 37 developing countries over the period 2000-2016. The study made the following key findings: First, the study revealed that banking system z-scores has positive effect on economic sustainability of developing economies while banking system regulatory capital and bank credit have negative

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effects on economic sustainability among selected developing economies. Second, while banking system z-scores, bank liquid assets and bank credit have positive effects on economic sustainability of Brazil, Russia, India, China, and South Africa (BRICS) economies, bank liquid assets and bank credit have negative effects on economic sustainability of non-BRICS economies except banking system scores, which has a positive effect. In addition, banking system z-scores has positive effect on economic sustainability of Asian and non-Asian economies. However, non-performing loans and bank credit has negative effects on economic sustainability of Asian economies while banking system regulatory capital has negative effect on economic sustainability of non-Asian economies. We conclude that banking system stability play a role in economic sustainability developing economies. However, banking system stability has differing effects on economic sustainability of BRICS and non-BRICS economies; and Asian and non-Asian economies.

Jayakumar et al (2018) examined whether feedback effects permeate banking stability, banking competition and economic growth for thirty-two European Countries over the period 1996-2014 using a panel VECM methodology. Their study revealed that both banking competition and banking stability are significant long-term drivers of economic growth in the European countries. A corollary to this policy-wise is that economic policies should recognize the differences in the relationship between both banking competition and banking stability in order to maintain sustainable economic performance of these countries.

Abuzayed et al (2018) explored bank diversification strategies and nexus to financial sector stability. Employing a coverage of 2001-2014 of listed and unlisted banks operating in the Gulf Cooperation Council (GCC) countries they unravel the diversification features of conventional and Islamic banks. Their key results show that income or asset diversification is retarding to bank stability. Nevertheless, evidence exist of a non-linear relationship between non-interest (non-financing) income and stability demonstrating that banks are able to dampen risk at higher levels of diversification. Conventional banks appear to be more adversely impacted on the risk side than Islamic banks. Furthermore, factors such as improved institutional quality, macroeconomic conditions, and other bank-specific factors bolster greater stability.

Aluko (2018) explored the determinants of banking sector with evidence from sub-Saharan African that This study examines the determinants of banking sector development in sub-Saharan African countries using a panel of 25 countries from 1997 to 2014. It utilizes the system Generalized Method of Moments (GMM) dynamic panel model estimator. Using a composite

index of banking sector development, the estimation results show that population density and simultaneous openness to trade and capital promote banking sector development while financial liberalization hinders banking sector development. This study reveals that institutional quality, population density, and trade openness increases the depth of the banking sector. Also, it demonstrates that law, inflation, and religion promote the efficiency of the banking sector while latitude, trade openness, income level, and ethnic diversity reduce banking sector efficiency. In addition, it shows that law and simultaneous openness to trade and capital enhances the stability of the banking sector while land area, financial liberalization, economic growth, and inflation adversely affect banking sector stability.

Udom et al. (2018) assessed the Financial System Stability over the period 1997 and 2016 using the macro prudential approach and employing time series methodology to unearth the weaknesses and strengths of the banking sector in Nigeria. The study showed that by the end of 2016, clear signs of impending crises had started to emerge in the system. The suggestions proffered for ameliorating such crises include the moderation of inflation, close monitoring of the risk management framework of the banks and strict enforcement of corporate governance standards. Their study could have been enhanced by including dummy variables to account for periods where the banking sector experienced debilitating effects.

Ogbeide et al. (2017) explored banking sector performance embedding financial regulations in Nigeria over the period 1993-2016 using cointegration methodology. Their findings revealed that the effect of various financial legislations and reforms on Nigerian banks performance and most regulation measures should be publicized frequently to build trust and transparency in the banking sector in particular, and the financial system in general. Their study could have been improved by including more financial soundness indicators that encapsulate the health of the banking sector.

Nderitu(2016) assessed the impact of elements that exacerbate risks of commercial banks in Kenya over the coverage 2008-2014 and employing panel Generalized Method of Moments estimation methodology. The study revealed that borrowing risk exposure was found not to be persistent, was impacted by the magnitude and velocity of concentration and also external sector exposures. Their study could have been enriched by giving specifics for Kenya on what monitoring indicators could be deployed to yield the substantial benefits of managing banking sector risks.

Jackson and Tamuke (2022) explored the credit risk management and the financial performance of domiciled banks in Sierra Leone employing unbalanced panel data methodology

with quarterly data over the period 2008-2018 with only eight banks. Their findings were that weaknesses of the banking sector stems from NPLs ratio. They also provide evidence that a low productive base in the domestic economy influences the state of high NPLs in the banking system.

This study embeds all banks in Sierra Leone and accounts for the Ebola Virus Disease period via a dummy variable. Against this backdrop, that the evidence from this study will keep policy makers more informed about the banking sector dynamics.

4. Theoretical Framework and Methodology

The theoretical framework for assessing banking sector stability in Sierra Leone is entrenched on the Learner Index Theory as a key indicator of banking sector's competitiveness. In its simplest form, it enables market power to prompt firms for setting price above the marginal cost. It is estimated thus:

$$LER_{i,t} = (K_{i,t} - MC_{i,t}) / K_{i,t} \text{-----}(1)$$

Where:

$K_{i,t}$ = Bank i price at year t,

$MC_{i,t}$ = Marginal Cost

Larger index values mean more market power or strength. The output price V is estimated as total revenues over total assets. Consistent with Beck et al(2013), a conventional marginal cost is couched using one output, three input and one-time trend translog cost function, hence resulting in a specification thus:

$$\ln TC = \bar{g} + \bar{g}_1 \ln V + \sum_{j=1}^3 \gamma_j \ln \beta_1 + \sum_{j=1}^3 \gamma_j \ln \beta_2 + \sum_{j=1}^3 \gamma_j \ln \beta_3 + \eta_1 t + \eta_2 / 2 t^2 + \xi_{it} \text{-----}(2)$$

Where:

TC = Total Cost

V = Commercial bank single output proxied by total assets

$\beta_1, \beta_2, \& \beta_3 =$ Prices used in the production process

$\beta_{1,} =$ Price of Labour, (expenses on personal divided by total assets)

β_2 = Price of physical capital (other admin outlays added to other operating expenses all divided by total expenses)

β_3 =Price of borrowed funds (interest expenses divided by total deposits)

t = Time trend encapsulating the cost function behavior over time

\bar{g} , γ and η = estimated coefficients

ξ_{it} = Two component error term

From equation 2, marginal cost is given as:

$$MC_{i,t} = (TC_{i,t} / V_{i,t}) [\bar{g}_1 + \bar{g}_2 \ln V + \sum_{j=1}^3 \gamma_j \ln \beta_j + \eta_3 t] \text{-----}(3)$$

By including bank stability, bank z-score(standard score) is employed and has been widely used in the banking literature(Iannota et al 2007;Laeven and Levine, 2009). The study leverages on this key indicator and is estimated as the difference between ROA and its mean divided by the standard deviations by which returns have to reduce in depleting banks equity. This follows as:

$$BZscore_{i,t} = \frac{ROA_{i,t} - \mu(ROA)}{\sigma(ROA)} \text{-----}(4)$$

Where:

$ROA_{i,t}$ = Return on assets for bank i in current period t

$\mu(ROA)$ = Average of return on assets

$\sigma(ROA)$ = Standard deviation of return on assets

BZscore is a gauge of bank soundness. Greater values mean a greater degree of solvency and thus it offers a direct indication of stability. Because banks are in the business of managing financial risk by on lending activities as their major source of earnings rather than intermediation activities, the study notes that banks' stability is strictly akin to loan quality. Therefore, loan assets are also a variable of choice.

The model to explore the banking sector stability in Sierra Leone is a prolongation of the recast version of the Lerner Index of perfect competition mirrored by Cihak & Hesse (2007). This is illustrated as follows:

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$$\mathbf{BZ}_t = \bar{g} + \bar{g}_1 \mathbf{O}_t + \bar{g}_2 \mathbf{S}_{t-1} + \bar{g}_3 \mathbf{T}_{t-1} + \bar{g}_4 \mathbf{I}_t + \bar{g}_5 \mathbf{M}_t + \xi_t \text{ -----(5)}$$

Where:

BZ= Regressand for bank sector at time t

O_i = Vector of banks particular variables

I = Vector of banking industry specific variables in country j

T_j& TI = Banks type and interaction between the type and some of the industry –specific variables as well as bank specific variables respectively

M_j= Vectors of Macroeconomic variable.

ξ_t =Residual

More specifically, the estimated recast form of equation 5 is expressed in log-linear form to interpret the coefficients as elasticities in equation (6). The model was estimated by explicitly introducing total bank assets, gross loans, as regressors and controlling for exchange rate and dummy variable for ebola virus disease.

$$\mathbf{DLBZscore}_t = \gamma_0 + \gamma_1 \mathbf{DLTBA}_{t-1} + \gamma_2 \mathbf{DLGL}_{t-1} + \gamma_3 \mathbf{DLNEXR}_{t-1} + \gamma_4 \mathbf{EVDUM}_{t-1} + U_t \text{ -----(6)}$$

Where: $U \sim \text{ii } N(\mathbf{0}, \sigma^2)$

BZscore = Bank Zscore

TBA = Total Bank Assets

GL = Gross Loans

NEXR = Nominal Exchange Rate

EVDUM = Ebola Virus Disease Dummy variable

The lags are chosen to be equal to 1 in order to save degrees of freedom.

The coefficient of total bank asset is expected to be positive and significant if they are liquid and a buildup of liquid assets safeguards banking sector stability. The coefficient of gross loan is

expected to be positive and significant if these loans are directed at sectors that drive the growth potentials of the economy. The effect of nominal exchange rate on bank zscore is ambiguous. It is expected to be positive when the leones has appreciated and translates to shoring-up banking sector stability as Sierra Leone is an import dependent economy. The effect of the ebola virus dummy variable on banks zscore is expected to be negative and significant.

4.1 Banking Sector Concentration or Diversity Index

To address the issue of banking sector diversity, mirroring Michie et al(2013), the banking sector diversity index for Sierra Leone is crafted on market competition and concentration index. Of the banking sector in Sierra Leone over the review period. The study encapsulates all banks to give a comprehensive assessment of the dynamics in the banking sector. Ideally, it is pertinent to point out that the banking sector accounts for the lions' share (about 80 per cent) of the financial system.(BSL Financial Stability Report, 2018). The concentration index gauges the degree of concentration and competition in the banking sector. The Herfindahl-Hirshman Index is used to assess the banking sector concentration for diversity. From an algebraic perspective, it is calculated thus:

$$HHI = \sum_{k=1}^n \left(\frac{q_k}{Q} \right)^2 = \sum_{k=1}^n (rk)^2 \text{ -----(7)}$$

Where:

n = Number of banks in the banking sector

qk =Volume of bank k's output

Q = Total volume of banking sector's output

rk = Bank k's share of the banking sector's output

k= Banking unit.

4.1.1 Estimation Technique

The estimation technique employs the Ordinary least squares technique. Furthermore, to unravel the diversity of the banking sector over the review period, the herfindahl-hirshman index is employed because it is mirrors the Sierra Leone banking sector and it is simple and straightforward.

4.1.2 The Data

The paper's coverage is from 2009-2019 using quarterly data as this period embodies potent policies that have been operationalized in the banking sector. Furthermore, this period is sufficient to examine the stability and diversity of the banking sector in Sierra Leone. Data on total bank assets and gross loans was sourced from the Bank of Sierra Leone's Financial Soundness Indicators as espoused by the IMF for standardization across countries.. Bank Z-score was calculated also using this data source. Exchange rate is sourced from the Banks' Data Warehouse over the period.

5. Estimation Results

This section presents the results of the empirical estimations and discussion of the findings. The result is estimated, and the estimates are interpreted accordingly. To ascertain the stationarity of the variables, the study employed the Dickey Fuller Generalized Least Squares test for unit roots because it has better size and power. The results are shown in Table 1. From the unit root test, all the variables are stationary after first difference. This means that the variables are integrated of order one (I(1)) reflecting that equation (6) can be estimated in using the Vector Auto Regressive method, as hypothesis tests and inferences can be made once the variables are stationary.

Table 1: Results for the Test for variable stationarity

Variable	Dickey-Fuller GLS Statistics(Levels);I(0)	Dickey-Fuller GLS Statistics(First Difference; I(1))	T-Statistics Critical Value	Implication	Order of Integration
LBZscore	-1.304749	-7.466069	-1.948886	A Stationary Variable	I(1)
LTBA	0.862575	-5.969893	-1.948886	A Stationary Variable	I(1)
LGL	0.905404	-4.801237	-1.948886	A Stationary Variable	I(1)
LNER	2.395895	-4.229198	-1.948886	A Stationary Variable	I(1)

Source: Author's estimation from research data

5.1 The Estimated Models of Bank zscore

Since all the variables are integrated of order one(1), the model of bank zscore is estimated by applying Johansen Cointegration technique to specification in equation (6). This test is carried out to know whether a long run relationship exist among the variables of interest. In conducting the Johansen cointegration test, the optimal lag length is first determined to include in the specification. This is done to avoid spurious regression results and over-parameterization because of insufficient lags. Hence, the **optimal lag length** was determined using Akaike information criterion, Schwarz information criterion, and Hannan-Quinn information criterion, and then selected as in shown in **Table 2**.

Table 2: Optimal Lag Length Selection

VAR Lag Order Selection Criteria

Endogenous variables: LZSCORE LTBA LNXR LGL

Exogenous variables: C EVDUM

Sample: 2009Q1 2019Q4

Included observations: 41

Lag	LogL	LR	FPE	AIC	SC	HQ
0	106.1047	NA	9.81e-08	-4.785595	-4.451239	-4.663841
1	319.8480	364.9277	6.40e-12	-14.43161	-13.42854*	-14.06635*
2	339.2296	29.30870*	5.60e-12*	-14.59657*	-12.92479	-13.98780
3	353.1346	18.31386	6.68e-12	-14.49437	-12.15388	-13.64209

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Source: Author's estimation from research data

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From the table 2, the AIC, FPE and LR criteria selected lag two at the 5% level of significance, therefore the optimal lag is lag two. Thereafter Johansen test of Cointegration is performed as shown in Table 3 and Table 4. An intercept was chosen with no trend in cointegrating equation.

Table 3: Results of Trace Test

Sample (adjusted): 2009Q4 2019Q4
Included observations: 41 after adjustments
Trend assumption: Linear deterministic trend
Series: LZSCORE LTBA LNEXR LGL
Exogenous series: EVDUM
Warning: Critical values assume no exogenous series
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.608650	68.98143	47.85613	0.0002
At most 1 *	0.340929	30.51711	29.79707	0.0413
At most 2	0.263398	13.42321	15.49471	0.1002
At most 3	0.021454	0.889203	3.841466	0.3457

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Source: Author's estimation from research data

From Table 3, the Trace test indicates two cointegrating equations between the variables at 5% level of significance. This test shows the existence of cointegrating relationships between the variables.

Table 4: Maximum-eigenvalue

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.608650	38.46432	27.58434	0.0014
At most 1	0.340929	17.09390	21.13162	0.1676
At most 2	0.263398	12.53401	14.26460	0.0922
At most 3	0.021454	0.889203	3.841466	0.3457

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Source: Author's estimation from research data

From Table 4, the Maximum Eigenvalue test indicates one cointegrating equations between the variables at the 5% level of significance. This test also shows the existence of cointegrating relationships between the variables. Taken together, these tests indicate the existence of cointegrating relationships among between the variables. e Max-eigenvalue test showing 1 cointegrating equation is employed.

Table 5: Normalized Equation

1 Cointegrating Equation(s): Log likelihood 337.8760

Normalized cointegrating coefficients (standard error in parentheses)

LZSCORE	LTBA	LNEXR	LGL
1.000000	0.009509	-1.816670	0.790773
	(0.35836)	(0.39532)	(0.33542)

Source: Author's estimation from research data

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From Table 5 displaying the normalized equation, the normalized model is what is estimated for the long run relationship. After establishing cointegration relationship, the Vector Error Correction Model (VECM) is estimated. The VECM comprises of the long run and short run estimated coefficients, and the error correction model (speed of adjustment) as shown in Table 6 and Table 7.

Table 6: Long-Run Parameter Estimates of the Model Dependent Variable: DLZSCORE

Variable	Coefficient	Standard Error	t-stats
DLZSCORE	1		
DLTBA	0.577149	-0.37202	1.55141
DLGL	0.478885	-37272	1.35201
DLNEXR	-2.206732	-0.3542	-5.92057
C	1.750725		1.35201

Source: Author's estimation from research data

In the long run, total bank assets rate has a positive effect on bank zscore, with a coefficient of 0.58, meaning a unit change in total bank assets will lead to 0.58 unit in bank zscore in the same direction as the two variables are directly related.

Moreover, gross loans has a positive impact on bank zscore with a coefficient of 0.48, this means that a unit increase in gross loans is expected to trigger 0.48 of a unit increase in bank zscore. This may be due to the fact that gross loans are directed at sectors that drive growth in the economy; and loan repayments from those sectors boost banking sector stability.

Furthermore, in the long run nominal exchange rate has a negative effect on bank zscore with a coefficient of -2.21, and this means that a unit change in nominal exchange rate is expected to trigger a 2.21 of a unit change in bank zscore in the opposite direction.

Table 7: Error Correction Model (Speed of Adjustment) and Short Run Model

Dependent Variable: D(LZSCORE)

Method: Least Squares

Sample (adjusted): 2009Q3 2019Q4

Included observations: 42 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECM(-1)	-0.347569	0.062799	-5.534588	0.0000
D(LZSCORE(-1))	-0.228342	0.110866	-2.059622	0.0469
D(LTBA(-1))	1.908519	0.421368	4.529337	0.0001
D(LNEXR(-1))	-2.309947	0.530452	-4.354674	0.0001
D(LGL(-1))	0.235118	0.290899	0.808246	0.4244
C	-0.043287	0.021485	-2.014733	0.0517
EVDUM	0.111787	0.029101	3.841311	0.0005
R-squared	0.584722	Mean dependent var		0.012208
Adjusted R-squared	0.513531	S.D. dependent var		0.094672
S.E. of regression	0.066031	Akaike info criterion		-2.446372
Sum squared resid	0.152603	Schwarz criterion		-2.156760
Log likelihood	58.37381	Hannan-Quinn criter.		-2.340218
F-statistic	8.213471	Durbin-Watson stat		2.109629
Prob(F-statistic)	0.000014			

Source: Author's estimation from research data

Table 7 shows the estimated coefficient of the error correction model (negative), indicating convergence towards long run equilibrium, and reports the coefficients of the short-run parameters, along with their standard errors and t-statistics. The error correction term(ecm-1) coefficient of approximately -0.3 indicates that approximately 30% of shocks can be justified as a long run trend, thus convergence towards the long run equilibrium. The implication of this is that deviations in the Bank zscore away from the equilibrium are corrected by 30% within a year.

The short run coefficients were significant at the 5% level of significance, except gross loans at first period lag. In the short run, total bank assets at first period lag was significant at the 5% level of significance but has a positive impact on bank zscore with a coefficient of 1.9. This implies that a unit change in total bank assets is expected to trigger 1.9 of a unit increase in bank zscore ceteris paribus during the period studied.

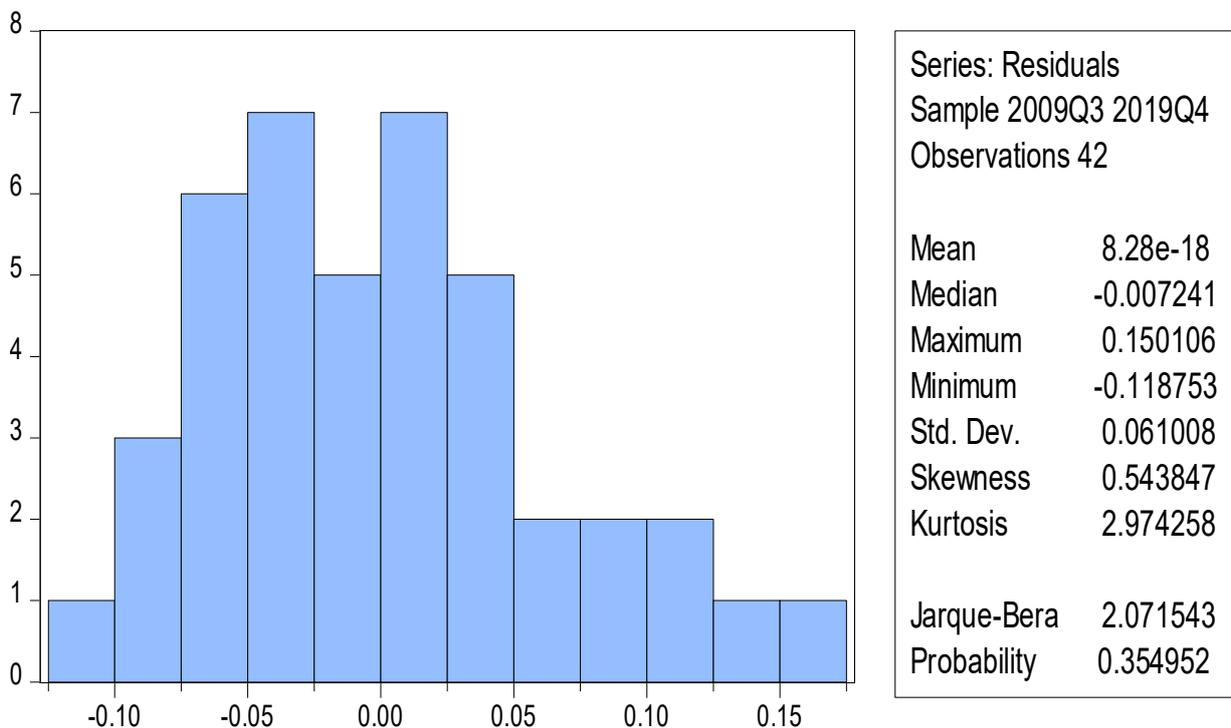
Furthermore, bank zscore at first period lag was significant at the 5% level of significance and has negative impact on its contemporaneous bank scores with coefficient of -0.23. It is surprising to note that the ebola virus dummy has a positive impact on bank zscore and it is statistically significant. However, it may be because international Non-Governmental Organizations and other countries including UK injected funds via the banking sector to address the scourge. This in turn contributed in the accretion of banks deposits and bolstering of the banking sector stability.

The overall fit of the model is such that R^2 has a value of 0.58. This shows that its regressors explain 58% of the total variations in bank zscore.

5.2 Diagnostics Tests

In order to ascertain the reliability of the estimated results, the following diagnostic test was conducted; Residual Normality Test, Heteroskedasticity test, autocorrelation, CUSUM and CUSUM of squares.

Figure 4: Residual Normality Test



Source: Author's estimation from research data

The results of the normality test show that the errors of the bank zscore model are normally distributed with mean zero and standard deviation of one. This means that the errors of the bank zscore model are normal since p-value is greater than the 5% significance level.

Table 8: Test of Homoskedasticity of the ECM

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.015703	Prob. F(6,35)	0.4312
Obs*R-squared	6.228544	Prob. Chi-Square(6)	0.3981
Scaled explained SS	4.269705	Prob. Chi-Square(6)	0.6402

Source: Author's estimation from research data

The results of the Heteroskedasticity White test show that the errors of the bank zscore model are homoscedastic. This Heteroskedasticity White test regresses the bank zscore-regressors upon the residuals to test if the bank zscore-regressors can explain the residuals. Since the p-value of the F-statistic is greater than 5% significance, the errors of the bank zscore model are homoscedastic.

Table 9: Autocorrelation Test of the ECM

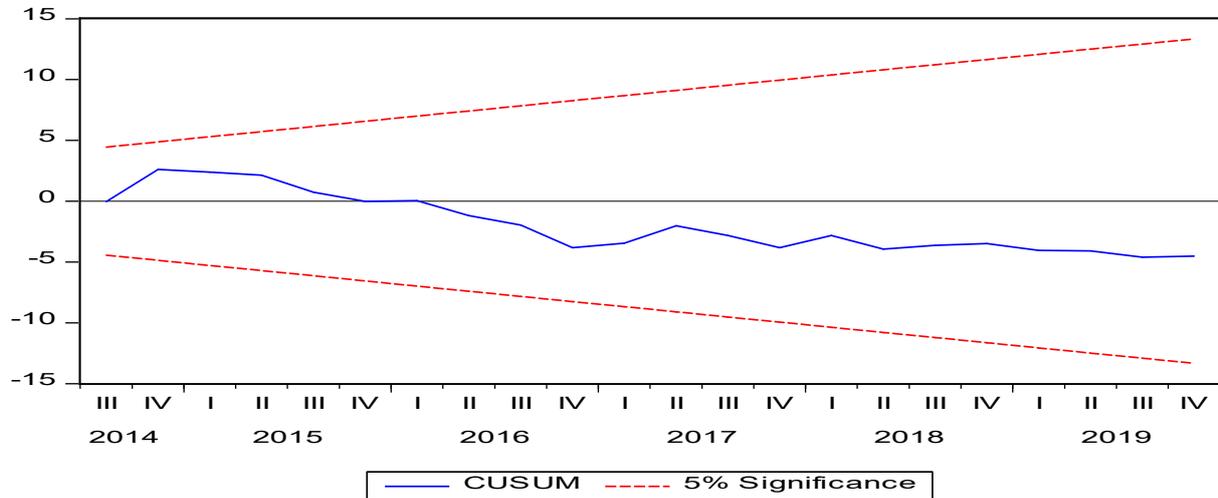
Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.252167	Prob. F(1,34)	0.6188
Obs*R-squared	0.309207	Prob. Chi-Square(1)	0.5782

Source: Author's estimation from research data

The results of the Breusch-Godfrey Serial Correlation LM Test show that the errors are non-correlated. This implies that because the p-value is greater than 5%, the errors are non-correlated. The study therefore establishes that the errors are non-correlated, the estimates obtained by ordinary least squares are optimal Best, Linear, Unbiased and Efficient (BLUE).

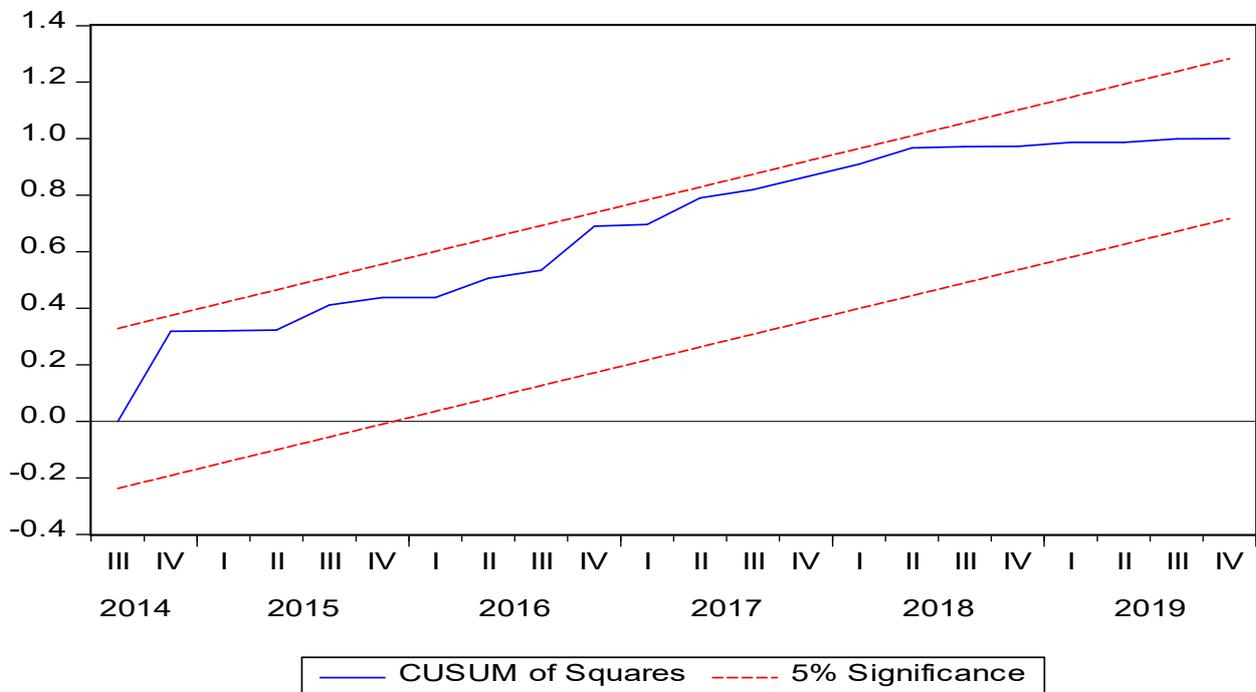
Figure 5: The CUSUM stability Test (Brown, Durbin, Ewans)



Source: Author's estimation from research data

The CUSUM stability test indicate such that the curve does not touch the corridor meaning that the bank zscore model is structurally stable at 5% level of significance.

Figure 6: The CUSUM squared stability Test (Brown, Durbin, Ewans)



Source: Author's estimation from research data

The CUSUM squared stability Test (Brown, Durbin, Ewans) is such that the curve does not touch the corridor meaning that the GDP model is structurally stable at 5% level of significance.

6. Conclusion & Policy Implications

6.1 Conclusion

The study was conducted to investigate the banking sector stability in Sierra Leone using an econometric analysis by using quarterly data over the period 2009-2019 and to assess the concentration in the banking sector over the review period.

To investigate banking sector stability the Johansen cointegration modeling approach was employed since all variables were integrated of order one to establish whether cointegration (long run relationship) exists between banking sector stability and its regressors over the coverage period. Hence, the approach used by study was regression analysis using time series data. The Johansen Approach to Cointegration showed that there was existing long run relationships between banking sector stability and its regressors. Consequently, the parsimonious short run model of banking sector stability was estimated during the study period.

The results reveal that total bank assets, and gross loans have positive impact on banking sector stability in the long run and the same is true of the short run. Conversely, exchange rate has a negative effect on banking sector stability in the long run as well as the short run. The dummy variable accounting for the Ebola virus disease on the banking sector stability reflected that it has a positive impact on banking sector stability.

On the banking sector concentration, the results from the Herfindahl Hirshman Index (HHI) indicated that the banking sector in Sierra Leone is competitive. This shows that intermediation has improved during the review period.

6.2 Policy Implications

A stable and sound banking sector is essential for sustainable economic development and improved social welfare. Furthermore, the banking sector is the vehicle through which most transactions are conducted in the real economy of Sierra Leone.

Based on the conclusion, the following policy suggestions are portended:

- Since total bank assets has positive impact on banking sector stability, it may be important for banks to continue the accretion of liquid assets via interbank lending activities and potent secondary market operations to deepen the financial markets in Sierra Leone and this will contribute to strengthening banking sector stability.
- Banks are encouraged to diversity their lending activities to private sector taking cognizance of their attendant risks. For instance, lending to business services, construction, commerce, and finance sectors amongst others may propel private sector growth that will contribute together with government investment to stimulate economic growth in Sierra Leone.
- Furthermore, the Bank should monitor the micro-dynamics of individual banks behavior in-order to enhance the soundness and stability of the banking sector. In addition, the dynamics on banking sector should be used as inputs for informing decisions on banking sector stability.
- Banks are encouraged to deepen and broaden their foreign exchange operations as this will contribute to building confidence by market participants and ultimately boosting banking sector stability.
- Since asset qualities issue have been prevalent in the banking sector, there is need to roll-out and implement the revised prudential guidelines for banks that addresses address various aspects of banks' credit operations, such as risk management, corporate governance, know-your-customer (KYC), loan loss provisioning; and also, the peculiarities of different loan types and financing to different sectors. The Bank remains committed to the enforcement of strict credit monitoring policies and engaging the management of banks through moral suasion to grant and manage the quality of risk assets in the industry and achieve and retain the NPL ratio at minimal levels.

In the spirit of building on the application of the models, there is need for conducting future studies (especially panel Autoregressive Distributed Lag (ARDL) models amongst others) to control for the nest of other macroeconomic variables such as output growth, inflation rate, institutional quality(governance) which also mimics banks economic outlook. These studies will control for other bank related features such as cost efficiencies (i.e. cost to income ratio). Taken together, this plethora of studies will surely complement banking sector stability dynamics in Sierra Leone.

7. Conflicts of Interest

The author declares no conflict of interest regarding the publication of this paper.

ANNEX

	ZSCORE	TBA	NEXR	GL
Mean	5.283243	4920873	5561.4	1246436
Median	5.138515	4486793	4520.845	1226188
Maximum	6.968915	9497899	9711.32	2133746
Minimum	3.720784	1549190	3103.74	481153.4
Std. Dev.	0.960613	2389852	1830.593	414035.7
Skewness	0.289873	0.404534	0.765628	0.137206
Kurtosis	1.914524	1.959124	2.249115	2.525506
Jarque-Bera	2.776332	3.186359	5.332385	0.550818
Probability	0.249533	0.203278	0.069516	0.759262
Sum	232.4627	2.17E+08	244701.6	54843189
Sum Sq. Dev.	39.67943	2.46E+14	1.44E+08	7.37E+12
Observations	44	44	44	44

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