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THE NEXUS BETWEEN BANK CREDIT RISK AND LIQUIDITY: DOES THE COVID-19 PANDEMIC MATTER? A CASE OF THE OLIGOPOLISTIC BANKING SECTOR

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Abstract

Background: There is a raging debate on how the COVID-19 pandemic disrupted the financial market environments, affected the banks' strength as the credit channel, and the nexus between market liquidity and credit risk. During the COVID-19 crisis in the banking sector, credit risk and liquidity risk cannot be ignored as they have a considerable bearing on the performance and survival of banks.
Purpose: Within the context of COVID-19, bank-specific and external factors were examined to determine the relationship between liquidity and the credit risk of South African domiciled banks.
Research methodology: Quarterly panel data from 13 South African domiciled banks from 2018 to 2021 were examined using panel data methodologies: fixed effects and the system GMM.
Results: In an analysis of the period between 2019Q1 to 2021Q1 the results suggest a positive relationship between liquidity and credit risk, the COVID-19 pandemic was found to have an implication on the nexus as the COVID-19 dummy variable was significant. Also, the results show that liquidity deteriorated with an increase in COVID-19 cases during the pandemic period. During the Pre-COVID-19 liquidity improved with a decrease in credit risk. Nevertheless, during COVID-19 liquidity was not influenced by credit risk. The results are contrary to the pre-COVID-19 period as the government interventions to support households and non-financial firms could have changed the dynamics of liquidity and loan losses.

Novelty: The pandemic has ushered in a novel set of responses whose lasting impacts are not yet certain. The originality of the article lies in the nature of the investigation, where the nexus between liquidity and credit risk under the COVID-19 shocks/pandemic set-up. This is a unique study as the study revealed that policymakers and researchers alike should pay particular attention to the vulnerabilities to shocks from within and outside of the financial system as COVID-19 was found to significantly affect liquidity and credit risk. Since the pandemic is still active, further research is necessary to examine the cointegrating and causal relationship in the long run.

Keywords: Liquidity risk, Credit risk, COVID-19, banks, fixed effects. System GMM, financial conditions

JEL classification: G010, G120, G150

Introduction

COVID-19 has brought unprecedented disruptions to the global economy both from the health perspective and the financial conditions. A past pandemic that is similar in nature to COVID-19 is perhaps the influenza pandemic of 1918. However, the outcomes of COVID-19 are unique in terms of its global scale and scope due to global connectivity. Pandemics have the potential of cascading to credit risk for the financial sector (Mckinsey, 2020). Periods of economic downturn increase the economic vulnerability of the financial sector especially banks due to the likelihood of nonperforming loans and bank runs (Lagoarde-Segot, Leoni, 2013) Some scholars warned of the economic cost of pandemics (see Bloom, Cadarette, Sevilla, 2018) and the need for economic risk management versus the potential likelihood of future pandemics (Bloom, Canning, 2004; Fan, Jamison, Summers; 2018). The announcement by the World Health Organisation of a disease of concern in December 2019 induced fear and anxiety in the global financial markets which resulted in severe social and economic consequences (Goodell, 2020). As the pandemic developed government responses to curtail the spread of the virus globally were asymmetric across economic sectors. Emerging and developing markets experienced portfolio outflows as investor perceptions of the pandemic triggered a flight to safety of their investment in emerging markets (Marozva, Magwedere, 2021). Despite the historic effects of pandemics on financial markets, modern finance studies are barely inclusive of studies on the role of pandemics in financial markets. Literature on the role of the pandemic on liquidity risk and credit risk is scant, particularly that which examines the nexus between these variables within the context of a pandemic.

The events surrounding the current pandemic have exposed big gaps in the literature as it is witnessed that pandemics directly affect financial markets and hence the economy. Goodell (2020) argues that pandemics cause disruptions in financial markets globally. Although the pandemic is a humanitarian crisis the response to contain the spread of the virus such as introducing lockdowns has affected the functioning of the global economy (Marozva, Magwedere, 2021). These responses have included cuts in interest rates and several fiscal responses to cushion the economy from the severe effects of the pandemic. During periods of very low interest rates and low liquidity, credit availability is subdued as banks tighten lending standards, especially unsecured lending alternatives (Borio, Gambacorta, 2017). Thus, periods of low interest rates are not favourable to the intermediary functions of banks as it depresses the interest margins of banks affecting the banks' willingness to lend (Olds, Steenkamp, 2020). Bech and Malkhozov (2016) argued that if interest rates are too low, banks have a reduced appetite for accumulating more capital reducing the need for additional lending.

Despite the interconnectedness of interest rates, liquidity and credit risk, the nature of the market structure matters. In oligopolistic market structures, the relationship between credit risks and liquidity risks may not be clearly determined (Borio, Gambacorta, 2017). The banking sector in South Africa is oligopolistic in nature comprising of the five largest banks with collective banking sector assets of 89.4 per cent in 2020 (see SARB, 2021). Therefore, the structural uniqueness of the sector also motivated the need to re-assess the nexus.

The market structure and hence the financial market environments seem to disrupt the strength of the credit channel, a decrease in market liquidity deteriorates the credit channel of monetary policy and results in slower economic growth for any given level of the policy rate (see Bernanke, Blinder, 1988; Salachas, Laopodis, Kouretas, 2017). The uncertainty accompanying the times of the pandemic has affected the banks' risk profiling, the banks' current credit risk management models can be irrelevant given the context of the economic impact of the virus (Mckinsey, 2020). Globally governments and the private sector significantly borrowed to stay afloat from the effects of the COVID-19 shock resulting in a debt overhang (IMF, 2021). The updating of the existing risk models to incorporate the effects of the pandemic can be a task achievable only in the long term (McKinsey, 2020). At the time of writing this paper, the virus is still very active with different stages of lockdowns implemented depending on the severity of its spread. During the COVID-19 crisis in the banking sector, these two risks cannot be ignored as they have considerable bearing on the performance and survival of banks (see Coyle, 2000).

The pandemic has resulted in a 51 per cent drop in the gross domestic product in South Africa in the second quarter of 2020 (Statistics South Africa (StatsSA), 2021). The pandemic hit South Africa when it was already experiencing a recession, presenting socio-economic downside risks for the financial sector, especially banks (South African Reserve Bank (SARB), 2021). All industrial sectors except the agricultural sector declined due to the lockdown policy and response to contain the spread of the virus. Despite the effects of the pandemic that the South African economy is experiencing, the banks' operating environment faces existing pressure which includes poor economic growth, power supply shortages, weak business confidence, and deep structural social inequalities (SARB, 2021). The uncertainty in the macroeconomic environment due to COVID-19 can increase the financial stability risks.

It is against this background that it was therefore imperative to study the relationship between the credit risk and liquidity in the banking sector in South Arica during the pandemic. Contrary to theoretical prediction credit risk was found to increase liquidity for the period 2018Q1–2021Q1 (entire period hereafter). During this period the COVID-19 dummy variable was found to be significant implying that the pandemic had a significant influence on liquidity and therefore mattered in the analysis of the relationship between liquidity and credit risk. From 2018Q1 to 2019Q3 (pre-crisis period hereafter) the results are opposite to the entire period results as liquidity was found to deteriorate with improvement in the loan book. Last, COVID-19 was found to negatively and significantly influence liquidity. Contrary to prediction credit risk had no linkage with liquidity during the pandemic period (2019Q4–2021Q1).

Considering the unearthed relationships and other empirical studies banks need to continuously manage non-performing loans (NPLs), loan loss provisioning and loan classifications given the ever-changing trajectory of the effects of COVID-19. It is argued that the relationship between liquidity and credit risk is negative, as the increase in bad loans triggers a shock in banks resulting in a decrease in bank liquidity. The nexus between liquidity and credit risk was studied before within the context of the global financial crisis (see for example Shin, Kim, 2015; Varotto, 2011). However, these relationships have not been studied under the COVID-19 shocks/pandemic set-up. Policymakers and researchers alike should pay particular attention to the vulnerabilities to shocks from within and outside of the financial system. The pandemic has ushered in a novel set of responses whose lasting impacts are not yet certain. Therefore, it is important to examine the relationship within the context of a pandemic.

The rest of the paper is organised as follows. A discussion of an overview of the financial conditions in South Africa is provided in section 1. In section 2 the theoretical and empirical literature for the paper is reviewed. Section 3, presents the methodology employed to examine

the nexus between liquidity and credit risk in South Africa with the discussion of the results of the study in section 4. The study is concluded in section 5 of the paper.

1. Overview of the financial conditions in South Africa during the pandemic

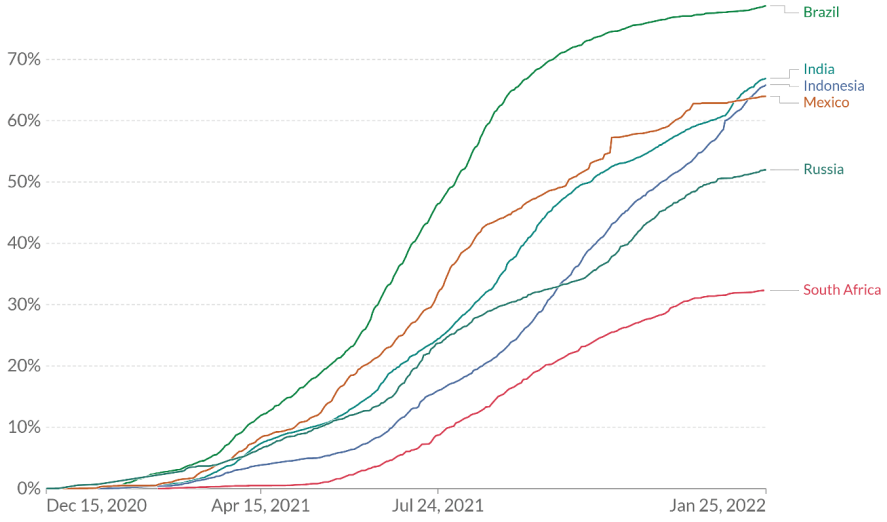
According to the SARB (2021) before COVID-19 the short-term market interest rates were above the repurchase (repo) rate with the potential of tightening liquidity premiums. However, the spread between the short-term interest rate such as the Johannesburg Interbank Average Rate (Jibar hereafter) and the repo rate narrowed with the onset of the pandemic (Olds, Steenkamp, 2021). Currently, the financial conditions index a tool for macro-prudential regulations and financial stability are loose in South Africa. Five variables are used in constructing the financial conditions index (FCI) which include real interest rates; the yield curve; earnings yield on shares; excess money supply growth; and real effective exchange rate change (SARB, 2021). During times of high market volatility, the FCI can serve as an indicator for the conduct of monetary policy (Zheng, Yu, 2014).

In March 2020 the financial conditions in South Africa tightened due to high-risk aversion in the financial markets (Olds, Steenkamp, 2021). The SARB extended its repurchasing facilities to ensure liquidity in the market. The repo rate was progressively reduced during the pandemic and has remained at 3.5 per cent since July 2020. Furthermore, the SARB incentivised the flow of credit by guiding banks on debt relief programmes (SARB, 2020). However, low interest rate reduces the interest margins of the banks affecting bank profitability (Olds, Steenkamp, 2021). Nevertheless, by December 2020 the policy interventions by the government and the central bank loosened the FCI as the policy interventions (which included substantial repurchase (repo) rate cuts and interventions in the bond market) supported improvements in asset prices and the liquidity in the financial markets (see SARB, 2020). As of 2020, the economy has witnessed an increased number of retrenchments and furloughs due to the pandemic with a likelihood of stress in the credit portfolios of the financial sector.

High capital and liquidity buffers in the financial institutions weathered the banks from the initial pandemic induced economic contraction in 2020 as the sector absorbed the shock and remained resilient. According to the South African Reserve Bank (2021), the funding conditions of banks have not eased to the equivalent magnitude as current monetary policy adjustments. The introduction of the level 5 lockdown in March 2020 saw a sharp increase in the ratio of impaired advances to gross loans which eased from September 2020 to December 2020. In January 2021 the ratio of impaired advances to gross loans and advances reached its highest

level of 5.2 per cent since 2011 (see SARB, 2021). The ratio is close to the highest ratio of 6% last reported in 2009 after the global financial crisis. The various funding markets experienced increased liquidity pressures with the spread of the pandemic.

South Africa announced its first level 5 lockdown on 26 March 2020. Furthermore, a stimulus package of $26 billion announced in South Africa which was 10% of the country's gross domestic product (GDP) (Bhorat, Köhler, 2020) provided some relief to the financial markets. The phasing in of mass vaccinations provided an opportunity of opening up the economy to its full functioning. In comparison with the other emerging markets, South Africa is lagging behind in its vaccination rate per 100 people as can be seen below in Figure 1. As of 15 August 2021, 12.46 per cent of the population had received vaccinations with only 6.9 per cent of the population fully vaccinated in South Africa (Our World in Data, 2021).



Note: The graph shows the share of people with at least one dose of the COVID-19 vaccine, vaccination rate as a percentage of the population.

Figure 1. Vaccination rates of COVID-19 in some emerging markets

Source: Our World in Data (2022).

2. Literature Review

2.1. Theoretical background

An increase in the credit risk of banks increases illiquidity in bank assets (Ejoh, Okpa, Inyang, 2014). Theoretically, the paper will be guided by the financial intermediation theory (see Bryant, 1980; Diamond, Dybvig, 1983; Allen, Sontomero, 1997). The significant function of financial intermediaries is to provide liquidity in the form of loan commitments (Holmström, Tirole, 1998). Banks reduce information asymmetry between lenders and borrowers and create adverse selection and moral hazards in the intermediation process (Stiglitz, Weiss, 1992). The financial intermediation models view banks as pools of liquidity that provide both depositors and borrowers with the ready availability of cash (see Allen, Santomero, 2016). Diamond and Dybvig (1983) opined banks have an important role in creating liquidity, whilst fulfilling valuable activities on both sides of their balance sheets by granting loans to borrowers and providing liquidity on demand to depositors.

Bryant (1980) and Diamond and Dybig (1983) opined that bank assets and liquidity structure are closely connected, especially concerning borrowers' default and fund withdrawals). Banks accept deposits from savers and lend those funds to borrowers, a bank's asset and liability structures are closely connected, especially in terms of borrower defaults and deposit outflows hence the theory of financial intermediation suggests a positive link between liquidity risk and credit risk in banks (Imbierowicz, Rauch, 2014). The relationship between liquidity risk and credits risk in banks has been studied however to the best of our knowledge there is a gap in the literature on the impact of COVID-19 on this relationship.

2.2. Empirical Review

The 2008 global financial crisis has created valuable lessons on the ethos of financial stability. Liquidity risk and credit risk are the major risk sources of default risk faced by the financial sector (Imbierowicz, Rauch, 2014). Credit risk is a severe risk to bank stability such that if it is not properly managed it would lead to the complete failure of banks (Saleh, Afifa, 2020). Credit risk arises when a lender is exposed to loss from a borrower, counterparty or an obligor who fails to honour their debt obligations as contracted (Colquitt, 2007). The Basel Committee on Banking Supervision defines liquidity risk as to the risk of being unable to meet the obligations of depositors or to fund increases in assets, which stems from a shortage of liquid assets (Bank of International Settlements, 2008). It was however argued that the market structure

of the banking sector has a crucial role in determining the extent of the relationship between liquidity risk and credit risk (see Imbierowicz, Rauch, 2014).

A debt default leads to lower cash flow and triggers depreciations in loan assets, which eventually increases liquidity risk in banks (Diamond, Rajan, 2005; Saleh, Afifa, 2020). However, Imbierowicz and Rauch (2014) did not find any significant and economically meaningful reciprocal contemporaneous or time-lagged relationship between liquidity risk and credit risk in US banks. Furthermore, it was argued that the relationship between the two risks was dependent on the overall level of risk in banks (Saleh, Afifa, 2020). In other studies, the relationship between liquidity risks and credit risk depends on the proxies that are used for the two risks (see Nikomaram, Taghavi, Diman, 2013). Acharya and Viswanathan (2011) suggest that when asset prices deteriorate, it is more difficult to roll over debt because a liquidity problem exists. Thus it is suggested that the relationship between credit risk and liquidity risk is positive.

During the COVID-19 crisis the markets are experiencing fading demand and impulsive supply chain disturbances, various firms and consumers continue to depend on banks as relationship lenders. Evidence suggests the existence of frictions in credit markets that affect the 'pass-through' of monetary policy (see Baldwin, Weder di Mauro, 2020). The policy response to the COVID-19 crisis has resulted in a series of new and additional measures by monetary and prudential authorities for banks. The pandemic has resulted in the loss of income for some households and firms as the lockdown levels have had adverse effects on income for both firms and individuals (SARB, 2020). Currently, the policy responses (which included fiscal stimulus packages) to the economic impacts of the COVID-19 pandemic have likely prevented many consumers from falling delinquent on their loan payments (see Standard, Poor, 2020). In the absence of these pandemic response measures, persistent impairment in access to market-based funding, coupled with the significant surge in credit demand for emergency liquidity needs would extremely weaken banks' intermediation capacity (see Schivardi, Romano, 2020).

However, the remaining risk from the pandemic is its economic impact if it gets worse, if it lasts longer than anticipated and how this will affect the asset quality of banks and liquidity risk. The support measures introduced have largely counterbalanced the effect on bank credit as significant economic volatility flowed through to bank borrowers (SARB, 2020). Nevertheless, if the economic effects of COVID-19 persist for a longer period, payment holidays may only delay delinquency and loan default by some consumers, rather than preventing this outcome. Hence this paper is different from the evidence that is already available as it incorporates the COVID-19 period to determine the relationship between liquidity risk and credit risk in banks. The empirical research has not concluded on the relationship between the two risks as

the evidence on the relationships remains open. Additionally, there are gaps in the literature on the effects of the novel coronavirus on the link between the two major risks in the South African banking sector.

3. Data and methodology

3.1. Data, sample selection and variables

The study utilised quarterly secondary data from 2018Q1 to 2021Q1. Bank specific data was extracted from the BA 900 forms of the South African Reserve Bank (SARB). The period of the study was guided by the availability of data for all of the variables. The data for total loans and advances was used as the proxy for bank credit risks. Money supply (M2) was used as the proxy for liquidity risk. To further analyse the nexus between credit risk and liquidity risk the study divided the data into two categories (the period before COVID-19 and the period during COVID-19). The COVID-19 period in this study was unique as monetary policy was eased through significant reductions in the repo rate, to a cumulative 275 basis points between January and July 2020. Extraordinary deviations to both monetary policy operations and prudential regulations were introduced to safeguard the sufficient flow of funds in the banking and financial systems (SARB, 2020). These strategies offered liquidity management and eased liquidity strains in the domestic financial markets. Hence the need to analyse the nexus between credit risk and liquidity risk during the period of policy interventions to stabilise the domestic financial markets.

The data in the panel below is comprised of thirteen South African domiciled banks that are locally controlled. According to SARB (2021), there are 13 locally controlled banks in South Africa thus individual bank-specific data was drawn from these banks for analysis. In addition to the bank-specific data which focused mainly on the two major variables (liquidity and credit risk) the Statistics South Africa (StatsSA) and the SARB databases were used to extract data on the unemployment rate, real GDP growth rate and the prime lending rate. Table 1 provides a descriptive summary of the variables used for the analysis and the data sources.

Table 1. Description of variables

Variable	Definition	Source	Expected Sign
Liquidity risk (LR)	Liquidity risk refers to how a bank's inability to meet its obligations (whether real or perceived) threatens its financial position or existence. The higher the liquidity in the markets the lower the liquidity risk and vice versa. (proxied by money supply (M2)	SARB	
Credit risk (CR)	when a lender is exposed to loss from a borrower, counterparty or an obligor who fails to honour their debt obligations as contracted (proxied by impaired loans and advances)	SARB	Positive /Negative (+/–)
Capital ratio (CAPR)	Total (Tier 1 and Tier 2) equity is divided by total assets as reported on the bank balance sheet.	SARB	Positive (+)
Total COVID-19 cases (COV19)	Cumulative number of confirmed coronavirus cases	Our World in Data	Positive/Negative (+/–)
COVID-Dummy	The dummy variable which is 1 during COVID-19 or 0 for the pre-COVID-19 period		
Unemployment rate (UNE)	percentage of the workforce that is unemployed but is willing and able to work and actively seeking employment	StatsSA	Positive (+)
Real GDP growth rate (GDPR)	Real GDP growth rate	SARB	Negative (–)
Prime lending rate (PLR)	rate of interest that commercial banks charge their customers when issuing a loan	SARB	Negative (–)

Source: own elaboration.

The relationship between liquidity risk and credit risk was determined using equations 1 to 3. Different econometric approaches were estimated and are reported for robustness. Firstly, a model was run for the 2018Q1–2021Q1 and a dummy variable was used: 0 for the quarters before the COVID-19 pandemic and 1 for the quarters during the period of COVID-19 (Equation 1). The Fixed Effects model as suggested by the Hausman test (see Baltagi, 1995) was used. The fixed-effect model for dynamic panels reduces the problems of bias in the parameter estimates and caters for heterogeneity across the cross-sectional units. The model estimated is parameterised in equation 1:

$$LR_{it} = \alpha + \beta_1 LR_{it-1} + \beta_2 CR_{it} + \beta_3 COV-19_Dummy_{it} + \beta_j \sum_{j=1}^{N} X_{j,it} + \mu_{it} + \varepsilon_{it} \quad (1)$$

where: LR is liquidity risk with money supply (M2) as the proxy implying that the higher the M2 the lower the liquidity risk and vice versa, CR credit risk (impaired loans and advances). X is a vector of control variables where j is the number of the control variables. Literature was used to draw the main determinants of liquidity risk in banks. The vector of the control

variables includes UNE (unemployment rate), CAPR is the capital ratio, COV is the number of active COVID-19 cases (see Al-Awadhi, Alsaifi, Al-Awadhi, Alhammadi, 2020; Marozva, Magwedere, 2021), GDPR is the gross domestic product growth rate, PLR is the prime lending rate and μ_{it} is the time-invariant country-specific effect, ε_{it} is a random error term for country i for time t. Additionally, the data were then divided into equal quarters for the pre-COVID-19 period and during the COVID-19 period. The number of quarters for the pre-COVID-19 was determined by the duration of the quarters in the COVID-19 period so that there are equal periods for both of the periods under consideration. Hence, we have 6 quarters for the pre-COVID-19 and 6 quarters during the COVID-19 quarter and data availability at the writing of this paper limited us to until the first quarter of 2021.

For the analysis of the two equal periods for pre-COVID-19 and the period during COVID-19, the Arellano and Bond (1991) generalized method of moments (GMM) for dynamic panels was employed to determine the relationship between liquidity risks and credit risk. While considering a dynamic specification, the GMM estimator aims at addressing any possible endogeneity bias. Depending on the source of the bias, this can lead to the over or underestimation of the relationship between credit risk and liquidity risk. The system GMM estimation method addresses these problems, and it is argued to be more efficient on short panels (see Arellano, Bond, 1991), hence it was a preferred technique to determine the relationship. Moreover, the bias due to the introduction of the lagged dependent variable among the regressors, reverse causality and measurement errors may be other sources of endogeneity (Arellano, Bond, 1991). Furthermore, there is a possibility of interdependencies among the banks and the dependences emanating from the same macroeconomic shocks hence the need to test for cross-sectional dependence (CD) (see De Hoyos, Sarafidis, 2006; Pesaran, 2006; 2021). The System GMM technique yields an asymptotically unbiased estimation of the t-statistics without requiring the heteroscedastic structure of the regression equation (Blundell, Bond, 1998; Hansen, 1982).

Also, the 2-Step System GMM technique assumes that the error term is not serially correlated. Thus, disturbances and the instrumental variables are uncorrelated in the equations, which are the lagged levels of the series after the equation has been first differenced to eliminate bank-specific effects. The instruments used in the study were differenced lag variables with lagged levels, and it instruments the levels with lagged differences. The exogenous instruments were validated using the Hansen test and Sargan test. The Arellano-Bond AR(1) and AR(2) were used to test for autocorrelation. The tests statistics were not significant meaning that the models did not have a problem of serial correlation, they were robust and not weakened by many instruments because the instruments were less than the number of groups in the model

estimation output. For the equal periods during COVID-19 and pre-COVID-19 equations 2 and 3 were estimated after the validation of the instruments:

$$\Delta LR_{it} = (\alpha - 1)\Delta LR_{it-1} + \beta_1 \Delta CR_{it} + \beta_2 \Delta COV - 19_Dummy_{it} + \beta_j \sum_{j=1}^{N} \Delta X_{j,it} + \Delta\mu_{it} + \Delta\varepsilon_{it} \quad (2)$$

$$\Delta LR_{it} = (\alpha - 1)\Delta LR_{it-1} + \beta_1 \Delta CR_{it} + \beta_j \sum_{j=1}^{N} \Delta X_{j,it} + \Delta\mu_{it} + \Delta\varepsilon_{it} \quad (3)$$

The following section presents and discusses the results of the study.

4. Results and Discussion

A preliminary analysis was performed and the results of the descriptive statistics of the study are presented in Table 2[1]

Table 2. Descriptive Statistics

Variable	Mean	Median	Maximum	Minimum	Std. Dev.	Jarque--Bera	Probability	Observations
CAPR	0.21	0.11	0.93	0.06	0.22	253.33	0.00	169
COV19	686,443.80	674,339.00	1,548,157.00	1,353.00	576,457.30	5.66	0.06	65
CR	9,692,668.00	2,715,385.00	41,269,571.00	0.00	11,616,382.00	25.53	0.00	169
GDPR	1.76	–0.50	67.30	–51.70	23.70	105.34	0.00	169
M2	3,077,633.00	2,992,942.00	3,489,713.00	2,703,936.00	260,083.80	15.89	0.00	169
PLR	9.08	10.00	10.25	7.00	1.40	26.72	0.00	169
UNE	28.66	29.00	32.60	23.30	2.44	1.36	0.51	169

Source: authors' own compilation from Stata 10.

The capital ratio has a standard deviation of 0.22 with a minimum of 0.93 and a minimum of 0.06 for the period under study. The COVID period presented an outlier in the gross domestic product growth rate with a minimum annualised quarter on quarter growth rate of –51.7% and a maximum of 67.3% (StatsSA, 2021). The prime lending rate in South Africa has been declining since the onset of COVID-19 with a minimum of 7% and a standard deviation of 1.4. South Africa has recorded the highest unemployment rate during the second quarter of 2021 and the maximum rate is 32.6. The StatsSA (2021) reckoned that the financial sector in South Africa was the largest contributor to unemployment for the second quarter of 2021 shedding a total

[1] Correlation analysis was not presented and reported for brevity.

of 278,000 jobs by June 2021. The maximum of cumulative cases of COVID-19 infections is 1,548,157.00 with a mean of 686,443.80 cumulative cases.

The results of the fixed effects panel regression are presented in Table 3. To check the robustness of the results to the estimation technique Pooled Effects, Random Effects and Feasible Generalised Least Squares results are also reported.

Table 3. Summary results for the determinants of liquidity during the pre-COVID-19 and COVID-19 period

	Pooled Effects (1)	Fixed Effects (2)	Random Effects (3)	GLS (4)
L.LM2	0.233** (0.0731)	0.233* (0.0805)	0.233** (0.0731)	0.233*** (0.0537)
LCR	0.000436 (0.000508)	0.00354* (0.00119)	0.000436 (0.000508)	0.000436 (0.000518)
COV19_DUMMY	0.0163*** (0.0000723)	0.0158*** (0.000399)	0.0163*** (0.0000723)	0.0163*** (0.00257)
CAPR	–0.00138 (0.00295)	0.00871 (0.00571)	–0.00138 (0.00295)	–0.00138 (0.00486)
GDPR	–0.000122*** (0.0000209)	–0.000121*** (0.0000207)	–0.000122*** (0.0000209)	–0.000122** (0.0000380)
PLR	–0.0123*** (0.00149)	–0.0121*** (0.00170)	–0.0123*** (0.00149)	–0.0123*** (0.00124)
UNE	0.00264*** (0.000397)	0.00254*** (0.000367)	0.00264*** (0.000397)	0.00264*** (0.000429)
_cons	5.004*** (0.476)	4.982*** (0.528)	5.004*** (0.476)	5.004*** (0.351)
N	156	156	156	156
R^2		0.944		

Coefficients reported. Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Source: authors' compilation using Stata 10.

Table 3 shows the results of the fixed effects (FE). For robustness and comparison purposes the table also presents the results from the Pooled Effects (PE), Random Effects (RE) and the Feasible Generalised Least Squares (FGLS). A percentage increase in credit risk increases liquidity as measured by M2 by 0.00354 and it is significant at 5 per cent. The findings confirm the findings by Acharya and Naqvi (2012) who suggested a negative relationship between liquidity risk/illiquidity and credit risk. On the contrary, Hassan, Khan and Paltrinieri (2019) did not find any relationship between liquidity and credit risk. The dummy variable was found to be significant implying that COVID-19 has a role to play in the nexus between the variables. For the whole period under analysis, the magnitude of the coefficients of growth in GDP, unemployment and prime lending rate largely explains a relationship with liquidity as compared to the other

variables in the study. Higher growth in GDP and lower prime lending rates reduce liquidity in banks. On the contrary, liquidity increases with increases in unemployment.

As specified earlier the data was divided into two equal periods and the results of the equal period: the period during COVID-19 and before the COVID-19 period are summarised in Tables 4 and 5 respectively.

Table 4. Summary results for the determinants of liquidity during the COVID-19 Period

Regressors	Pooled Effects (1)	Fixed Effects (2)	Random Effects (3)	2 Step System GMM (4)	GLS (5)
L.LM2	–0.0134 (0.0632)	–0.0417 (0.118)	–0.0134 (0.0632)	–0.201* (0.0691)	–0.0134 (0.0303)
LCR	0.000128 (0.000135)	0.00419 (0.00274)	0.000128 (0.000135)	0.00230 (0.00426)	0.000128 (0.000166)
LCOV19	–0.00243*** (0.000319)	–0.00234* (0.000983)	–0.00243*** (0.000319)	–0.00370* (0.00166)	–0.00243*** (0.000429)
CAPR	0.000697 (0.00101)	0.00990 (0.0107)	0.000697 (0.00101)	0.0258* (0.0111)	0.000697 (0.00271)
GDPR	–0.000104*** (0.00000924)	–0.000110*** (0.0000178)	–0.000104*** (0.00000924)	–0.000138*** (0.0000121)	–0.000104*** (0.00000904)
PLR	–0.0192*** (0.00117)	–0.0195*** (0.00196)	–0.0192*** (0.00117)	–0.0262*** (0.00285)	–0.0192*** (0.000785)
UNE	0.00271*** (0.000114)	0.00275*** (0.000320)	0.00271*** (0.000114)	0.00334*** (0.000230)	0.00271*** (0.000117)
_cons	6.689*** (0.416)	6.849*** (0.781)	6.689*** (0.416)		6.689*** (0.198)
N	65	65	65	52	65
R^2		0.989			
#Instruments				12	
#Groups				13	
AR(1)				0.893	
AR(2)				0.307	
Sargan				0.0000	
Hansen				0.616	

Coefficients reported. Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Source: authors' own calculation using Stata 10.

The results of the COVID-19 period were estimated using the 2 Step System GMM and there was no significant relationship between liquidity and credit risk. This relationship was not expected. However, several fiscal and monetary interventions by the government and the central bank to ensure financial stability and cushion the economy from the effects of the pandemic might have influenced the relationship between liquidity and credit risk in banks during the COVID-19 period (see SARB, 2020; National Treasury, 2020). The results are contrary to

Table 5. Summary results for the determinants of liquidity during the Pre-COVID-19 Period

Regressors	Pooled effects (1)	Fixed Effects (2)	Random effects (3)	2 Step System GMM (4)	FGLS (5)
L.LM2	0.156* (0.0647)	0.178 (0.0870)	0.156* (0.0647)	0.120 (0.185)	0.156*** (0.0432)
LCR	–0.000655 (0.000661)	–0.00168 (0.00125)	–0.000655 (0.000661)	–0.0331* (0.0111)	–0.000655 (0.000483)
CAPR	–0.0147 (0.0101)	–0.0224 (0.0222)	–0.0147 (0.0101)	–0.379* (0.125)	–0.0147** (0.00458)
GDPR	–0.00114*** (0.0000310)	–0.00115*** (0.0000833)	–0.00114*** (0.0000310)	–0.000672* (0.000270)	–0.00114*** (0.000245)
PLR	–0.0187*** (0.000602)	–0.0236*** (0.00242)	–0.0187*** (0.000602)	–0.0312*** (0.00623)	–0.0187*** (0.00147)
UNE	0.00427*** (0.00106)	0.00315*** (0.000717)	0.00427*** (0.00106)	–0.00384 (0.00224)	0.00427*** (0.000826)
_cons	5.534*** (0.390)	5.478*** (0.537)	5.534*** (0.390)	6.380*** (1.172)	5.534*** (0.267)
N	65	65	65	65	65
R^2		0.989			
#Instruments				12	
Groups				13	
AR(1)				0.005	
AR(2)				0.501	
Sargan				0.0000	
Hansen				1.0000	

Coefficients reported. Standard errors in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Source: authors' compilation using Stata 10.

the pre-COVID-19 period where a significant negative relationship between credit risk and liquidity was observed. Interventions to support households and non-financial firms could have helped in reducing loan losses such that banks need not use their capital buffers (SARB, 2020). Furthermore, the pandemic is still active and further research is necessary to examine the relationship in the long term. Overall, banks did not face large liquidity pressures and the defensive actions by the banks to maintain their liquidity levels above the regulatory minimum can explain the insignificance of the relationship between liquidity risk and credit risk during the COVID-19 period.

However, since the pandemic is still active as of writing of this paper the relationship between liquidity and credit risk during the COVID-19 period may not be precisely determined. The South African Reserve Bank (SARB) argued that banks in South Africa are resilient and have adequate capital buffers to absorb the stress from the pandemic (SARB, 2020). The support measures may have delayed the impact of potential amplification mechanisms on the relationship

between liquidity and credit risk. An empirical study on the relationship between liquidity and credit risk during COVID-19 is very thin. However, the relationship between liquidity and credit risk differs for COVID-19 and the pre-COVID-19 period as during the COVID-19 period there was no significance in the relationship whilst pre COVID-19 shows a negative relationship between the two risks. This relationship holds even with the alternative version of other models used for robustness purposes in this study. Table 5 reports the pre-COVID-19 results for the divided sample.

As the data were divided into two groups the COVID-19 period is reported in Table 4 whilst pre-COVID-19 is in Table 5. It was observed that during the COVID-19 period unemployment significantly affects liquidity where an increase in unemployment increases with an increase in liquidity in banks. It can possibly be explained by the fiscal and monetary interventions which disrupted. The effect of the capital ratio (CAPR) during COVID-19 and pre COVID-19 significantly differ. There is no exact effect of capital ratio for the two periods as during COVID-19 an increase in capital ratio increases liquidity whilst during the pre-COVID-19 period an increase in COVID-19 reduces liquidity and both opposing effects are significant at 5 per cent. Increasing the capital ratio in overall leads banks to engage in less liquidity transformation, and during periods of high liquidity stress, when uncertainty is high and the value of assets is particularly uncertain liquidity risk increases sharply (Acosta Smith, Arnould, Milonas and Vo, 2019). In summary, all of the variables of the study except for the GDP growth and prime lending rate had no exact effect on liquidity from the results of the two periods.

Conclusions

The link between liquidity and credit risk was examined in this paper. Initially, the fixed effects panel regression was used to predict the relationship between the two risks. Furthermore, the data was divided into two equal periods (period during COVID-19 and pre-COVID-19 periods). Our empirical results are mixed on the relationships between liquidity and credit risk during the COVID-19 period and the pre-COVID-19 period. Contrary to theoretical prediction credit risk was found to increase liquidity as the entire period was put into perspective. Also, under the same period, the COVID-19 dummy variable was found to be significant implying that the pandemic had a significant influence on liquidity and therefore mattered in the analysis of the relationship between liquidity and credit risk. Pre-crisis period results are opposite to the entire period of results as liquidity was found to deteriorate with a deteriorating loan book. Last,

COVID-19 was found to negatively and significantly influence liquidity. Contrary to prediction credit risk had no linkage with liquidity during the pandemic period.

There are discussions in anecdotal literature that macroeconomic interventions by the government and the central bank provided significant insights for the debate on timely interventions to cushion the financial sector and the economy from fundamental economic shocks. Based on our results for the two periods the effect of government responses to curb the impact of the pandemic on financial markets is recommended. As the pandemic is still active the scale and scope of an empirical study are improving hence it will be necessary for a further analysis of the effects of the pandemic on financial market dynamics. Furthermore, policymakers need to understand the effects of COVID-19 at aggregated and sectoral levels to minimise the long-term effects of the pandemic. Hence further empirical studies at both aggregate and sectoral levels should be done for evidence-based policy interventions to ensure social and economic sustainability.

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