Macroeconomic and bank-specific determinants of non-performing loans in sub-Saharan Africa

Trust R. Mpofu[1]

Abstract

This paper investigates the determinants of non-performing loans (NPLs) using macroeconomic and bank-specific factors in selected eight sub-Saharan African economies. The study is motivated by the fact that some of these economies have experienced banking crises in the past, their NPLs have relatively been rising post the 2008/2009 global financial crisis and have recently experienced rapid growth of bank credit to the private sector. Such issues pose credit risks in the banking sector. Employing dynamic panel data methods over the period 2000-2017 and using a variety of specifications, the results show that NPLs decrease when real GDP growth rate, return on equity, return on assets, and total liabilities to total assets ratio increase and rises when unemployment rate, public debt, inflation rate, broad money, lending interest rate and domestic credit to private sector by banks increase.

Keywords: Non-performing loans; Macroeconomic factors; bank-specific factors; Dynamic panel; sub-Saharan Africa.

JEL classification: E44; G21

[1] Corresponding author. Postdoctoral Research Fellow, School of Economics, University of Cape Town, Rondebosch 7701, South Africa. E-mail: trustmpofu@gmail.com

1 Introduction

Investigating the determinants of non-performing loans is important for understanding some of the banking sector vulnerabilities and the concerns about financial stability. One way of measuring the credit risk that banks face is to use non-performing loans (NPLs) which are loans and advances overdue by 90 days or more from the due date. The 2008/2009 global financial crisis renewed the interest on the causes and effects of banking crisis given the adverse effects they have on the whole economy. Reinhart and Rogoff (2011) point out that NPLs can mark the onset of a banking crisis. The aftermath of the financial crisis also recognized the interlinkages between sovereign debt crisis and banking crisis. Reinhart and Rogoff (2010) show evidence that banking crises often either precede or coincide with sovereign debt crises.

According to the World Bank (2019), public debt in sub-Saharan Africa (SSA) remain a concern. In addition, the IMF (2017) state that SSA region is still recovering from the financial crisis. Most of the studies on the determinants of NPLs focus on advanced economies and emerging markets while there is limited number of empirical studies on the issue for SSA economies. Some of these studies in SSA use the country-aggregate level of NPLs applying cross-country panel analysis with a focus on either macroeconomic determinants only (see Mpofu and Nikolaidou, 2018) or both macroeconomic and bank-specific determinants (see Fofact, 2005). Others like Nikolaidou and Vogiazas (2017) also use country-aggregate level of NPLs but focus on individual countries (Kenya, Namibia, South Africa, Uganda and Zambia). However, Andrianova et al. (2015) analyse why African banks lend so little and find that one of the reasons is that the quality of information about potential borrowers varies from bank to bank. This suggests heterogeneity in bank behavior.

As such, the present study contributes to the determinants of NPLs literature in SSA economies, a region that has been neglected in the relevant literature, by using NPLs for each bank rather than the country-aggregate level. In this paper, we focus on eight SSA economies (Angola, Botswana, Eswatini, Ghana, Malawi, Mauritius, Nigeria, and Seychelles). These countries are chosen based on data availability and that one of them experienced banking crisis in the past (for example, Nigeria during 2009-2010). Their NPLs have been relatively rising post the 2008/2009 global financial crisis which poses credit risks in the banking sector (see Figure A1 in the Appendix). In addition, Plamen and Khamis (2009) show that these countries are part of the SSA economies that have experienced rapid growth of bank credit to the private sector. Figure A2 shows a positive trend of credit to private sector by banks in these countries. This credit expansion poses credit risks because it raises questions of whether the quality of these loans granted was appropriately evaluated by the banking system.

Given the concerns about the rising public debt in SSA and that Africa is the only part of the world where bank credit to the public sector exceeds bank credit to the private sector as stated by Honohan and Beck (2007), our study also investigates the effect of public debt on NPLs. We consider the impact of public debt on NPLs because this might be an example of a fragile public finance conditions which can lead to a rise in NPLs. In other words, the study also investigates the effect of the sovereign debt on the banking system via the use of NPLs.

The study focuses on sub-Saharan Africa because the banking sector remains underdeveloped. As such, bank risks are detrimental because most economies in this region are developing and a few are emerging markets where they rely on bank credit for investment (a key component to economic growth). In addition, studies like Kasekende et al. (2010) and EIB (2013) state

that although the banking sector in SSA is underdeveloped, it is fast growing relative to other developing regions. All these developments motivate the need for more empirical studies on the determinants of NPLs in the region, to come up with policies that minimise the occurrence of banking crises in the future.

The literature does not give a standardised approach of analysing the determinants of NPLs. Data availability is the major limitation which then determines the methodological approach adopted. This paper uses a bank-level panel data comprising of 85 banks in eight SSA countries spanning from 2000-2017. Employing dynamic panel data methods and using a variety of specifications, the results show that NPLs decrease when real GDP growth rate, return on equity, return on assets, return on capital and total liabilities to total assets ratio increase and rises when unemployment rate, public debt, inflation rate, broad money, lending interest rate, domestic credit to private sector by banks, and non-interest income to total operating income increase. The results also show significant and ambiguous results for bank size and net interest income to average assets.

The rest of the paper is organised as follows. Section 2 presents a review of the literature while Section 3 defines the data and explains the model specification and estimation technique. Section 4 presents the results and Section 5 gives the conclusion.

2 Literature review

There are several studies in the banking literature that investigate the determinants of non-performing loans. Most of these papers either use macroeconomic factors or bank-specific factors separately, or both together as possible factors that explain the evolution of NPLs. The literature also shows that macroeconomic factors (which are classified as systematic factors) are the ones that mostly affect NPLs. One possible explanation is that other systematic factors like changes in economic policies and political changes are difficult to measure and examine. Furthermore, as Breuer (2006) mentions, this type of data is only available for a very short period.

In this line of research, it has been found that the expansion phase of the economy sees relatively low rate of NPLs, as both consumers and firms face a sufficient stream of income and revenues to service their debts. But, as the booming period continues, credit is extended to lower-quality debtors and subsequently, when the recession phase sets in, NPLs rise. Using the theoretical life-cycle consumption model, Lawrence (1995) introduces the probability of default and derives a model which states that borrowers with low incomes have higher rates of default because of the increased risk of unemployment rate and the failure to settle their debts. The unemployment rate adversely influences the cash flow streams of households and increases the debt burden. On the other hand, an increase in unemployment rate may signal a decrease in production by firms due to a drop in effective demand which might lead to a reduction in revenues and raises debt burdens to firms (Castro, 2013).

Given the above, the general macroeconomic environment is fundamental in explaining the evolution of the NPLs. Examples in the literature include Nkusu (2011) for 26 advanced countries, Castro (2013) for Greece, Ireland, Portugal, Spain and Italy, Beck et al. (2015) for 75 advanced and developing countries, Havrylchyk (2010) for South Africa and Mpofu and Nikolaidou (2018) for 22 SSA countries, among others, that concentrate on the influence of macroeconomic factors on NPLs. These studies find a significant and negative effect of GDP

growth rate on NPLs. Nkusu (2011) and Castro (2013) also find a positive and significant effect of unemployment rate while Mpofu and Nikolaidou's (2018) variable is insignificant. Moreover, other studies that combine macroeconomic and bank-specific factors, still find a negative effect of GDP growth rate and /or positive effect of unemployment rate. All these studies state that macroeconomic factors are the main drivers of NPLs (see Fofact, 2005; Nikolaidou and Vogiazas, 2017 for selected SSA countries, Espinoza and Prasad, 2010 for Gulf countries; Louzis et al. 2012 for Greece; Klein, 2013 for Central Eastern and South-Eastern European countries, inter alia). However, few of the above studies considered the effect of the 2008/2009 global financial crisis. As such, we use the growth rate of real gross domestic product and unemployment rate as the primary macroeconomic determinants of NPLs while other specifications include the dummy for the 2008/2009 global financial crisis. This forms the basis of our baseline model.

We also consider other macroeconomic variables. These variables are interest rate, inflation rate, public debt and real exchange rate. The interest rate influences NPLs because it affects the debt burden by borrowers. The literature shows that rising interest rates increases the debt burden which then leads to an increase in NPLs. Therefore, we expect to find a positive effect of interest rates as shown by Fofact (2005), Espinoza and Prasad (2010), Nkusu (2011), Warue (2012), Castro (2013), Beck et al. (2015), inter alia. Other studies like De Bock and Demyanets (2012) and Mpofu and Nikolaidou (2018) find this variable insignificant. The impact of inflation is ambiguous because higher inflation reduces the real value of outstanding loans which makes debt servicing easier. However, it also weakens borrowers' abilities to service their debt by reducing their real income. Klein (2013) and Mpofu and Nikolaidou (2018) find a positive effect while Ekanayake and Azeez (2015) find a negative effect of inflation rate. Others find no effect (see Fofact, 2005; Castro, 2013; among others).

An increase in public debt may lead to reductions in social expenditures and the wage component of government consumption. This may lead to a negative shock to households' income and firms loans due to reduced demand (Louzis et al. 2012). Following Reinhart and Rogoff (2011), a reduction of public finances places a ceiling on the market evaluation of the credibility of the national banks which may cause banks to cut lending due to being hard-pressed for liquidity. This causes failure of debtors to refinance their debts. In addition, a rise in public debt decreases investor confidence which then increases the interest rates and positively affect NPLs (Castro, 2013). High debt rates also signal how easy it is to get access to credit which then increases the likelihood of more defaults in the future. The impact of real exchange rate may be ambiguous. On one hand, the appreciation of the real exchange rate makes domestic goods and services more expensive relative to foreign goods, which then decreases the competitiveness of export-oriented firms and worsens their ability to service their debt (see results by Fofack, 2005; Nkusu, 2011; Castro, 2013; Beck et al.2015). On the other hand, exchange rate depreciation might have a negative impact on NPLs in countries with a large amount of lending in foreign currency to un-hedged borrowers (Klein, 2013).

However, macroeconomic factors are exogenous to the banking industry given the peculiar features of each bank with regards to efforts to improve efficiency, risk management and profitability, which is likely to affect NPLs differently. As such, another strand in the literature investigates the relationship between bank-specific factors and NPLs. Berger and De Young (1997) examine the links among NPLs, cost efficiency and bank capitalization. They explain the causality from cost efficiency to NPLs through the "bad management" hypothesis. This

hypothesis states that low cost efficiency is a signal to poor management practices which results in poor loan underwriting, monitoring and control, thus leading to an increase in NPLs. Another hypothesis by the same authors is "skimping", which suggests a positive relationship between high cost efficiency and NPLs. They argue that high efficiency might reflect little resources allocated to monitor lending risks and thus may result in a rise in NPLs in the long-run. Berger and De Young (1997) also discuss the "moral hazard" hypothesis (see also Keeton and Morris, 1987). This hypothesis argues that low capitalization of banks increases the riskiness of banks' loan portfolio which then leads to a rise in NPLs in the long-run following the moral hazard incentives of bank managers.

Empirically, Berger and De Young (1997) and Louzis et al. (2012) find support of the "bad management" hypothesis while Berger and De Young (1997), Salas and Saurina (2002) find support of the "moral hazard" hypothesis. Using return to equity to proxy performance, Louzis et al. (2012) argue that the effect of performance on NPLs is ambiguous. On one hand, worse performance may proxy for lower quality of skills with regards to lending activities, thus performance is negatively associated with increases in future NPLs. On the other hand, performance is positively related with future increases in NPLs due to "procyclical credit policy" hypothesis (i.e. a bank may try to convince the market that it is profitable by inflating current earnings at the expense of future NPLs).

Banks' diversification is another variable likely to influence NPLs. Using bank size to proxy diversification, Salas and Saurina (2002) and Hu et al. (2004) find that diversification lowers NPLs because larger size allows for more diversification opportunities and that larger banks have superior access to resources and economies of scale in information process. However, bank size may lead to a rise in NPLs because of the "too-big-to-fail" hypothesis (i.e. larger banks may take more risks due to the bail-out guarantee by the government and thus operate with higher NPLs) as argued by Louzis et al. (2012). Using non-interest income to total income to proxy diversification, Louzis et al. (2012) find that diversification reduces risk because it reflects banks' reliance on other types of income except for loan making. However, banks may neglect screening and monitoring of borrowers when focusing on non-banking activities which might lead to higher NPLs (Lepetit et al. 2008). Excessive lending also leads to higher NPLs probably due to poor credit screening and monitoring quality. The literature uses loan-asset ratio or loan-to-deposit ratio (see Klein, 2013; Nikolaidou and Vogiazas, 2017).

Overall, the empirical evidence on the studies that either focus just on macroeconomic or banking variables, or a combination of two tend to be mixed as far as inflation, exchange rate, bank size and non-interest income influence NPLs. Such findings further motivate the need for more empirical work on the drivers of NPLs. Also, some of these studies use country-aggregate level of NPLs which might not properly control for bank heterogeneity. As such, this study uses the bank-level data to overcome these limitations and considers the possible effect of both macroeconomic and bank-specific variables. The next section defines the data we use, the model specification and the estimation technique.

3 Data, model specification, and estimation method

This paper uses annual bank level data over the period 2000-2017 for a sample of eight sub-Saharan African economies (Angola, Botswana, Eswatini, Ghana, Malawi, Mauritius, Nigeria, and Seychelles). The data is obtained from the Banker database, World Bank World Development Indicators, and International Monetary Fund's WEO and IFS. Data availability

is a major limitation when dealing with developing economies. As such, our sample is an unbalanced panel.

The variables are defined as follows: the dependent variable is non-performing loans (NPL) which is measured as the ratio of non-performing loans to total (gross) loans in percentages. Independent variables for macroeconomic factors are as follows: GDP growth rate (GDPGR) is the annual percentage growth rate of real GDP based on local currency. Unemployment rate (UNEMP) is the total unemployment rate as a percent of total labour force based on ILO estimate. Inflation rate (INFLC) is the annual percentage change in the cost to the average consumer of acquiring basket of goods and services while (INFLG) is the inflation rate based on GDP deflator. The lending interest rate (LIR) is the interest rate that banks offer when lending money to their clients. The real interest rate (RIR) is the lending interest rate adjusted for inflation as measured by the GDP deflator. TBR91D is the 91-days treasury bill interest rates. DCPGDP is domestic credit to private sector by banks as percentage of GDP. Public debt (DEBT) is the general government gross debt (% of GDP). The real effective exchange rate (REER) is in logarithmic form with a base year of 2010 and defined such that an increase represents an appreciation. BMONEY is broad money as percent of GDP. FINCRISIS is the dummy variable for the 2008/2009 global financial crisis which takes the value one from 2008 onwards and zero otherwise. We also use other two dummy variables to represent the financial crisis as follows: CRISIS takes the value one for 2008-2009 only and zero otherwise while CRISIS09 takes the value one for 2009 only and zero otherwise.

Explanatory variables for bank-specific factors are as follows: SIZE is measured as the natural logarithm of total assets in millions of US dollars, ROA is return on assets %, ROC is return on capital %, ROE is return on equity %. LOANA is loans to assets ratio %, LOAND is loans to deposits ratio %, TLTA is total liabilities to total assets ratio %, NII is net interest income to average assets %, and NNII is net non-interest income to total operating income %. Descriptive statistics for all the variables we use in this study are reported in Table A1.

To inform model specification, we test for the presence of unit roots in all the variables. We apply the Fisher-ADF and Fisher-PP tests because the Fisher-type tests do not require a balanced panel. The results are shown in Table A2 and they indicate that all the variables are stationary in levels when using the Fisher-ADF at 1% significance level. The Fisher-PP tests, on the other hand, indicate that almost all the variables are stationary at 1% significance level, with the exception of unemployment rate, lending interest rate, real effective exchange rate, net interest income to average assets, and broad money (though its level is significant at 10% which is weak) that are only stationary at 1% significance level after first difference. Therefore, we can carry on with the empirical analysis using the stationary variables in our econometric model.

In analysing the determinants of NPLs, we follow the literature by adopting a dynamic approach to account for the effect of possible omitted explanatory variables and for the time persistence in the NPL structure. Therefore, our regression equation is as follows:

$$NPL_{ijt} = \alpha_0 + \sum_{k=1}^{K} \gamma_k NPL_{ijt-k} + \beta X_{ijt} + \phi(L) M_{jt} + \lambda_i + \varepsilon_{ijt} \quad (1)$$

where NPL_{ijt} denotes the ratio of NPLs of bank i located in country j in year t. α_0 is the constant to be estimated. β is a vector of coefficients to be estimated, X_{ijt} is a vector of bank-specific explanatory variables, $\phi(L)$ is the 1 x k lag polynomial vector, M_{jt} is the k x 1 vector of macroeconomic explanatory variables, λ_i are the unobserved individual bank-specific effects and ε_{ijt} is the error term.

To estimate equation (1), we use two alternative estimation techniques. First, we use the Arellano and Bond (1991) two-step difference generalized method of moments (GMM). Between the one-step and the two-step GMM estimators available, we use the two-step GMM estimator because it is asymptotically more efficient than the one-step estimator. Second, we use the system GMM because the literature states that the difference GMM of Arellano and Bond (1991) has a weakness in providing estimations with low precision when the sample period has "small T" and high persistence. We use these two estimators because they address the weaknesses of other panel data estimators like the pooled-OLS, fixed-effects and random-effects. The pooled-OLS estimator is biased and inconsistent even when the error term is not serially correlated (Baltagi, 2008) while Anderson and Hsiao (1981) and Arellano and Bond (1991) show that the OLS estimator becomes biased for small values of T when the lagged dependent variable is included as an explanatory variable. The random effects estimator is also biased in a dynamic panel data model.

On the other hand, the fixed-effects estimator may give rise to Nickell's (1981) bias which results from the possible endogeneity of the lagged dependent variable and the fixed effects in the error term especially in the "small T, large N" panels. Even though as T gets large, the fixed-effects estimator becomes consistent, still, Judson and Owen (1999) indicate that even for T = 30 the bias can be as much as 20% of the true value of the coefficient of interest. The difference GMM estimator addresses the problems of these other estimators by first differencing equation (1) and in the process eliminating the fixed effect element and then uses instrumental variables for the explanatory variables. Given that macroeconomic factors are exogenous to the banking sector, we treat all macroeconomic factors as strictly exogenous variables and enter the regression equation with at least one lag. We treat bank specific variables as weakly exogenous or predetermined explanatory variables. Strictly exogenous variables are instrumented with themselves while the dependent, predetermined and endogenous variables are instrumented with their lagged levels. We test the validity of the instruments using the Sargan specification test following Arellano and Bond (1991), Arellano and Bover (1995) and Blundell and Bond (1998). In addition, we test for no second-order autocorrelation in the estimated differenced equation because the presence of the second-order autocorrelation implies that the GMM estimates are inconsistent.

4 Results

The findings from the regression analysis are in Tables A3-A7. We start our empirical analysis by estimating the baseline model (see Table A3). That is, looking at the effects of the general macroeconomic environment on non-performing loans (NPLs). As mentioned earlier, we do this by using real GDP growth rate, unemployment rate, and the dummy variable for the 2008/2009 global financial crisis. Next, we add other macroeconomic variables separately (see Table A4) and then several macroeconomic variables together (see Table A5). Furthermore, we add each of the bank-specific variables to the baseline model (see Table A6) and lastly add several bank-specific explanatory variables together (see Table A7). This procedure reduces

the number of instruments generated given that we have an unbalanced panel. In that spirit, we first present the results from the Arellano-Bond (AB) estimator (i.e. two-step Difference GMM) then explain using the two-step System GMM as robustness checks to overcome potential shortcomings associated with the AB estimator. Various specifications indicate that our estimators are consistent given that the AR tests for serial correlation in the differenced error terms are sometimes significant for first-order autocorrelation but insignificant for second-order autocorrelation. The validity of the instruments is also confirmed by the insignificant p-values for the Sargan test[2].

Given that we are estimating a dynamic model, we begin by interpreting the lagged dependent variable. Table A3 shows the baseline results using the difference GMM (Columns 1-3) and system GMM (Columns 4-6). The results indicate that the one-lagged dependent variable is both significant and robust at 1% level in columns 4-6 in the range of 0.644-0.677 percent, at 5% level in column 1 by 0.548 percent, and at 10% level in columns 2-3 in the range of 0.485-0.546 percent. These results suggest that a shock to NPLs is likely to have a prolonging effect in the banking sector. The second lag of NPLs is insignificant. Our results also show that an increase of one percentage point in the real GDP growth rate decreases NPLs by about 0.193-0.229 percentage points, holding all other things constant. Unemployment rate variable is insignificant. On the other hand, the global financial crisis increased NPLs by about 3.739 percentage points using the dummy variable FINCRISIS[3] while CRISIS and CRISIS09 dummies are insignificant. These results suggest that NPLs tend to increase when the general macroeconomic environment deteriorates, which is similar to the findings by Salas and Saurina (2002), Nkusu (2011), Louzis et al. (2012), Castro (2013), Beck et al. (2015), among others in other regions. As for sub-Saharan Africa region, our results are similar to Mpofu and Nikolaidou (2018) but differ with Fofact (2005) who finds insignificant real GDP growth rate and does not include the period during and after the global financial crisis (to the best of our knowledge, these are only the studies in the region that apply cross-country panel analysis).

The results in Table A4 present the results using the difference GMM when we include other macroeconomic variables separately. Row two reinforce the persistency of one-lagged NPLs after economic shocks in the range of 0.391-0.583. The coefficient of the second-lagged NPLs is now significant in the range of -0.337 to -0.950. This suggests that NPLs are likely to decrease when they have increased in the previous period probably due to write-offs. The real GDP growth rate variable is still significant and now our results suggest that a one percentage point increase in this variable reduces NPLs by about 0.216-0.471 percentage points, ceteris paribus. Unemployment rate is still insignificant.

As for the 2008/2009 global financial crisis dummy variable (FINCRISIS), it is also significant and in the range of 3.133-5.325. This result confirms the argument by the IMF (2017) that sub-Saharan African economies are still recovering from the financial crisis given that this dummy takes the value one from 2008 onwards and zero otherwise. Except for few sub-Saharan African economies like South Africa with matured financial sector and likely to have been directly affected by the global financial crisis, most banking sectors in SSA were indirectly affected via trade linkages. That is, the global economic recession led to reduced exports and slower

[2] Also, the number of instruments is less than the number of groups in each specification though we do not show these results.

[3] This dummy takes the value one from 2008 onwards and zero otherwise. CRISIS takes the value one for 2008-2009 only and zero otherwise. CRISIS09 takes the value one for 2009 only and zero otherwise.

domestic economic growth which in turn adversely affected borrowers' abilities to settle their rising debts. In addition, Table A4 shows that a one percentage point increase in public debt leads to an increase in NPLs by about 0.191 percentage points (see column 1). This finding is similar to Castro (2013). Other variables like real effective exchange rate, interest rates, inflation, broad money, and domestic credit to the private sector by banks are all insignificant. This motivates us to do some robustness checks using the system GMM.

Using system GMM, we still affirm the persistence of the one-lagged NPL and the negative relationship between NPLs and real GDP growth rate. However, all other variables are still insignificant[4].

Next, we explore the impact of all macroeconomic variables (i.e. the ones tried earlier via one by one) on NPLs. The results in Table A5 still show the persistence of the one-lagged NPLs (columns 3-7) in the range of 0.354-0.706 while the two lagged NPLs is negative and significant. This implies that NPLs are likely to decrease due to write-offs. Our results also reinforce the importance of general macroeconomic environment in influencing the evolution of NPLs. We find that a one percentage point increase in unemployment rate significantly increases NPLs by about 1.589 percentage points, ceteris paribus and that the 2008/2009 financial crisis also led to significant rise in NPLs. Hence, these findings point to the importance of implementing economic policies that enhance economic growth and employment to minimize the problems of credit risk in the banking sector.

Credit growth is important for economic growth in most developing countries. However, excessive credit growth may be harmful to economic growth because the more credit expands, the higher the likelihood that the defaults will increase in the future. As such, results in Table A5, indicate that a one percentage point increase in domestic credit to private sector by banks as a percent of GDP increases NPLs by about 0.116 percentage points, ceteris paribus. Studies like Espinoza and Prasad (2010), Klein (2013), Castro (2013), Mpofu and Nikolaidou (2018) find similar results while Fofack (2005) finds an insignificant value. On the other hand, a one percentage point increase in public debt significantly increases NPLs by about 0.112-0.134 percentage points, holding all other things constant. Comparing the private and public sector credit, public debt influences NPLs with larger magnitudes and has more significant coefficients. One possible explanation is that in Africa, the public sector borrows more than the private sector from banks relative to other regions as stated by Honohan and Beck (2007). Given the concerns about the rising public debt in sub-Saharan Africa, our results suggest that regulatory authorities should prevent the situation where risky loans are being issued without proper supervision to avoid potential credit risks in the future.

In addition, we now find that the lending interest rate, inflation rate and broad money positively and significantly increase NPLs. Regarding the economic significance of the findings, ceteris paribus, the results suggest that a one percentage point rise in lending interest rate, inflation rate and broad money, increases NPLs by about 0.320, 0.351, and 0.438 percentage points respectively. The results for lending interest rate are similar to the studies by Nkusu (2011), Louzis et al. (2012), Klein (2013), Castro (2013), Beck et al. (2015). Inflation rate results are similar to Klein (2013), Mpofu and Nikolaidou (2018) but different to Ekanayake and Azeez whose results are negative while Fofack's (2005) and Castro's (2013) find insignificant

[4] The results of the system GMM are not presented in the paper but are available upon request.

coefficients. The increase in interest rates affects the debt burden of borrowers and increases their likelihood of defaulting on their debts. While an increase in inflation rate reduces the borrowers' ability to service their debts by decreasing their real income, which also increases the likelihood of defaults. The choice of different macroeconomic variables at once is based on the notion of avoiding the explosion of the instruments generated and the correlation matrix of all the macroeconomic variables[5].

Furthermore, we add one by one bank-specific variable to the baseline model. The results for one-lagged and two-lagged NPLs, and real GDP growth rate are as the ones in Tables A3-A5. As such, we do not discuss these findings. Our results show that a one percentage point increase in return on equity and return on assets which proxy performance, significantly leads to a reduction in NPLs by about 0.173 and 0.922 percentage points respectively. These findings are shown in Table A6 using system GMM respectively[6]. These results suggest that good performance by banks in monitoring lending activities leads to lower credit defaults as pointed out by Louzis et al. (2012) and Klein (2013). The same table indicates that a one-lagged return on assets leads to a significant increase in NPLs. This implies that bad performance by banks in monitoring lending activities results in higher credit defaults as also evidenced by Louzis et al. (2012).

Using bank size to proxy diversification, we find that this variable is ambiguous. The contemporaneous bank size leads to a reduction of NPLs by about 8.691 percentage points, ceteris paribus while the one-lagged bank size increases NPLs by about 7.311 percentage points as shown in Table A6. These findings confirm the arguments by Salas and Saurina (2002) and Hu et al. (2004) that large bank size allows diversification opportunities and that larger banks have superior access to resources and economies of scale in information process which gives them better screening and monitoring lending activities, thus decreasing NPLs. However, larger banks may take more risks due to bail-out guarantee by the government and therefore operate with higher NPLs which is in line with the "too-big-to-fail" hypothesis by Louzis et al. (2012).

However, Louzis et al. (2012) use the leverage ratio (total liabilities to total assets ratio) to test the 'too-big-to-fail' hypothesis. We also use this variable and find that a one percentage point increase in leverage ratio decreases NPLs by about 0.356 percentage points, ceteris paribus. Conditioning the leverage ratio with the size variable results in insignificant variables for the leverage ratio and the interaction term.

Adding all bank-specific variables at once leads to similar significant results as before. That is, persistence in NPLs, negative relationship between NPLs and real GDP growth rate, return on equity, return on assets and bank size respectively, and a positive relationship with unemployment rate. Now other variables become significant; these are net interest income to average assets, return on capital and net non-interest income to total operating income. We find that the contemporaneous effect of net interest income to average assets leads to a reduction in

[5] Such correlations are: Inflation rate based on consumer price index (INFLC) and real interest rate (RIR) have a correlation of 0.645, INFLC and 91-days treasury bill interest rates (TBR91D) is 0.640, DEBT and TBR91D is 0.544, inflation rate based on GDP deflator (INFLG) and RIR is 0.757. We consider a correlation of above 0.500 to be high.

[6] The results of ROE and ROA are also significant using the difference GMM. These results are not presented in the paper but available upon request.

NPLs of about 1.576 percentage points while the one-lagged component of the same variable increases NPLs in the range of 0.753-0.798 percentage points, ceteris paribus. We expected such findings because high net interest income to average assets cushions banks from negative shocks and, thus having a decreasing effect on NPLs. However, high net interest income to average assets may be due to banks charging high interest rates which signals credit risk portfolio of the banks because of high likelihood of future defaults. Using return on capital, we find that a percentage point increase of one-lagged component of this variable leads to a reduction in NPLs of about 0.085 percentage points, ceteris paribus. This supports earlier arguments that good performance by banks has a reduction effect on credit defaulting. As for net non-interest income to total operating income, we find a positive effect of the one-lagged component of the variable with NPLs. This suggests negligence by banks when focusing on non-banking activities which has an effect of increasing NPLs (Lepetit et al. 2008).

5 Conclusion

The analysis of non-performing loans (NPLs) is essential because it can provide signs of alarm when the banking sector becomes vulnerable to adverse risks. Several studies have investigated the causes of NPLs, however, most of these studies focus on advanced economies and large emerging markets with a few in sub-Saharan Africa. Except for Warue (2012) for a study in Kenya and Havrylchyk (2010) for South Africa, most studies in sub-Saharan Africa use country-aggregate level of banking data to analyse the determinants of NPLs which might mask the heterogeneity among banking institutions. As such, this paper uses bank-level data to empirically examine the impact of macroeconomic and bank-specific explanatory variables on NPLs in eight sub-Saharan African economies (Angola, Botswana, Eswatini, Ghana, Malawi, Mauritius, Nigeria, and Seychelles).

Employing dynamic panel data methods to these countries over the period 2000-2017, we find that the level of NPLs is significantly affected by both macroeconomic and bank-specific variables. NPLs decreases when real GDP growth rate, return on equity, return on assets, and total liabilities to total assets ratio increase and rises when unemployment rate, public debt, inflation rate, broad money, lending interest rate and domestic credit to the private sector by banks increase. We also observe significant and ambiguous results for bank size and net interest income to average assets. NPLs also substantially increased as a result of the 2008/2009 global financial crisis.

Overall, our findings suggest that policies that enhance the general macroeconomic environment (i.e. increase economic growth and employment) should be implemented in these countries as these could bring about substantial benefits in the banking system by reducing the likelihood of credit defaults. Given the significance of variables like private and public debt, bank performance and bank diversification, our results also suggest that regulatory authorities should focus on managerial performance and place emphasis on measures and procedures that reduce excessive and risky lending activities in order to detect potential problem loans in the banking sector.

Even though panel analysis allows researchers to investigate economic problems when data points are not adequate for a single country using time series, there is a need for more single country case studies in sub-Saharan Africa that analyse not only the macroeconomic and banking industry determinants of NPLs in the banking sector but also the impact of institutional variables.

Appendix

Figure A1: Non-performing loans to total gross loans (%)

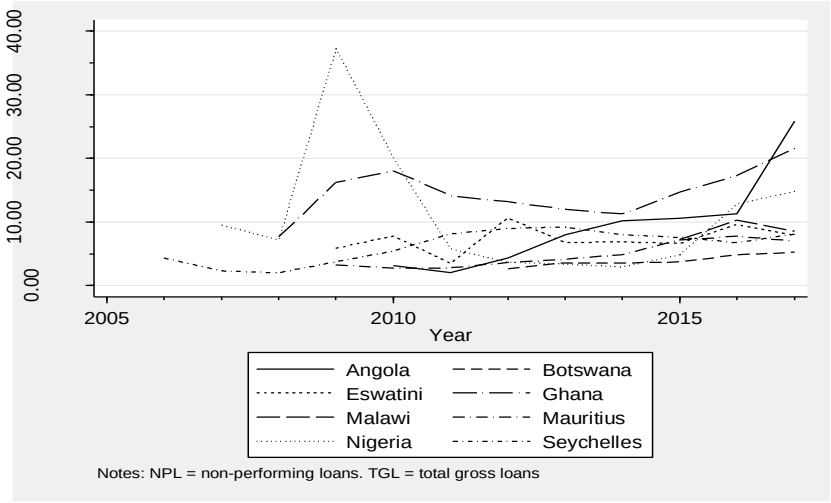

Figure A2: Credit to private sector by banks (% of GDP)

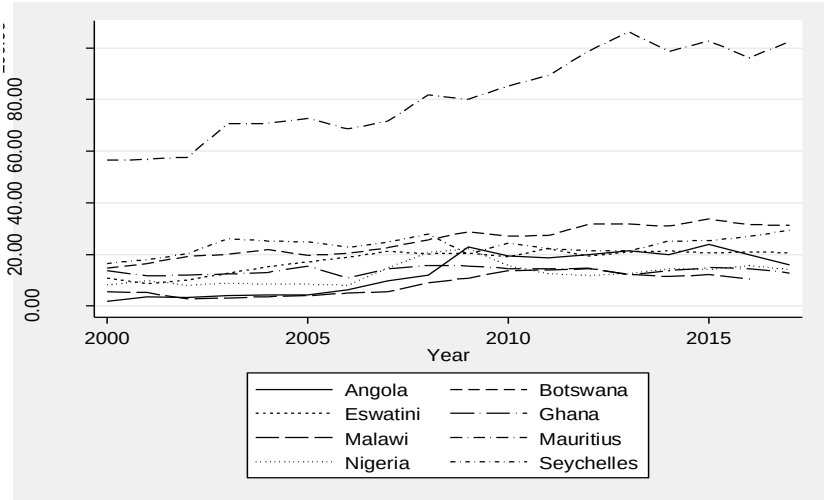

Table A1: Descriptive statistics

Variable	Obs	Mean	Std. Dev	Min	Max
NPL	433	8.34	9.10	0.04	73.05
GDPGR	1530	5.34	3.72	-7.65	15.33
UNEMP	1494	9.83	6.66	3.42	28.28
INFLC	1530	18.70	37.68	-2.40	325.00
INFLG	1530	22.02	48.53	-16.76	418.02
LIR	1170	23.47	21.77	6.88	103.16
RIR	1170	6.25	13.12	-60.78	38.98
TBR91D	750	16.33	9.77	0.48	67.46
DCPGDP	1525	25.07	25.78	1.97	106.26
DEBT	1502	42.39	29.13	5.51	199.79
REER	756	4.53	0.18	4.17	5.06
FINCRISIS	1530	0.56	0.50	0	1
CRISIS	1530	0.11	0.31	0	1
CRISIS09	1530	0.06	0.23	0	1
BMONEY	1525	38.53	27.63	10.48	114.19
ROA	810	2.94	3.36	-28.46	24.99
ROC	630	26.00	34.18	-205.13	197.54
ROE	517	18.82	29.69	-386.62	142.52
NII	449	5.80	3.25	-3.63	21.16
NNII	536	38.27	16.73	-27.02	145.48
SIZE	824	6.99	1.45	1.67	10.11
LOANA	587	52.32	17.94	0.58	103.2
LOAND	591	71.70	29.16	1.78	244.56
TLTA	541	86.27	7.85	20.21	100

Notes: NPL is non-performing loans, GDPGR is the growth rate of real GDP, UNEMP is unemployment rate, INFLC is the inflation rate based on consumer price index, INFLG is the inflation rate based on GDP deflator, LIR is the lending interest rate, RIR is the real interest rate, TBR91D is the 91-days treasury bill interest rate, DCPGDP is domestic credit to private sector by banks as percentage of GDP, DEBT is public debt. FINCRISIS is the dummy variable for the 2008/2009 global financial crisis which takes the value one from 2008 onwards and zero otherwise while CRISIS is the dummy variable taking the value one for 2008-2009 and zero otherwise, and CRISIS09 is the dummy variable which takes the value one for 2009 only and zero otherwise. BMONEY is broad money as percent of GDP. ROA is return on asset ratio, ROC is return on capital ratio, ROE is return on equity, NII is net interest income to average assets ratio, NNII is net non-interest income to total operating income ratio, SIZE is In (total assets), LOANA is loans to assets ratio, LOAND is loans to deposit ratio. TLTA is total liabilities to total assets ratio. The variables are defined in Section 3. Obs stands for observations. Std. Dev refers to standard deviation. Min is minimum and Max is maximum.

Table A2: Panel unit root tests

Variables	Fisher-ADF Inverse normal	Fisher-PP Inverse normal
NPL	-6.56***	-3.62***
GDPGR	-18.81***	-16.86***
UNEMP	-17.45***	2.01
DUNEMP		-7.23***
INFLC	-20.93***	-25.84***
INFLG	-21.71***	-30.89***
LIR	-11.65***	2.82
DLIR		-19.06***
RIR	-16.43***	-22.98***
TBR91D	-14.36***	-14.14***
DCPGDP	-15.85***	-3.71***
DEBT	-16.64***	-7.24***
REER	-6.74***	2.62
DREER		-15.95***
BMONEY	-13.58***	-1.34*
DBMONEY		-22.13***
ROA	-11.37***	-8.84***
ROC	-10.19***	-6.90***
ROE	-10.11***	-4.62***
NII	-7.00***	-0.49
DNII		-9.18***
NNII	-8.28***	-6.65***
SIZE	-11.31***	-7.27***
LOANA	-10.02***	-4.96***
LOAND	-9.26***	-5.27***
TLTA	-8.65***	-9.92***

Notes: See notes in Table A1 for the abbreviation of the variables. The Fisher-type unit-root tests are based on augmented Dickey-Fuller (Fisher-ADF) tests with drift and one lag in all regressions and Phillips-Perron (Fisher-PP) tests with one lag in all regression. The null hypothesis is that "all panels contain unit roots". The Fisher-type tests do not require a balanced panel because the tests are conducted for each panel individually before combining the p-values from those tests to produce the overall test. The statistics are reported and respective p-values are represented by the stars. ***, * indicate rejection of the null hypothesis at 1% and 10% level of significance respectively. D before a variable refers to first difference of the variable.

Table A3: GMM estimation results-baseline model

Variable	AB (1)	AB (2)	AB (3)	SGMM (4)	SGMM (5)	SGMM (6)
NPL_{t-1}	0.548**	0.485*	0.546*	0.644***	0.674***	0.677***
	(2.16)	(1.69)	(1.84)	(3.51)	(3.67)	(3.70)
NPL_{t-2}	-0.192	-0.205	-0.186	-0.145	-0.126	-0.124
	(-0.88)	(-0.97)	(-0.73)	(-1.16)	(-0.96)	(-0.95)
$GDPGR_{t-1}$	-0.196**	-0.207**	-0.193**	-0.179	-0.228**	-0.229**
	(-2.01)	(-2.03)	(-2.22)	(-1.36)	(-2.11)	(-2.09)
$DUNEMP_{t-1}$	0.395	0.830	0.561	-0.252	0.141	0.059
	(0.45)	(1.15)	(0.49)	(-0.17)	(0.11)	(0.05)
FINCRISIS	3.739**			-0.827		
	(2.13)			(-0.36)		
CRISIS		0.830			0.641	
		(0.79)			(0.51)	
CRISIS09			0.435			0.254
			(0.43)			(0.15)
CONSTANT	2.294	6.289***	5.743***	5.473	4.836***	4.665***
	(0.79)	(4.06)	(3.69)	(1.58)	(4.29)	(4.03)
No. Obs	183	183	183	258	258	258
AR (1)	-1.538	-1.405	-1.372	-1.789	-1.710	-1.720
	[0.124]	[0.160]	[0.170]	[0.074]	[0.087]	[0.085]
AR (2)	-0.695	-1.490	-0.565	-1.184	-1.277	-1.315
	[0.487]	[0.624]	[0.572	[0.237]	[0.202]	[0.189]
Sargan tests	2.757	3.708	3.054	18.876	18.150	17.755
	[0.997]	[0.988]	[0.995]	[0.875]	[0.899]	[0.911]

Notes: The models are estimated with robust standard errors. ***, **, * indicate the 1%, 5%, and 10% level of significance. Robust t-statistics are in () brackets. The models in columns 1-3 were estimated using the two-step difference GMM of Arellano-Bond (AB) while in columns 4-6 using the two-step system GMM (SGMM). See the notes in Table A1 for the abbreviation of the variables. No. Obs = the number of observations. AR (1) and AR (2) represent the Arellano-Bond tests for first and second order autocorrelation in first-differenced errors. The numbers in [] represent the p-values for the AR(1 or 2) and Sargan-test.

Table A4: Empirical results based on additional macroeconomic variables-Difference GMM

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
NPL_{t-1}	0.391***	0.563**	0.529**	0.500	1.183	0.583**	-0.309	-0.298	0.923
	(5.12)	(2.25)	(2.39)	(1.56)	(1.63)	(2.09)	(-0.89)	(-0.86)	(1.64)
NPL_{t-2}	-0.429	-0.208	-0.176	-0.337*	-0.950*	-0.327	-0.771**	-0.736***	-0.902*
	(-1.60)	(-1.00)	(-0.60)	(-1.82)	(-1.84)	(-1.05)	(-2.46)	(-3.15)	(-1.78)
$GDPGR_{t-1}$	-0.008	-0.216**	-0.089	-0.215	-0.162	-0.219**	-0.471**	-0.413*	-0.010
	(-0.07)	(-2.14)	(-0.81)	(-1.63)	(-0.50)	(-2.31))	(-2.01)	(-1.91)	(-0.05)
$DUNEMP_{t-1}$	0.476	0.311	0.340	0.684	-1.563	0.503	1.827	1.405	-1.564
	(0.39)	(0.35)	(0.30)	(0.59)	(-0.27)	(0.60)	(1.33)	(1.33)	(-0.34)
FINCRISIS	4.915***	3.880**	5.325**	2.249	-5.421	3.133**	1.005	1.429	12.844
	(5.73)	(2.10)	(2.34)	(1.34)	(-0.05)	(2.01)	(0.63)	(1.27)	(0.14)
$DEBT_{t-1}$	0.191***								
	(4.26)								
$DCPGDP_{t-1}$		0.054							
		(0.45)							
$INFLC_{t-1}$			0.139						
			(1.24)						
$INFLG_{t-1}$				-0.044					
				(-1.26)					
$DREER_{t-1}$					3.765				
					(0.53)				
$DBMONEY_{t-1}$						0.064			
						(0.60)			
$DLIR_{t-2}$							0.136		
							(0.99)		
RIR_{t-2}								0.011	
								(0.15)	
$TBR91D_{t-1}$									0.045
									(0.30)

CONSTANT	-4.204	0.839	-1.245	5.698	12.891	3.678	13.642***	11.726***	-4.146
	(1.32)	(0.25)	(-0.32)	(1.71)	(0.12)	(1.00)	(2.77)	(2.69)	(-0.05)
No. Obs	183	183	183	183	119	183	128	128	119
AR (1)	0.027	0.084	0.117	0.088	0.237	0.101	0.416	0.444	0.249
AR (2)	0.792	0.511	0.542	0.984	0.786	0.803	0.213	0.178	0.596
Sargan test	0.966	0.998	0.998	0.951	0.716	0.971	0.499	0.748	0.870

Notes: The models are estimated with robust standard errors. Robust t-statistics are in () brackets. ***, **, * indicate the 1%, 5%, and 10% level of significance. See the notes in Table A1 for the abbreviation of the variables. No. Obs is the number of observations. AR (1) and AR (2) represent the p-values for first and second order autocorrelation in first-differenced errors. Sargan test represents the p-values for the validity of the set of instruments used for overidentifying restrictions.

Table A5: Empirical results based on additional macroeconomic variables-Difference and System GMM

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
NPL_{t-1}	-0.186	-0.233	0.646***	0.354**	0.653**	0.649***	0.706***
	(-0.75)	(-0.85)	(2.96)	(2.02)	(2.45)	(2.78)	(2.77)
NPL_{t-2}	-0.286**	-0.737***	-0.168	-0.047	-0.196	-0.161	-0.175
	(-2.07)	(-3.22)	(-0.87)	(-0.21)	(-0.92)	(-0.85)	(-0.94)
$GDPGR_{t-1}$	-0.152	-0.071	0.006	-0.045	-0.050	-0.049	0.317
	(-0.93)	(-0.23)	(0.03)	(-0.34)	(-0.24)	(-0.26)	(1.13)
$DUNEMP_{t-1}$	1.589*	1.842	1.657	1.417	1.275	1.404	1.141
	(1.73)	(0.84)	(1.58)	(1.25)	(0.97)	(1.39)	(1.04)
FINCRISIS	2.499*	1.136	-5.037	-7.550	-6.729	-5.306	-8.060
	(1.92)	(0.59)	(-0.76)	(-1.48)	(-1.54)	(-0.66)	(-1.03)
$DEBT_{t-1}$	0.024		0.127*	0.112***	0.149	0.134*	
	(0.29)		(1.67)	(2.83)	(1.07)	(1.90)	
$DCPGDP_{t-1}$		0.116*			-0.028		0.079
		(1.67)			(-0.25)		(1.19)
$INFLC_{t-1}$	0.177	0.311	0.105	0.096			0.351*
	(1.49)	(1.40)	(0.68)	(0.78)			(1.70)
$INFLG_{t-1}$					-0.005	-0.009	
					(-0.03)	(-0.08)	
$DBMONEY_{t-1}$		0.061					0.438*
		(0.25)					(1.67)

$DLIR_{t-2}$		0.083	0.303		0.320*	0.355	0.206
		(0.55)	(1.37)		(1.66)	(1.37)	(0.73)
CONSTANT	5.899	3.754	3.277	8.110	6.322	4.369	3.407
	(1.07)	(0.85)	(0.35)	(1.02)	(1.06)	(0.43)	(0.41)
No. Obs	123	128	183	174	183	183	183
AR (1)	0.948	0.274	0.112	0.150	0.142	0.123	0.144
AR (2)	0.841	0.248	0.481	0.540	0.507	0.397	0.381
Sargan test	0.9290	0.566	0.655	0.857	0.507	0.598	0.438

Notes: The models are estimated with robust standard errors. Robust t-statistics are in () brackets. ***, **, * indicate the 1%, 5%, and 10% level of significance. The models in columns 1-2 were estimated using the difference GMM while in columns 3-7 use the system GMM. See the notes in Table A1 for the abbreviation of the variables. No. Obs is the number of observations. AR (1) and AR (2) represent the p-values for first and second order autocorrelation in first-differenced errors. Sargan test represents the p-values for the validity of the set of instruments used for overidentifying restrictions.

Table A6: Empirical results based on additional bank-specific variables-System GMM

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
NPL_{t-1}	0.829***	0.499**	0.603***	0.761***	0.704***	0.595***	0.713***	0.758***	0.614***	0.562***
	(5.69)	(2.20)	(2.83)	(11.26)	(5.24)	(3.39)	(3.46)	(4.08)	(3.22)	(4.07)
NPL_{t-2}	-0.063	-0.202	-0.078	-0.169	-0.065	-0.145	0.021	-0.075	-0.153	-0.202*
	(-0.33)	(-1.46)	(-0.31)	(-1.55)	(-0.38)	(-1.32)	(0.11)	(-0.31)	(-1.16)	(-1.82)
$GDPGR_{t-1}$	-0.009	-0.083	0.014	-0.246*	-0.158	-0.214*	-0.292***	-0.268**	-0.201**	-0.117
	(-0.05)	(-0.51)	(0.05)	(-1.68)	(-1.10)	(-1.83)	(-2.81)	(-2.34)	(-2.25)	(-1.47)
$DUNEMP_{t-1}$	0.485	0.493	0.069	-0.996	-0.017	-0.182	0.573	-0.170	1.550	-1.659
	(0.47)	(0.38)	(0.06)	(-0.71)	(-0.01)	(-0.20)	(0.62)	(-0.12)	(1.51)	(-1.49)
ROA_t	-0.922***									
ROA_{t-1}	0.9066***									
ROC_t		-0.042								
ROC_{t-1}		-0.016								
ROE_t			-0.173**							
ROE_{t-1}			0.038							
$DNII_t$				-2.194						
$DNII_{t-1}$				0.249						
$NNII_t$					0.105					
$NNII_{t-1}$					-0.123					

$SIZE_t$						-8.691***				14.983
$SIZE_{t-1}$						7.311**				-2.435
$LOANA_t$							0.075			
$LOANA_{t-1}$							-0.050			
$LOAND_t$								-0.007		
$LOAND_{t-1}$								-0.031		
$TLTA_t$									0.273	2.126
$TLTA_{t-1}$									-0.356***	-1.275
$SIZE*TLTA_t$										-0.319
$SIZE*TLTA_{t-1}$										0.162
CONSTANT	0.054	7.207***	6.470***	4.632***	4.271*	18.403***	2.188	6.606	12.125	-59.709
No. Obs	256	237	217	174	228	258	234	236	227	227
AR (1)	0.102	0.042	0.412	0.113	0.105	0.027	0.226	0.165	0.089	0.054
AR (2)	0.171	0.585	0.273	0.717	0.259	0.702	0.143	0.182	0.723	0.577
Sargan test	0.999	0.653	0.270	0.889	0.259	0.997	0.731	0.484	0.948	0.459

Notes: The models are estimated with robust standard errors. Robust t-statistics are in () brackets. ***, **, * indicate the 1%, 5%, and 10% level of significance. See the notes in Table A1 for the abbreviation of the variables. SIZE*TLTA is the interaction term of SIZE and TLTA. No. Obs is the number of observations. AR (1) and AR (2) represent the p-values for first and second order autocorrelation in first-differenced errors. Sargan test represents the p-values for the validity of the set of instruments used for overidentifying restrictions.

Table A7: Empirical results based on additional bank specific variables-Difference and System GMM

Variable	(1)	(2)	(3)	(4)	(5)	(6)
NPL_{t-1}	-0.159	0.478	-0.160	0.692***	0.284**	0.346***
	(-0.34)	(0.68)	(-0.39)	(5.06)	(2.56)	(4.30)
NPL_{t-2}	-0.206	-0.468	-0.040	0.117	0.255**	0.243
	(-0.30)	(-1.56)	(-0.15)	(0.50)	(2.41)	(1.24)
$GDPGR_{t-1}$	-0.474*	-0.480	-0.896**	-0.124	-0.175	-0.120
	(-1.71)	(-1.57)	(-2.38)	(-0.83)	(-1.25)	(-1.16)
$DUNEMP_{t-1}$	4.568	0.810	2.479*	0.944	3.439**	2.272
	(1.52)	(0.47)	(1.81)	(1.00)	(2.21)	(1.60)
ROA_t		-0.530			-0.804***	

ROA_{t-1}		0.462				
ROC_t	0.014			0.007		
ROC_{t-1}	-0.085**					
ROE_t			-0.073			-0.137***
ROE_{t-1}			-0.001			
$DNII_t$	-0.607	0.600	-0.969	-1.576*	-0.538	-0.625
$DNII_{t-1}$	0.887	0.753*	0.798*			
$NNII_t$	-0.340			-0.045		
$NNII_{t-1}$	0.184*					
$LOANA_t$	0.068	-0.056	-0.043	0.294	-0.085	0.000
$LOANA_{t-1}$	-0.411	-0.035	0.223			
$LOAND_t$	0.032	0.112	0.040	-0.170	0.017	
$LOAND_{t-1}$	-0.069	-0.080	-0.328			
$SIZE_t$		0.6251	-16.172		-4.927***	-1.750
$SIZE_{t-1}$		0.930	-59.598			
$TLTA_t$	-0.607	0.122	-0.511	-0.365	0.190	0.083
$TLTA_{t-1}$	-0.433	0.034	-5.860			
$SIZE*TLTA_t$			0.141			-0.022
$SIZE*_{t-1}$			0.798			
CONSTANT	128.247*	-13.467	530.888	32.305	30.245	26.915
No. Obs	117	117	113	210	210	207
AR (1)	0.966	0.244	0.595	0.326	0.945	0.994
AR (2)	0.743	0.766	0.442	0.630	0.239	0.400
Sargan test	0.799	0.692	0.429	0.606	0.929	0.785

Notes: The models are estimated with robust standard errors. Robust t-statistics are in () brackets. ***, **, * indicate the 1%, 5%, and 10% level of significance. See the notes in Table A1 for the abbreviation of the variables. SIZE*TLTA is the interaction term of SIZE and TLTA. No. Obs is the number of observations. AR (1) and AR (2) represent the p-values for first and second order autocorrelation in first-differenced errors. Sargan test represents the p-values for the validity of the set of instruments used for overidentifying restrictions.

References

Andrianova, S., Baltagi, B., Demetriades, P. and Fielding, D. (2015). Why do African banks lend so little?. Oxford Bulletin of Economics and Statistics, 77(3), pp.339-359.

Anderson, T. and Hsiao, C. (1981). Estimation of dynamic models with error components. Journal of the American Statistical Association 76, 598–606.

Arellano, M. and Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Review of Economic Studies 58, 277–297.

Arellano, M. and Bover, O. (1995). Another look at the instrumental variable estimation of error-component models. Journal of Econometrics 68, 29–51.

Baltagi, B. (2008). Econometric Analysis of Panel Data, 4th ed. John Wiley & Sons, Ltd.,Chichester, UK.

Beck, R., Jakubik, P., and Piloiu, A. (2015). Key Determinants of Non-performing Loans: New Evidence from a Global Sample. Open Econ Review 26, 525-550

Berger, A. and DeYoung, R. (1997). Problem loans and cost efficiency in commercial banks. J. Banking Finance 21, 849–870.

Blundell, R. and Bond, S. (1998). Initial conditions and moment conditions in dynamic panel data models. Journal of Econometrics 87, 115–143.

Breuer, J.B. (2006). Problem bank loans, conflicts of interest, and institutions. Journal of Financial Stability 2, 266–285

Castro, V. (2013). Macroeconomic determinants of the credit risk in the banking system: The case of the GIPS. Economic Modelling 31, 672–683.

De Bock, R. and Demyanets, A (2012). Bank Asset Quality in Emerging Markets: Determinants and Spillover. IMF Working Paper 12/71

EIB (2013). Banking in sub-Saharan Africa: Challenges and Opportunities. European Investment Bank Report.

Ekanayake, E.M.N.N. and Azeez, A.A (2015). Determinants of Non-Performing loans in licensed Commercial Banks: Evidence from Sri Lank. Asian Economic and Financial Review, 5 (6), 868-882

Espinoza, R. and Prasad, A. (2010). Nonperforming Loans in the GCC Banking System and their macroeconomic effect. IMF Working Paper, 10/224

Fofack, H. (2005). Nonperforming loans in Sub-Saharan Africa: Causal Analysis and Macroeconomic Implication. World Bank Policy Research Working Paper, 3769.

Havrylchyk, O (2010). A macroeconomic credit risk model for stress testing the South African banking sector. South African Reserve Bank Working Paper, 10/02.

Honohan, P. and Beck, T. (2007). Making Finance Work for Africa, The World Bank, Washington, DC.

Hu, J., Yang, Li. and Yung-Ho, C. (2004). Ownership and non-performing loans: evidence from Taiwan's banks. Developing Economies 42, 405–420.

IMF, (2017). Global Financial Stability Report October: Is Growth at Risk?

Judson, R., Owen, L., 1999. Estimating dynamic panel data models: a guide for macroeconomists. Economics Letters 65, 9–15.

Kasekende, L., Brixova, Z and Ndikumana, L (2010). Africa: Africa's Counter-cyclical Policy Responses to the Crisis. Journal of Globalization and Development 1 (1).

Keeton, W.R.and Morris, C.S. (1987). Why Do Banks' Loan Losses Differ, Economic Review. Federal Reserve Bank of Kansas City, pp. 3–21.

Klein, N. (2013). Non-Performing Loans in CESEE: Determinants and Impact on Macroeconomic Performance. IMF Working Paper 13/72.

Lawrence, E. (1995). Default and the life cycle model. Journal of Money, Credit and Banking 27, 939–954.

Lepetit, L., Nys, E., Rous, P. and Tarazi, A. (2008). Bank income structure and risk: An empirical analysis of European banks. Journal of Banking & Finance 32, 1452–1467.

Louzis, D. P., Vouldis, A. T and Metaxas, V.L. (2012). Macroeconomic and bank-specific determinants of non-performing loans in Greece: A comparative study of mortgage, business and consumer loan portfolio. Journal of Banking & Finance 36 (4), 1012–1027.

Mpofu, T. R. and Nikolaidou (2018). Determinants of credit risk in the banking system in Sub-Saharan Africa. Rev. Dev. Finance 8(2), 141-153.

Nickell, S. (1981). Biases in Dynamic Models with Fixed Effects. Econometrica 49 (6), 1417-1426.

Nikolaidou, E., Vogiazas, S.D. (2013). Credit risk modelling in the Romanian banking system: evidence from an ARDL model. In: Karasavvoglou, A., Polychronidou, P. (Eds.), Contributions to Economics: Balkan and Eastern European Countries in the Midst of the Global Economic Crisis. Springer.

Nikolaidou, E., and Vogiazas, S.D. (2014). Credit Risk Determinants for the Bulgarian Banking System. Int Adv Econ Res 20 (1), 87–102.

Nikolaidou, E., and Vogiazas, S. (2017). Credit risk determinants in Sub-Saharan banking systems: Evidence from five countries and lessons learnt from Central East and South East European countries**,** Review of Development Finance 7, 52-63.

Nkusu, M (2011). Nonperforming Loans and macro financial Vulnerabilities in Advanced Economies. IMF Working Paper 11/161**.**

Plamen, K. and Khamis, A. (2009). Credit Growth in Sub-Saharan Africa: Sources, Risks and Policy Response (Vol. 180). IMF Working Paper wp/09.

Reinhart, C.M. and Rogoff, K.S. (2011) From Financial Crash to Debt Crisis. American Economic Review, 101(5), 1676-1706

Reinhart, C.M. and Rogoff, K.S. (2010) From Financial Crash to Debt Crisis. NBER Working Paper 15795

Salas, V. and Saurina, J. (2002). Credit risk in two institutional regimes: Spanish commercial and savings banks. Journal of Financial Services Research 22, 203–224.

The World Bank (2019). Global Economic Prospects, Heightened Tensions, Subdued Investment.(http://www.worldbank.org/en/publication/global-economic-prospects)

Warue, B.N., (2012). The effects of Bank Specific and Macroeconomic Factors on Nonperforming loans in Commercial Banks in Kenya: A comparative Panel Data Analysis. Advances in Management and Applied Economics 3 (2), 135–164.