UDC classification: 336.7

JEL Classification: N27

Loan asset indicators and commercial bank fragility in Kenya

A. C. O. Bwire[‡]

Purpose. To test the predictive ability of loan asset indicators on Commercial bank fragility in Kenya.

Design/Method/Research approach. The study adopted positivism research philosophy with exploratory research design. The study population was 42 Commercial banks in operation on 31st December 2015. Secondary data was collected from Central Bank of Kenya and analysed using Stata Statistics/Data analysis. Generalised Linear Model was used to establish the relationship between asset indicators and bank fragility. The concept of credit creation was explored as the genesis of bank fragility. This study is part of early warning systems in detecting bank fragility.

Findings. The research found a direct relationship between a lagged dependent variable, loan portfolio growth, loan deposit ratio and bank fragility.

Practical implications. Recommendations are followed on the basis of this study. At first, regulator develop a potential solution to control loan portfolio growth, cap loan deposit ratio and limit the level of non-performing loans. Banking practitioners should model monthly reporting requirements to ensure that banks are able to disclose the ratio and explain any significant changes. Secondly, since Non-performing loans can act as an incentive for bank managers to seek deposits and lend more thereby exacerbating the problem, banks with NPL to gross loans greater than an upper threshold determined by the regulator should not be allowed to attract more deposits. Thirdly, set the maximum level of loan deposit ratio to avoid expensive, sensitive and high-risk loan capital. Implementation of these recommendations will lead to secured social welfare.

Originality/Value. The study examines the role of certain loan asset indicators on bank fragility and extends the discussion in the area of early warning systems and commercial bank instability in Kenya.

Research limitations/Future Research. This research contributes to the discussion on bank fragility and early warning systems. The further research should review evidence from other jurisdiction with high numbers of distressed institutions to determine how many months or years before distress the three significant variables could predict fragility. Besides, there is need for research on insider loans as defined and why there was no statistical significance.

Paper type. Empirical.

Keywords: bank fragility; loan assets; credit creation; generalised linear model.

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Показники кредитних активів та вразливість комерційного банку у Кенії

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Мета роботи. Перевірити прогностичну здатність показників позикових активів щодо вразливості комерційних банків у Кенії.

Дизайн/Метод/План дослідження. Ця робота базується на позитивістській дослідницькій філософії з дослідним дизайном. У дослідженні брало участь 42 діючих на 31 грудня 2015 року комерційних банки. Вторинні дані були зібрані з Центрального банку Кенії і проаналізовані з використанням Stata Statistics/Data analysis. Узагальнена лінійна модель використовувалася для встановлення зв'язку між показниками активів і вразливістю банків. Концепція створення кредитів була досліджена як генезис вразливості банків. Це дослідження – частина систем раннього попередження для виявлення нестабільності банків.

Результати дослідження. Виявлено прямий зв'язок між залежною змінною, що відстає, зростанням позичкового портфеля, коефіцієнтом позичкових депозитів і вразливістю банків.

Практичне значення дослідження. Рекомендації, що наведено нижче, розроблено на основі цього дослідження. По-перше, регулятору потрібно розробити потенційне рішення для контролю за зростанням кредитного портфелю, співвідношення кредитного портфелю банку до обсягу депозитів та обмеженням рівня непрацюючих позик. Необхідно змоделювати вимоги щодо щомісячної звітності банківських установ, щоб банки могли розкривати ці показники та пояснювати будь-які їх суттєві зміни. По-друге, оскільки непрацюючі позики можуть слугувати стимулом для менеджерів банків шукати депозити та надавати більше позик, тим самим посилюючи проблему, банкам з непрацюючими позиками на загальну суму вище верхньої межі, що встановлена регулятором, слід не дозволяти залучати додаткові депозити. По-третє, встановити максимальний рівень коефіцієнта позичкових депозитів, щоб уникнути дорогого, чутливого та високоризикового позикового капіталу. Виконання цих рекомендацій зумовить гарантоване соціальне забезпечення.

Оригінальність/Цінність/Наукова новизна дослідження. Досліджено роль окремих показників кредитних активів у вразливості банків й розширено обговорення в області систем раннього попередження й нестабільності комерційних банків в Кенії.

Перспективи подальших досліджень. Це дослідження сприяє обговоренню уразливості банків і систем раннього попередження. В ході подальших досліджень доцільно вивчити дані з іншої юрисдикції з великою кількістю проблемних установ, щоб визначити, за скільки місяців або років до настання кризової ситуації три важливі змінні можуть передбачити вразливість. Крім того, існує потреба в дослідженні інсайдерських кредитів в тому вигляді, в якому вони визначені, і причин відсутності статистичної значущості.

Тип статті. Емпіричний.

Ключові слова: нестабільність банків; позичкові активи; створення кредиту; узагальнена лінійна модель.

1. Introduction

T he focus on loan asset indicators in this study was predicated on the fact that loans constitute the highest percentage of bank assets, are a source of fraud in form of insider loans and cause liquidity problems when the rate of loan default is high. Besides, loans are a source of interest income and therefore high loan default leads to lower profitability or losses. Losses have to be absorbed by bank capital. Bank fragility may emerge from the institution's liability or asset side of its balance sheet. *Shen and Chen (2008)* posit that weaknesses from the liability side may come about due to depositors run on a commercial bank. The asset side triggers concern due to deterioration of the quality of the loan asset. *Laeven (2011)* shows that large losses on bank's balance sheets will render the bank insolvent. These losses normally emanate from long periods of asset quality deterioration due in part to excessive credit expansion.

Alvarez-Franco and Restrepo-Tobon (2016) state that during and immediately after 2007-2009 US financial crisis three hundred twenty-two (322) US Commercial banks failed with an estimated loss of USD 86 billion to the FDIC compared to the period 1980-1989 when one thousand four hundred sixty-seven (1467) banks failed with an estimated cost of $62 billion and to the period 1990-1999, four hundred thirty-six (436) banks failed with estimated loss of $7 billion. *Cleary and Hebb (2016)* state that the FDIC fund went into the red during 2009 and that is a confirmation of the severity of bank distress. *Papanikolau (2018)* using US Commercial and Savings Bank data for the period 2003-2009 finds that in the course of the global financial crisis a considerable number of banks were distressed which inflicted substantial losses on governments and led to a surge in the level of public debt in a number of countries. Many governments borrowed to bail out their banking institutions.

Brownbridge (1998b), shows the impact of bank distress in some African countries and states that for the period 1993/94 about 11 % of total assets of banks and Non-Bank Financial Institutions (NBFIs) was held by collapsed institutions in Kenya, while in Nigeria and Uganda the failed institutions accounted for 8 per cent and 6 per cent of all bank assets respectively. According to *Granja, Matvos and Seru (2017)*, the mean FDIC loss from selling a distressed bank was 28% of assets over the period 2007 to 2013, such losses left the deposit funds reserves virtually depleted.

Kenya has witnessed periodic bank instability with consequences on bank stakeholders and the economy. *Brownbridge (1996)* states that the first cycle of bank problems in Kenya was the period 1984-1986, during which time Central Bank of Kenya liquidated banks after they failed to repay deposits obtained from state owned enterprises. *Le Gall, Daumont and Leroux (2004)* find four (4) banks and twenty-four (24) non-bank financial institutions accounting for 15% of Kenya's financial systems liabilities that were affected by liquidity or solvency problems between 1985-1989.

Le Gall et al. (2004) assert that a systemic banking crisis occurs when non-performing loans to total assets are between 5-10%. *Shehzad, Haan and Scholtens (2010)* argue that bank owners and managers may collude against depositors and may grant loans that are considered high risk and may lead to high levels of impaired loans imperiling the banks health. *Caprio and Klingebiel (1997)* state that banks can disguise troubled loan credits by rolling them over or embark on deposits expansion to help improve the outlook of balance sheets. With improved deposits banks invest in high-risk and high return areas. *Zhang, Cai, Dickinson and Kutan (2016)* argue that managers have self-motivation to take on highly risky lending than the desired level because of managerial rent seeking. Banks then shift this risk to depositors.

Laeven (2011) confirms the potential debilitating effect of bank instability on the economy due to its role in allocation of funds. Besides, a bank crisis leads some businesses to suffer drains of working capital and investment. Therefore, there is need to distinguish banks according to their financial health and intervene early to avoid an economy-wide impact. If the regulatory authorities can detect problems early enough and take action, this ends up preventing or minimizing the cost of distress. It is because of huge costs of distress resolution as *Dungey and Gajurel (2015)* argue that major focus of prudential effort should centre on avoiding banking crises because they are costly. *Huang, Chang and Liu (2012)* state that the consequence of bank failure is financial distress, which may affect other industries. *Huang et al. (2012)* assert that banks receive deposits, which they loan out to earn income, it is this intermediation process which fosters an industrial growth and economic development, the process that distinguishes banks from other business entities. This process is disrupted when there is bank instability. *Kedir, Iftikhar, Murinde and Kamgnia (2018)* hold that bank characteristics are a key driver of fragility. However, *Gorton (2018)* asserts that financial crises have taken place in market economies throughout history. Since early bank distress studies carried out by *Meyer and Pifer (1970)* and *Thomson (1991)*, banks still fail. Consequently, the gap in research was how to model loan asset indicators and bank fragility to build on the knowledge on early warning systems.

2. Theoretical background

2.1. Bank fragility

D emirguc-Kunt and Detragiache (1998) state that bank fragility arises when NPL ratio to total assets is greater than 10%. Non-performing loans (NPL) are therefore significant variables in fragility studies. *Ozili (2015)* asserts that early warning signals of an impaired loan asset (NPLs) as a variable is gaining importance to bank managers and credit controllers. An increment in the impaired loan asset without corresponding expansion in a good loan portfolio reduces the value of the loan portfolio and could precipitate bank solvency problems.

2.2. Loan asset indicators and bank fragility

U ysal (2013) states that loans and deposits make up about 65% and 80% of banks assets and liabilities respectively; this makes the financial statements of Commercial banks different from those of other firms. According to *Wheelock and Wilson (1995, 2000)*, loans constitute the most illiquid and risky bank assets. Besides, the more concentrated bank assets are in loans the more the possibility of distress is. *Poghosyan and Čihák (2009)* find that asset indicators play an important role in early warning models of bank distress. According to *Ozkan-Gunay and Ozkan (2007)* asset quality variables present a better picture of performance with a lower portion of non-performing loans to total loans. *Cole and White (2010)* find that banks with better asset quality stand a lower chance of financial distress, and worse asset quality is associated with the probability of failure.

Loans are an integral part in virtually all CAMELS indicators. Besides, loans constitute the most significant percentage of total assets, *Uysal (2013)*. *Sarkar and Sriram (2001)*, *Ozkan-Gunay and Ozkan (2007)* use non-performing loans to primary capital as a measure of capital adequacy and state that capital adequacy is useful for survival because capital absorbs losses. *Tatom and Houston (2011)*, *Zaghdoudi (2013)*, *End (2016)* measure liquidity indicators using total credit to total deposits. When a bank issues loans, borrowers pay interest, which is bank's revenue. When there is borrowers' default, the interest income is lost. Besides, when a periodic repayment of principal stops, the banks face a liquidity crunch.

Kedir et al. (2018) find that banks on the African continent have had bad debts problem due to a long-standing problem of credit risk management. Therefore, *Bologna (2013)* argues that there is need to regulate financial institutions. This is to ensure the preservation of financial stability and the protection of depositors as these entities are susceptible to adverse selection and moral hazard. According to *Makinen and Solanko (2018)*, poor asset

quality has a positive association with bank distress. *Whalen and Thomson (1988)* argue that non-performing loans are good proxy for asset quality as asset quality has a predictive ability in assessing the solvency of a bank. The growth of indebtedness (loans) by directors, officers and employees (DOE) is considered a red flag. *Meyer and Pifer (1970)* state that loans to insiders are riskier than loans to outsiders, and large loans to insiders are considered a pointer to poor management or embezzlement. *Sarkar and Sriram (2001)* argue that deterioration of asset quality is a risk that indicates that a bank is unlikely to collect 100% of its asset, which means a lower asset quality could lead to a greater loan charge off during bad economic times leading to increased chances of insolvency.

2.3. Non-performing loans and bank fragility

B oudriga, Taktak and Jellouli (2009) argue that aggregate rate of NPL is a frequently used measure of bank soundness. Further they state that NPLs are a major problem for both local and international regulators and whereas aggregate NPLs exhibit wide disparities between countries, some suffer severely with rates greater than fifteen (15) percent. Some researchers including *Whalen (1991)* find asset quality as a predictor of bank failures. *Fofack (2005)* states that incidences of banking crises are frequently associated with a huge build-up of non-performing loans. Further non-performing loans account for a sizeable percentage of total assets of distressed financial institutions. *Fofack* states that the banking crises that affected most sub-Saharan African countries were precipitated by an accumulation of nonperforming loans.

2.4. Growth of loan portfolio and bank fragility

M essai and Gallali (2015) find that during an expansion phase, banks take on more risks through uncontrolled lending activities without considering the quality of individual loans. Such loans are prime candidates of impairment during an economic downturn, thereby exposing the bank to insolvency. *Altunbas, Manganelli and Marques-Ibanez (2015)* concur and state that an aggressive loan growth and excessive reliance on short term funding point to risk concentration. *Jin, Kanagaretnam and Lobo (2018)* find a positive association between higher loan growth rates and bank fragility. *Logan (2001)* also finds the failure of Bank of Credit and Commerce International SA (BCCI) was due to among other reasons, dependency on net interest income, low loan growth and low profitability. *Logan* argues that when there is a fast loan growth, concentrations occur, appraisal standards may become weaker, and may be financed by more volatile funding sources. Following this sequence, loan quality problems start, profits decline, and inadequate provision levels start to surface.

2.5. Insider loans and bank fragility

T he Banking Act and Central Bank of Kenya Prudential Guidelines (2013) limit borrowings by a single insider to twenty-five percent (25%) of the bank's core capital. Besides, in aggregate credit facilities to all insiders are capped at 100% of the core capital. These prohibitions ensure that facilities to insiders are limited to owners' capital component and, therefore, limit the level of depositors' funds that may be misapplied by directors, management and staff and their related associates.

Brownbridge (1998a) finds that the most significant contributor to bad debts of the failed banks in Kenya, Nigeria, Uganda and Zambia was insider lending. Insider loans accounted for 65% of the total loans of four banks liquidated in Nigeria in 1995, and almost half of the loan portfolio of a bank taken over by the Bank of Uganda. According to *Thomson (1991)*, insider loans act as a proxy for management risk that is the risk of fraud. Insider loans can be treated as self-lending and this is to mainly take advantage of asset price booms. Besides, insider loans may be granted at discretionary rates.

2.6. Loan quality and bank fragility

T he *Federal Reserve Bank of Kansas City (2016)* avers that Loans constitute most commercial bank assets, therefore interest earned on this asset class form an important source of a revenue stream. In such a case a relatively small problem with the loan portfolio can reduce earnings, deplete capital and precipitate bank weaknesses. *Logan (2001)* states that management should diversify into other types of businesses to earn fees, commissions, or trading income. Besides, the probability of a bank failing declines with increase in net interest income. A declining net interest income can result from poor loan quality and increase in interest expense. An increase in interest expense means the sources of deposit are expensive thereby undermining the return from interest on loans. *Clancy and Zhao (1999)* show that the performance of a bank in the intermediation function is determined by its efficiency. Failing banks tend to pay higher interest rates to attract deposits and earn lower returns on loans due to high levels of underperforming assets.

2.7. Loan deposit ratio and bank fragility

E nd (2016) states that Loan Deposit Ratio (LDR) is an indicator of liquidity mismatch risk and therefore when loans exceed a deposit base, the funding gap has to be met through the access of funds in the financial markets. *Cecchetti, King and Yetman (2011)* show that during the financial crisis of 2007/2008 economies where banks had relatively low LDR managed the crisis relatively well compared to those with high LDR. *Cucinelli (2015)* finds that a lower level of the ratio of loans to deposits represents a lower dependence on wholesale funding which means that the bank is less market constrained in its asset growth. *Momparler, Carmona and Climent (2016)* also find that the higher the net loan to deposits is, the higher the chance of future financial distress is.

A study conducted by *Wood and Skinner (2018)* on commercial banks in Barbados found LDR to have a significant effect on non-performing loans; ultimately increase in LDR leads to aggressive lending resulting in setting aside funds to low quality borrowers thereby increasing the riskiness of the loan portfolio and thus pointer to bank weaknesses. *End (2016)* shows that China imposed an upper limit of 75% for its banks. An upper limit can help avoid mismatches between loans and stable funding and help check a build-up of systemic risks in the banking system.

2.8. Credit creation theory and bank fragility

T he proponents of credit creation like *Werner (2014, 2016)* advance argument that banks can create credit without any deposits. *Werner (2016)* avers that the credit creation theory holds that each bank can individually create money out of nothing through accounting operations and it is done by creating loan facilities. *Werner (2014)* asserts that when a bank extends credit to a customer, it creates a fictitious deposit by recording the loan amount in the borrower's account even though no deposit is made. Two entries are made, a credit to the borrower's current account and a debit to the borrower's loan account. What is created is a loan whose disbursement creates a deposit called an imaginary deposit. *Werner (2014)* concludes that banks invent funds by crediting the borrower's account with a deposit when no new deposit has actually taken place. *Turner (2012)* states that the most distinctive thing banks can do is to create credit, which result in spending power. *Cochran, Call and Glahe (1999)* show that money enters the economic system as banks grant new loans. These loans are negotiated using other people's money (deposits). They further argue that money creation does not involve reduction in present satisfaction on the part of depositors and can therefore finance investments without any previous equal savings.

McLeay, Radia and Thomas (2014, 2015) state that when a bank grants a loan, it concurrently creates a matching deposit in the

borrower's bank account. It is argued that it is the way new money is created. *Cochran et al. (1999)* show that borrowed money can be spent and returned to the banking system as additional deposits and the process continues as new deposits and leads to additional loanable funds. *Turner (2012)* shows that the ability of banks to create credit and money has implications on demand and can be disastrous if the loans created are poor credits. These poor credits can easily lead the bank to insolvency especially if depositors precipitate a run on the bank. In view of these facts, there are necessary prudential controls on maturity transformation and the degree of leverage by the bank.

Credit creation is linked to loan quality, growth, insider credit and concentration of the loan portfolio. A bank creates deposits from nothing when it credits borrowers both insiders' and outsiders' current accounts with loan proceeds. This artificial deposit means that the level of deposits goes up as more loans are granted. As the level of deposits increases, therefore the bank can lend more, the process continues like that if the borrowers do not use the funds for consumption. However, due to impairment of the loan portfolio, credit creation must have a limit. With increased lending, some credits get impaired.

3. Statement of the problem and research hypotheses

During the latest episode of bank instability in Kenya 2015-2016, customer deposits of about 129 billion Kes was held up in three distressed Commercial banks. The customers funds became inaccessible with borrowers and depositors impacted negatively. Besides, it takes many years to resolve bank fragility problems, the reason ways should be found to minimise the incidence of bank weaknesses. According to Kenya Deposit Insurance Corporation annual report 2015, the payment of deposits to customers with banks distressed in 1990s is still ongoing! Due to the documented financial crises, *Ozkan-Gunay and Ozkan (2007)* argue that it is done in order to look for a new crisis prevention, prediction and management method. *Baron and Xiong (2017)*, on the other hand, contend that policy makers should embrace early warning systems in order to stem future financial crises. *Messai and Gallali (2015)* affirm that the objective of early warning models is to ensure ability to forecast problems in financial institutions and take remedial measures before they occur. *Kolari, Glennon, Shin and Caputo (2002)* suggest that bank examiners are concerned about early warning systems that aid information collected during the on-site inspection as this helps predict impending distresses and also allow early intervention to prevent failure or reduce costs of distress.

Purpose of this study is to test the predictive ability of loan asset indicators on Commercial bank fragility in Kenya.

Main hypothesis:

H_{01}: Growth of a loan portfolio has no statistically significant relationship with bank fragility.

H_{02}: Loans to a deposit ratio has no statistically significant relationship with bank fragility.

H_{03}: Loan quality has statistically no significant relationship with bank fragility.

H_{04}: Insider loans have statistically no significant relationship with bank fragility.

4. Research design, method and data

4.1. Research Design

Bryman (2012) shows that a research design provides a framework for the collection and analysis of data. Besides, the research design shows the importance given to causal relationship among variables, the generalisations to larger groups from the sample, understanding behaviour and meaning and temporal appreciation of social phenomena and interconnection. Consequently, the research design in this study was an explanatory research.

4.2. Method, data collection, exclusion and measurement of variables

This study is based statistical analysis method using Stata Statistics/Data analysis.

Target population according to *Welman and Kruger (2001)* is the population in which the researcher would ideally like to generalise the results. The target population of this research was forty-two (42) commercial banks. In this study, a census was adopted due to the small population size.

Secondary data was collected from the Central Bank of Kenya. The study period was 2010-2014. The banks that ceased to exist due to mergers and acquisition or were incorporated after the end of study period that was 2015 were excluded from the study. Commercial banks with less than five-year data or with zero non-performing loans were excluded. The study did not extend data collection to 2016 and 2017 following the Banking (Amendment) Act of 2016, which introduced interest rate caps in Kenya in September 2016. Interest rate caps have an impact on bank performance.

Whereas the inferential study period is 2010-2014, this study conducted a cross-sectional-time series analysis from 2005 to 2015 to test the stability of the study variables and measure a fragility variable. The reason for the period 2005-2015 centered on the introduction of an interest ceiling in 2016 which had an influence on the performance of banks.

Besides, the period of 2005 is significant because the last bank placed under statutory management was in 2006, therefore a year before the event was found appropriate.

The study variables were measured as indicated in *Tab. 1*.

Table 1: Variable Measurement[*]

Variables	Researcher(s)	Measures
Bank fragility	*Carapeto Moeller, Faelten, Vitkova and Bortolotto (2011)*	$\dfrac{\text{Gross Non – Performing Loans}}{\text{Total Loans}}$
Growth of loan portfolio	*Rauch (2000)*	$\dfrac{\text{Total Loans year t minus Total Loans year t} - 1}{\text{Total Loans year t} - 1}$
Loan quality	*Calomiris and Mason (2003)*	$\dfrac{\text{Net Interest Income}}{\text{Total Income}}$
Loans to Deposit Ratio	*Cecchetti, King and Yetman (2011)*	$\dfrac{\text{Net Loans}}{\text{Customer Deposits}}$
Insider Loans	*Thomson (1991)*	$\dfrac{\text{Total Insider Loans}}{\text{Total Assets}}$

[*]***Source:*** compiled by the author.

5. Results

5.1. Descriptive statistical analysis

T he importance of a descriptive statistical analysis for the period 2005-2015 was to draw inferences over a longer time for the mean, minimum, maximum percentages of the variables and then make meaningful conclusions.

Non-Performing Loans to Total Assets

This ratio is the measure of bank fragility and is pegged at 10%. In 2005 and 2006 the NPL/total assets ratio was 18.70% and 13.58%. The two years 2005-2006 coincide with the end of 1993-2005 bank distress in Kenya. The ratio of NPL to total assets declined from 9.34% in 2007 to 4.28% in 2011; then started an upward trajectory in 2012 at 4.35%, 2013 at 5.20% and had reached 6.36% and 6.50% by 2014 and 2015 respectively.

The minimum NPL/Total assets ranged from 0.00% to 0.76%; maximum ratio oscillated from 22.84% in 2011 to 102.67% in 2005. The maximum ratio in 2013 and 2014 was 51.32% and 66.08% respectively from 26.08% in 2012. The spike in the maximum ratio started one-two years before fragility events of 2015- 2016.

Growth of Loan Portfolio

The average growth of the loan portfolio in a banking industry during the period was minimum of 21.30% with the highest growth of 333.44%. Dubai Bank and National Bank of Kenya had the negative growth of 5.36% and 70.39% respectively. Though the overall industry growth from 2005-2015 ranged from 21.30% to 41.16%, there was mixed growth percentages among individual banks.

Loan Deposit Ratio

The maximum LDR for the period ranged from 103.24% to 200.46%. During the entire period of eleven years, the maximum LDR was above 100.00% signalling overreliance on loan capital by some Commercial Banks. Higher LDR as shown by some banks in this study reflects fewer customer deposits to fund a loan book.

Loan Quality

Loan quality is a measure of dependency on interest income. During the period under the study, the minimum loan quality was 1.28% and maximum 76.92%. The industry average was 45.50%, a confirmation of non-dependency on interest income as a source of revenue for Commercial Banks in Kenya. It also shows the structure of deposit and Loans in Commercial banks businesses.

Insider Loans

The industry average for insider loans for the period was between 3.3% between 2005 and 2015. The statistics for the period 2005-2006 are indicative of a problem time with high insider loan levels of 54% to 59.7% for some of the banks.

This was a clear breach of fiduciary duty by the directors, management and staff of the commercial banks, an indication of the fact that insiders use customer deposits for their own self-interest.

5.2. Diagnostic tests

Normality Test Results

According to *Gujarati and Porter* (*2009*), if the computed p-value is sufficiently low, then the hypothesis that the residuals are normally distributed is rejected.

The p-values for all variables are prob>z, 0.00. The p-values in this case are low therefore, the normality test assumption was rejected and concluded that the residuals were non-normally distributed. Using the Shapiro-Wilk W test for normality, the H_o=data is normally distributed was rejected.

Heteroscedasticity Test Results

A null hypothesis was constructed that the variance of the error term was constant that is homoscedastic. *Ott and Longnecker* (*2010*), the null hypothesis is H_o: Homogeneous variances while H_a: test heterogeneous variances for the regression model. The White's test $Chi2(35)=87.76$, $Prob>Chi2=0.00$ shows the evidence of heteroscedasticity, therefore the null hypothesis that the variances are constant was rejected.

Stationarity Test Results

Using the Harris-Tzavalis Unit Root test, some of the study data was found stationary. The null hypothesis that the data was a unit root was rejected for some study variables. The following variables were stationary, loan growth (*p-value*=0.00), loan quality (*p-value*=0.00), insider loans (*p-value*=0.00), lagged dependent variable (*p-value*=0.00), while bank fragility (*p-value*=0.97); Loan deposit ratio (*p-value*=0.25) showed the evidence of a unit root.

Multicollinearity Test Results

According to *Gujarati and Porter* (*2009*), the CLRM assumption that there is no exact linear relationship between independent or explanatory variables that is no multicollinearity. *Ott et al.* (*2010*) argued that the consequences of highly correlated independent variables are that the overall F-Test would be highly significant but none of the individual t-tests would come close to significance. The variance inflation factor (*VIF*) was used to test for the presence of multicollinearity in the study data (*Tab. 2*).

Table 2: Multicollinearity*

Variable	VIF	1/VIF
lagbf1	1.74	0.573253
il	1.47	0.679442
lq	1.28	0.781290
ldr	1.23	0.816042
lg	1.05	0.949270
Mean	VIF	1.36

***Source:** compiled by the author.

The Variance Inflation Factor (VIF) for lagged bank distress was 1.74; insider loans 1.47, loan quality 1.28, loan deposit ratio 1.23, and loan growth 1.05 indicated that VIF for all the variables was below 10 and 1/VIF was above 0.1 that is a confirmation of tolerable levels of collinearity. *Gujarati and Porter* (*2009*) argue that multicollinearity is a matter of degree. The researcher concluded collinearity between the independent variables was too low to be problematic.

Table 3: Pearson Correlation matrix*

	bf	lagbf1	lg	ldr	lq	il
bf	1.0000					
lagbf1	0.8948	1.0000				
lg	-0.1190	0.0752	1.0000			
ldr	0.3949	0.3378	-0.1292	1.0000		
lq	-0.3032	-0.3403	0.0320	0.0436	1.0000	
il	0.4747	0.4897	-0.0589	0.3207	0.0519	1.0000
95% confidence interval						

***Source:** compiled by the author.

Gujarati and Porter (*2009*) states that correlation coefficient more than 0.8 means collinearity is a serious problem. The above (*Tab.3*) shows a high significant positive correlation 0.89 (0.00) between the dependent variable and the lagged dependent variable meaning it contributes significantly to the variations in the dependent variable. The dependent variable is negatively correlated to the growth of loan portfolio -0.12, loan deposit ratio 0.39, loan quality -0.30, and insider loans 0.47. The correlation between the dependent variable and the loan growth is negative and insignificant while it is low and positive with the loan deposit ratio. The loan quality and dependent variable have a negative but significant relationship, insider loans are positively correlated with the dependent variable and significant at 0.05 level.

5.3. Generalised linear model analysis

T he GLM is preferably where variables show non-normality. The assumptions underlying GLM state that the data $Y_1, Y_2, \ldots Y_n$ are independently distributed, the dependent variable Y_1 does not need to be normally distributed but assumes a distribution from the exponential family, does not assume a linear relationship between dependent and independent variables but assumes a linear relationship between the transformed response in terms of the link function. Besides, the independent variable can take on power terms or some non-linear transformation, the homogeneity of variances does not need to be satisfied, errors need to be independent but not normally distributed.

The study utilised a lagged dependent variable as one of the independent variables in the model. According to *Keele and Kelly* (*2006*), the use of a lagged dependent variable is part of a robust estimation strategy. Besides, it is a strategy to eliminate autocorrelation in the residuals.

The GLM was specified as follows (1):

$$g(E(Y|X_1, X_2, \ldots XP)) = Ybf_{it} = \beta_0 Ybf_{it-1} + \beta_1 lg_{it} + \beta_2 ldr_{it} + \beta_3 lq_{it} + \beta_4 il_{it} \quad (1).$$

The variables were defined as follows:

$Y = bfit$ = Bank Fragility for i^{th} firm in t^{th} year,

Y_{BFit-1} = lagged dependent variable (*lagbf1*),

lg_{it} = Growth of loan portfolio (*lg*),

ldr_{it} = Loan Deposit Ratio (*ldr*),

lq_{it} = Loan quality (*lq*),

il_{it} = Insider Loans (*il*),

$\beta_1 to \beta_5$ = Coefficient of independent variables,

i=1,2,…30 (Individual banks),

t=1,2,…5 (time indicator).

5.4. Generalised linear model regression

T he GLM regression (*Tab.4*) with clustered robust showed a lagged bank fragility variable β=0.87, Z=12.26, P>z=0.00. This variable had the most influential impact on bank fragility. The growth of a loan portfolio variable had β=-0.08, Z=-2.91, P>z=0.00, the growth of a loan portfolio had a negative relationship with bank fragility. Loan Deposit ratio β=0.13, Z=2.78 with P>z=0.00 was statistically significant. A loan deposit ratio is a significant variable in bank fragility studies as confirmed by z-values. The loan quality had β=-0.06, Z=-1.49, P>z=0.14. The loan quality had a negative and insignificant relationship while Insider loans β=0.16, z=0.88 and p-value of 0.38 had a positive insignificant relationship with bank fragility.

Table 4: GLM Regression*

Generalized linear models				No. of obs=120		
Optimization: *ML*				Residual df=114		
				Scale parameter=0.0018501		
Deviance=0.2109083935				(*1/df*) *Deviance*=0.0018501		
Variance function: *V(u)*=1				[Gaussian]		
Link function: *g(u)*=u				[Identity]		
				AIC=-3.405946		
Log pseudolikelihood=210.3567642				BIC=-545.5632		
(*Std. Err. adjusted for 120 clusters in bf*)						

bf	Robust Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
lagbf1	0.8669464	0.0707056	12.26	0.000	0.7283661	1.005527
lg	-0.0794346	0.0273098	-2.91	0.004	-0.1329608	-0.0259083
ldr	0.1318089	0.0473954	2.78	0.005	0.0389156	0.2247021
lq	-0.0561592	0.0377602	-1.49	0.137	-0.1301678	0.0178495
il	0.1607703	0.1835397	0.88	0.381	-0.1989609	0.5205014
cons	-0.0539984	0.0387617	-1.39	0.164	-0.12997	0.0219732

*__Source:__ compiled by the author.

6. Discussion

D escriptive statistics are shown in *Tab. A-1 - Tab. A-6* (*Appendix A*). The measure of fragility averaged between 13.58% to 18.70% with maximum ratios between 51.32% and 66.08%. The ratios were above 10% fragility measure that was an indication of banking sector instability that required intervention before the banking distress events of 2015-2016. It is therefore established the Kenyan banking industry was unstable.

The maximum LDR for the period 2005-2015 ranged between 103.24% to 200.46%. Consistent with *End* (*2016*), an LDR of 120% is a presumptive benchmark for a banking crisis while an average of 80% according to ECB is a sign of impaired financial intermediation. Practically, LDRs above such prescriptive rates were considered a sign of bank fragility. *Bologna* (*2011*) argues that LDR provides a measure of funding mix by a bank to finance its loan portfolio. Consequently, banks that rely on high level loan capital as a percentage of deposits tend to be fragile. Based on this analysis, high industry LDR were an early sign of weaknesses within the banking sector. High LDR indicates that a credit creation process is less dependent on deposits.

Some banks had the negative growth of a loan portfolio of 5.36% and 70.39% over the period. The negative growth of a loan portfolio signals a contraction in a loan asset ultimately resulting in decline in interest income. The loan quality variable averaged 45.50%, however, the maximum percentage for the period was 76.92%. A rapid increase in the loan portfolio could signal the low standards of loan underwriting. This is a credit creation process. Some banks had an insider loans ratio between 54% and 59.7% but was camouflaged by the average industry ratio of 3.3%.

The GLM regression results showed LDR β=0.13, p-value 0.00. At 5% level, the LDR variable has a positive significant relationship with bank fragility. Consequently, the null hypothesis is rejected.

The variable was statistically significant, as LDR goes up, bank fragility also goes up. Continued credit creation could lead to bank distress especially if some of the credits are impaired. Other researchers like *Wood and Skinner* (*2018*) found LDR coefficient of 0.334, p>t of 0.028 which was significant at 5% level and concluded that LDR had a significant positive effect on non-performing loans, a proxy for distress.

The growth of a loan portfolio had β=-0.08, p-value 0.00, that was a significant but negative relationship. An increase in the loan portfolio in this case led to the decline in fragility. The growth of a loan portfolio is a significant variable. An increase in loans confirms credit creation by banks. *Kedir, Iftikhar, Murinde and Kamgnia (2018)* also found that the growth of a loan was statistically significant at 10% level with the coefficient of -0.019 which meant a high loan growth reduced fragility as measured by impaired loans as a percentage of gross loans. However, with a few banks exhibiting a negative growth, this showed the possibility of instability.

The loan quality variable had β=-0.06, p-value 0.15, which was a negative relationship but statistically insignificant. *Alvarez-Franco and Restrepo-Tobon (2016)* observe that loan quality is an important pointer to bank survival and argue that less diversified banks are more likely to fail due to dependence on interest income. *Huang et al. (2012)* study found p-value for ASEAN at -0.156; G8 -0.859, EU at -1.253, NIC at -0.086 and G-20 at -0.258 all being significant at 5% level that is p-value<0.05 and concluded that net interest income predicted the financial distress of global banks best. *Logan (2001)* found bank distress to be positively related to dependence on traditional sources of income that is net interest income for the banks. *DeYoung and Torna* (2013), however, found that one standard deviation increases in net interest income reduced chances of failure by 27%. The above results are at a variance with *Huang et al. (2012)*, *DeYoung* and *Torna (2013)*. Most Kenyans commercial banks have reduced dependency on interest income and ventured into non-interest income due to among others the legislation to control interest which was discussed for a long time and culminated in-duplum rule section 44A (1) and (2) of the Banking Act which was enacted in 2006 and interest rate capping in 2016.

Insider loans had β=0.16, p-value=0.38. The results showed a positive relationship but statistically insignificant. *Thomson (1991)* used insider loans as a ratio of total assets as a proxy for fraud and insider abuse. Using logit regression, Thomson found insider abuse positively related to bank distress. The proxy could predict distress well beyond 36 months before actual failure, the results of this research are at a variance with Thomson's findings.

From the analysis, three variables were found statistically significant in explaining the bank fragility in Kenya. The lagged dependent variable β=0.87 with p-value 0.00 confirms the lag between loan issuance and when the assets become non-performing. Besides, it confirms the decisions made today will have impact in the future. The loan growth ratio had a negative relationship meaning for the Kenyan scenario, the growth was as a result of good credits. The Loan Deposit Ratio had a good predictive ability. One of the banks that collapsed in 2015 had had LDR consistently above 100% for many years!
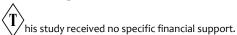
The loan quality ratio was statistically insignificant. However, this ratio could mean less reliance on interest income by Kenyan banks. Finally, Insider Loans were found statistically insignificant contrary to the Central Bank of Kenya onsite report on one of the banks that was distressed in the study period. Whereas insider loans did not seem a problem between 2011-2014, the Central Bank of Kenya and the external auditors found that one distressed bank had falsified records of actual insider loans before the bank was placed under receivership.

7. Conclusions and recommendations for further research

The study concludes that three of the study variables have powerful predictive powers; they are a lagged dependent variable, loan growth and loan deposit ratio. Regulatory authorities should watch the loan growth since the decrease in the variable is related to the increase in bank fragility. The regulatory authorities and policy makers must also watch a loan deposit ratio for evidence of weaknesses in the system.

Inordinately high loan deposit ratios are indicative of inability to attract cheap retail deposit and therefore reliance on expensive and volatile deposit. The regulator should model monthly reporting requirements to ensure that banks are able to disclose the ratio and explain any significant positive change. Monitoring of the ratio will be able to detect reduction in customer deposits and increase in volatile and sensitive wholesale funding. It is concluded that Kenyan banks do not rely heavily on interest income. The banks showed evidence of income diversification. The insider loans variable was insignificant in explaining bank fragility contrary to the Central Bank of Kenya Bank Supervision reports. The level of NPL can act as an incentive for bank managers to seek deposits and lend more thereby exacerbating the problem. Consequently, it is recommended that any bank with NPL to gross loans greater than a regulator imposed upper limit should be dissuaded from attracting more deposits. The second policy intervention should cap the level of LDR to limit the attraction of loan capital by banking institutions thereby jeopardizing depositors' funds. In the continuing research on early warning systems, it is established that lagged non-performing loans as a ratio of gross loans, loan growth and loan deposit ratio are significant variables in determining the fragility of the banking sector in Kenya.

There is need for further studies in other jurisdiction with a high number of distressed banks to test if the three significant variables could detect the fragility of distressed institutions months or years before the distress. Besides, there is need to find out why Insider loans as defined had no significance on bank fragility.

8. Funding

9. Competing interests

The authors declare that they have no competing interests.

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Appendix A

Table A-1: Proxy of Bank Fragility*

Year	N	mean	sd	min	max
2005	33	0.4087375	0.7768731	0.0167364	4.172078
2006	34	0.2721234	0.3856532	0.0059963	1.707729
2007	34	0.2122351	0.2945185	0.0033501	1.16441
2008	36	0.1597563	0.1957502	0	0.8028391
2009	40	0.1162156	0.1345746	0	0.6267483
2010	40	0.0977027	0.1073367	0	0.4493554
2011	42	0.0896979	0.1125715	0	0.5960265
2012	42	0.0833657	0.0760755	0	0.3780146
2013	42	0.0882673	0.1086208	0	0.6784101
2014	42	0.1046848	0.1328875	0	0.7940975
2015	39	0.1096047	0.0888995	0	0.4071137
Total	424	0.1507352	0.2896993	0	4.172078

Source: compiled by the author from Stata Statistics/Data Analysis output.

Table A-2: Growth of Loan Portfolio*

Year	N	mean	sd	min	max
2005	33	0.2131825	0.2140217	-0.1630371	0.9786386
2006	34	0.213021	0.2107561	-0.1630371	0.9786386
2007	34	0.2519601	0.2824062	-0.7039372	0.9978042
2008	36	0.3711972	0.3451691	-0.1250662	1.562112
2009	40	0.2270918	0.2748775	-0.1883741	1.562112
2010	40	0.2599354	0.1968056	-0.068375	0.6502594
2011	42	0.4116382	0.492529	0.0893787	3.334437
2012	42	0.2443357	0.5162727	-0.1799585	3.334437
2013	42	0.2779468	0.3017702	0.0093115	1.910619
2014	42	0.2144532	0.1802936	-0.1512667	0.6589835
2015	39	0.2154551	0.4496083	-0.1848745	2.723433
Total	424	0.2649128	3424105	-0.7039372	3.334437

Source: compiled by the author from Stata Statistics/Data Analysis output.

Table A-3: Loan Deposit Ratio*

Year	N	mean	sd	min	max
2005	33	0.7341218	0.2766879	0.2789369	1.49235
2006	34	0.6854252	0.2048741	0.2990568	1.197418
2007	34	0.6971794	0.2449538	0.2258798	1.557511
2008	36	0.7335653	0.2336494	0.2611004	1.563182
2009	40	0.7084006	0.2926496	0	2.004624
2010	40	0.6639429	0.1895773	0.2021739	1.316728
2011	42	0.7227055	0.1846156	0.3912855	1.419091
2012	42	0.7063401	0.1880586	0.3004646	1.310066
2013	42	0.7600754	0.2112341	0.3181635	1.562456
2014	42	0.7697374	0.2129954	0.2052573	1.639842
2015	39	0.802096	0.1460029	0.4293477	1.03243
Total	424	0.7266285	0.2198255	0	2.004624

Source: compiled by the author from Stata Statistics/Data Analysis output.

Table A-4: Loan Quality*

Year	N	mean	sd	min	max
2005	33	0.4882343	0.1135493	0.1025641	0.6630435
2006	34	0.4775237	0.0832258	0.293578	0.6396761
2007	34	0.4698134	0.0949192	0.1084337	0.6398467
2008	36	0.47167	0.0819143	0.2827225	0.6449865
2009	40	0.4752037	0.1086106	0.2406417	0.7692308
2010	40	0.4425364	0.1196403	0.1871508	0.6845361
2011	42	0.4603842	0.1195319	0.1791383	0.6973684
2012	42	0.3754972	0.1644486	0.0128168	0.6723744
2013	42	0.4714465	0.1090485	0.2572081	0.6862327
2014	42	0.448489	0.1122881	0.1553398	0.6792123
2015	39	0.4399926	0.11167	0.1708075	0.6492212
Total	424	0.4549881	0.1165592	0.0128168	0.7692308

Source: compiled by the author from Stata Statistics/Data Analysis output.

Table A-5: Insider Loans*

Year	N	mean	sd	min	max
2005	33	0.0484101	0.0972467	0.0053989	0.5411552
2006	34	0.0460712	0.1001267	0.0062645	0.5966282
2007	34	0.0305265	0.0262466	0.0046404	0.1294629
2008	36	0.0294487	0.0255902	0.0034999	0.1387994
2009	40	0.0311615	0.0311458	0	0.1863853
2010	40	0.0301898	0.0257053	0	0.1434271
2011	42	0.0279721	0.0194431	0.0012477	0.0893372
2012	42	0.0326445	0.0310684	0.0012059	0.1838235
2013	42	0.0312339	0.0231369	0.0010416	0.1252847
2014	42	0.0327975	0.0268342	0.0014548	0.147168
2015	39	0.030574	0.0219513	0.0013282	0.1016804
Total	424	0.0333577	0.045707	0	0.5966282

*Source: compiled by the author from Stata Statistics/Data Analysis output.

Table A-6: Non-Performing Loans to Total Assets*

Year	N	mean	sd	min	max
2005	33	0.1870357	0.2666168	0.0075973	1.026731
2006	34	0.1357565	0.1920376	0.0030345	0.9315948
2007	34	0.0934425	0.1182658	0.0019366	0.490285
2008	36	0.081946	0.1017988	0	0.4197682
2009	40	0.0629958	0.0831811	0	0.4492481
2010	40	0.0484044	0.0537299	0	0.2604055
2011	42	0.0428235	0.0447897	0	0.228411
2012	42	0.0434899	0.045313	0	0.2608359
2013	42	0.0520122	0.0787318	0	0.5131534
2014	42	0.0636486	0.1045178	0	0.6607653
2015	39	0.064975	0.055702	0	0.2341396
Total	424	0.0763867	0.1228863	0	1.026731

*Source: compiled by the author from Stata Statistics/Data Analysis output.