Liquidity Mismatch Index and Bank Performance

Godfrey Marozva[1]

[1] School of Economic and Financial Sciences, College of Economic and Management Sciences, University of South Africa, South Africa

Correspondence: Godfrey Marozva, School of Economic and Financial Sciences, College of Economic and Management Sciences, University of South Africa, South Africa.

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Abstract

The relationship between liquidity and bank performance in finance literature remains an unresolved empirical issue. The main objective of this article was to investigate the relationship between liquidity mismatch index (LMI) initially developed by Brunnermeier, Gorton and Krishnamurthy (2012) and further developed by Bai, Krishnamurthy, and Weymuller (2018) and South African bank performance empirically. Different from other prior studies, the study undertook to determine the relationship employing the liquidity measure that integrates both market liquidity and funding liquidity within a context of asset liability mismatches. The unit of analysis was a panel of 12 South African banks over the period 2008–2018. Specifically, two liquidity measures – the bank liquidity mismatch index (BLMI) and the aggregate liquidity mismatch index (ALMI) were regressed against bank performance matrices. The newly developed liquidity measures are based on portfolio management theory and they account for the significance of liquidity spirals. Results revealed that, bank performance is negatively and significantly related with BLMI. While the bank performance is positively related to ALMI, the relationship is not significant. Also, the nature of relationship is dependent on the measure of profitability employed.

Keywords: liquidity mismatch index, bank liquidity, liquidity risk, measures of liquidity, global financial crisis, systemic risk, market liquidity, funding liquidity

1. Introduction

Liquidity is the centrepiece in the performance of banks. In the theoretical model by Diamond and Dybvig (1983), banks performance is primarily derived from the difference between the returns from illiquid bank assets and the cost of liquid bank liabilities. Therefore, bank liquidity should be analysed from the asset standpoint and liability view point. International Monetary Fund (2011) assent that liquidity should be viewed from two realities, namely market liquidity and funding liquidity. Also, Brunnermeier, Gorton and Krishnamurthy (2012) argue that liquidity should be viewed from the perspective of the overall banking system which comprise of the bank assets, bank liabilities and the liquidity of the general market.

This article empirically tests the relationship between bank performance and the modified liquidity mismatch indices. Specifically, Bai, Krishnamurthy and Weymuller's (2018) liquidity mismatch index was further developed to come up with two liquidity measures, the bank liquidity mismatch index (BLMI) and the aggregate liquidity mismatch index (ALMI). The modified liquidity measures were then regressed against the bank performance measures including, return on assets (ROA), net interest income (NIM) and return on equity (ROE). This investigation is premised on the hypothesis that bank performance is influenced by its level of liquidity as measured by BLMI and the ALMI.

During the global financial crisis of 2007–2009, several banks underperfomed because of their failure to manage liquidity in a prudent manner (Berger & Bouwman, 2017). Thus, the crisis emphasised the importance of liquidity to the proper functioning of financial markets and the banking sector. Before the financial crisis, financial intermediaries were stable as funding was readily available and at low cost. The rapid reversal in market conditions illustrated how quickly liquidity can evaporate, and that illiquidity can reserve already earned profits as financial institutions are either forced to sell assets well below their market value or borrow at interest rates charges above their weighted return on assets (Castiglionesi, Feriozzi, & Lorenzoni, 2017).

Lack of liquidity is one of the major reasons why banks fail, however, holding liquid assets has an opportunity cost of higher returns (Marozva, 2015; 2017; Marozva & Makina, 2020)). Bourke (1989) finds a positive significant link between bank liquidity and profitability. However, in times of instability banks may choose to increase their cash holding to mitigate risk. On the other side Molyneux and Thornton (1992) found that there is a negative correlation between liquidity and profitability levels. While it is generally agreed (Lartey, Antwi, & Boadi, 2013; Chronopoulos, Liu, McMillan, & Wilson, 2015) that there is a negative relationship between liquidity and bank profitability, there is counter evidence which shows the need to consider the trade-off between resilience to liquidity shocks and cost of holding less profitable liquid assets as the latter is assumed to impact on the bank’s ability to take advantage of opportunities arising in the market which may result in increase in revenue, capital or ability to extend capital credit (Bordeleau & Graham, 2010). Liquidity management becomes a very important part in financial management decisions, where the liquidity management efficiency could be achieved by firms that manage a trade-off between liquidity and profitability (Bhunia & Khan, 2011; Alshatti, 2015).

Brunnermeier, Krishnamurthy and Gorton (2013) notes that it is not the level of gearing that is important, but rather the proportion of debt that is comprised of short-term demandable deposits. As banks hold illiquid assets financed by short-term debt of which if bank run behaviour emerges this may result in increased systemic risk. Of the few studies that have looked at the bank liquidity and bank performance nexus most of them took a theoretical approach and the few studies that attempted to empirically test this phenomenon used net interest margin as the indicator for bank profitability (Berrós, 2013; Chowdhury, Siddiqua, & Chowdhury, 2016).

The linkage between net interest margin and liquidity is assumed to be positive. Empirical studies by Pradhan and Shrestha (2016) found a significant negative relationship bank performance and liquidity as their results show that return on assets and return on equity deteriorated with the improvement in bank liquidity. However, Maudos and Solís (2009) though they found a negative relationship between market liquidity and net interest margin the relationship is not significant.

While it is generally agreed that there is a negative relationship between liquidity and bank profitability there is counter evidence which shows the need to consider the trade-off between resilience to liquidity shocks and cost of holding less profitable liquid assets. The latter is assumed to impact on the bank’s ability to take advantage of opportunities arising in the market which may result in increase in revenue, capital or ability to extend capital credit (Bordeleau & Graham, 2010). Banks on the asset side hold low yielding securities such as treasury bills and highly rated short-term corporate bonds in order to minimise a scramble for liquidity when credit use increases in time when money is constricted (Holmstrom & Tirole, 1998). This is confirmed by Maudos and De Guevara (2004) who find a positive and significant relationship between market liquidity risk and net interest income. Thus, in essence, a liquid bank is encouraged to have a smaller portion of its assets in long-term loans and a greater proportion of its assets in short-term securities that can be quickly liquidated into cash that can then be loaned out. Nevertherless, other scholars argue that a highly liquid bank might mean lack of profitable projects to invest the money.

Bai et al. (2018) empirically tested the LMI using American banks focusing on the performance of the bank as measured by enhancement of shareholder capital (changes in bank’s share price). They find that as the aggregate liquidity conditions worsen, a firm with a inferior LMI should be more negatively affected. In this article bank performance is measured in terms of net interest margin (NIM), return on assets (ROA), return on equity (ROE) and economic value added (EVA).

Due to the strong persistent behaviour of bank performance, the estimation model is specified as a dynamic panel model which includes a one period lag of the bank performance. The models were estimated employing the Arellano and Bover (1995) two-step system generalised method of moments (GMM) with forward orthogonal deviations instead of differencing. Fixed effects model was also estimated specifically for robustness checking.

Given the nature of data under examination, the 2-step system GMM model was deemed superior method for estimating this panel of data. The results were dependent on the measure of profitability that was used. Estimation results from a cross-section of 12 South African registered banks over the period of 11 years show that banks with a worse BLMI performed better during the period. This meant that as the BLMI was improving, bank performance deteriorated. ALMI positively associated with bank performance and the relationship was not significant. Though the outcome of the investigation in this article points to the fact that illiquid banks tend to perform better over time, this can only be true during stable periods. Therefore, banks must actively manage liquidity within the context of asset liability mismatches for a better performance as market liquidity vanishes.

Other results revealed that, banks’ performance deteriorated as capital ratio improves. The difference could be explained by Repullo’s (2004) theory of moral hazard incentives, where large banks are presumed to hold less liquid assets as they think they have greater chance to borrow from the central bank. Bank performance was also found to be negatively related to NPL meaning that, the higher the NPL the higher the bank cost and therefore the lower the bank's profitability. Therefore, it is recommended that banks should diligently manage their loan book.

The liquidity dynamics in the banking sector underscored bank performance especially during and after the global financial crisis of 2007–2009. Thus far, the impact of bank liquidity risk on bank performance has been studied scantly in both emerging and developed markets, and such studies were done using standard liquidity measures. Amongst the known empirical studies on liquidity phenomenon, liquidity was explored within the segments of market liquidity and funding liquidity; yet, these two are profoundly interconnected. Liquidity standard measures also failed to grasp the banking sector important characteristic of liquidity spirals (Bai et al., 2018; Berger & Bouwman, 2009). Despite the introduction of theoretically baseless Basel III liquidity measures, there are still some shortcomings as both the standard and Basel III liquidity measures are not comprehensive enough, cannot be aggregated and therefore cannot be used as part of DSGE models (Brunnermeier et al., 2013).

However, there is a plethora of studies (see Oberholzer & Van der Westhuizen, 2004; Okeahalam, 2006; Erasmus, 2014) on bank performance and efficiency in South Africa. However, very few studies (e.g. Marozva, 2015; Visser & Van Vuuren, 2014) investigated the pertinent issue of bank liquidity in South Africa. Visser and Van Vuuren (2014) built liquidity stress testing model but did not examine the main determinants of liquidity risk. Whilst Marozva (2015) investigated liquidity under two dimensions of asset liquidity and funding liquidity, the analysis was not done within the context of asset liability mismatches. The conversional liquidity measures were interrogated and empirically tested. Moreover, their models were not tested within a context of other liquidity stress testing measures like the LMI.

It is against this background that this article aimed at testing the effect of BLMI and the ALMI on bank performance empirically. These new liquidity measures capture both the funding liquidity risk and the market liquidity risk within the context of asset liability mismatches. Furthermore, they address the pertinent issue of liquidity spirals. The IMF (2011) argues that the Basel III liquidity measures fail to address the additional risk of simultaneous shortfalls that arise from the nexus of various financial institutions across the universe of financial markets. Therefore, they recommend the development of a macro-prudential liquidity measure that captures the liquidity spirals, which can be used to mitigate systemic liquidity risks. A study by Brunnermeier (2008) laid the foundation to the understanding of systemic risk and liquidity spillover effects. Then Brunnermeier (2012) gave one basis for modelling the key response indicator of the spillover effects, the liquidity mismatch index (LMI).

The LIM by Brunnermeier (2012) laid the background for the LMI by Bai et al. (2018) and the modified liquidity mismatch indices by Marozva (2017; 2020). The BLMI and the ALMI are better measures of liquidity as they account for the systemic risk. The BMLI and the ALMI are useful in the context of macro-prudential, as the measures placate three fundamentals. These are: (i) the BLMI can be aggregated to give ALMI, and the aggregated LMI can capture the liquidity condition of the whole banking sector quantitatively, (ii) BLMI is seful at bank level as it points out the institution that is more susceptible to liquidity shocks, and (iii) they account for time variation as liquidity conditions vary through time.

This article examines the empirical relationship between the modified liquid mismatch indices and bank performance by means of a strongly balanced sample using annual data (2008- 2018) from 12 South African banks. Most studies investigated this phenomenon using the traditional liquidity measures and conversion and standard bank performance measures, ROE, ROA and NIM. Over and above these standard measures the Economic value Added (EVA) is also employed as a performance measure. EVA is tested because it is considered a financial performance yardstick, an investment decision tool and a performance measure that shows the absolute amount of shareholder value created (Owusu-Antwi, Mensah, Crabbe & Antwi, 2014). According to Bhasin (2017), EVA links economic, accounting and shareholder returns, this makes it a superior performance measure.

The paper is presented as follows. Section 2 discusses the data, variables, and presents a brief elaboration on how the BLMI and the ALMI are computed. Section 3 presents the methods employed to analyse the data and the econometric models. Section 4 presents and analyses the results, and section 5 concludes.

2. Data and Variables

This article employed monthly and annual financial and economic data drawn from the *i*ress INET BFA database, the South African Reserve Bank (SARB), Bankscope – Bureau van Dijk, the World Bank databases on African Development Indicators and Global Development Finance. The focus was on South Africa; hence, single-country data were employed. Since the approach was both longitudinal and cross-sectional, the study therefore conducted a panel study using pooled time series and cross-sectional data on selected South African banks.

From a country population of 18 locally registered banks in South Africa a sample of 12 banks was selected for this study. These banks constituted 99% of the assets of all South African registered banks by the time of analysis. These banks were included in this study because of the availability of bank-specific data on the variables under investigation for the study period running from 2008 to 2018. Six small banks were excluded from the analysis because data on non-performing loans and bank profitability was inaccessible for the period of study. The study primarily used annual data. However, some monthly data was used to compute annual averages for the modified liquidity mismatch indices (MLMI). The list of South Africa registered banks are presented in Table 1 with their corresponding asset bases.

Table 1. South African banks: names of banks registered or licensed in terms of the Banks Act 90 of 1990 as at 31 December 2017 and their rankings

Name of bank	**Total assets as at 31 December 2017 (R millions)**	**Ranking of the bank by total assets**
Standard Bank- South Africa Ltd	1254 849	1
FistRand Bank Ltd	1120 747	2
Absa Bank Ltd	983 378	3
Nedbank Ltd	892 006	4
Investec Bank Ltd	415 285	5
Capitec Bank Ltd	87 033	5
African Bank Ltd	31 356	7
Grindrod Bank Ltd	16 696	8
Merchantile Bank Ltd	12 892	9
Bidvest Bank Ltd	8509	10
Sasfin Bank Ltd	7778	11
Albareka Bank Ltd	5390	12
UBank Ltd	5 224	13
HBZ Bank Ltd	4 856	14
The South African Bank of Athens Ltd	2 355	15
Habib Overseas Bank Ltd	1 186	16
Commonwealth Bank of South Africa Ltd	1 403	17
Discovery Bank Ltd	622	18

Source: South African Reserve Bank (2017)

The article tests the effects of BLMI and the ALMI on bank performance. These two liquidity measures were part of the independent variables. Table 2 below shows details of the liquidity measures tested in this paper.

Table 2. Liquidity measures (Independent variables)

VARIABLE	***MEASURE***	***DATA SOURCES***
	LIQUIDITY MISMATCH INDEX	
$BLMI_t^i$ (Bank liquidity mismatch index)	$\sum_{k} \lambda_t A_k, x_t^i A_k + \sum_{k'} \lambda_t L_{k'}, x_t^i L_{k'}$	• South African Reserve Bank • *i*ress INET BFA database
$ALMI_t$ (Aggregate Liquidity mismatch index.)	$\frac{\sum_{i} \sum_{k} x_t^i, A_k (1 - \frac{1}{LIX_{K,t}}) + \sum_{i} \sum_{k'} x_t^i, L_{k'} \left(\bar{\lambda}_{L'_K} + (1 + \bar{\lambda}_{L'_K}) \beta_{L'_K} (1-\alpha) STBS_t \right)}{1 - \sum_{i} \sum_{K'} x_t^i, L_{K'} (1 + \bar{\lambda}_{L'_K}) \beta_{L'_K}}$	• South African Reserve Bank • *i*ress INET BFA database

Sources: Adapted from Marozva (2017).

2.1 Liquidity Mismatch Index (LMI)

The LMI measures the mismatch between the market liquidity of assets and the funding liquidity of liabilities (Bai et al., 2018). This measure incorporates both the asset side and the liability side (Brunnermeier, 2012). Therefore, the BLMI for an entity *i* at a given time *t* is the net of the asset and liability liquidity, calculated as,

$$\sum_{k} \lambda_t A_k, x_t^i A_k + \sum_{k'} \lambda_t L_{k'}, x_t^i L_{k'} \tag{2.1}$$

where assets ($x_t^i A_k$) and liabilities ($x_t^i L_{k'}$) are balance sheet items that vary over time depending on their asset class (k) or liability class (k') . The liquidity weights, $\lambda_t A_k > 0$ and $\lambda_t L_{k'} < 0$ are key components that are computed (Bai et al., 2018). The liquidity weight on the asset side should ideally represent the market liquidity, which is defined by Holden, Jacobsen, and Subrahmanyam (2014) as the ability of an institution to trade a significant portion of a security at a low cost in a short time. Like Bai et al. (2018) the asset weights assigned ranges from 0 to 1 depending on the asset class, and these vary over time. Using the data from the banks' balance sheets, the computed asset liquidity weight is set at $\lambda_t A_k = 1$ to represent cash and cash equivalent and $\lambda_t A_k = 0$ to represent mainly the non-current goodwill and intangible assets. The other assets were assigned weights between 0 and 1. Deviating from Krishnamurthy, Bai & Weymuller (2016) and Bai et al. (2018) the weights were computed using Danyliv, Bland and Nicholass's (2014) liquidity index (LIX). The liquidity index takes into account both the price range and volume traded. Using the selected bank stock prices over the period under investigation, the asset liquidity weights were computed as follows:

$$m = \left[1 - \frac{1}{LIX_t}\right] \pi \tag{2.2}$$

The calculated weight is adjusted by π which is the coefficient allocated to the assets depending on the level of liquidity. The asset weights took the weights between 0 and 1, implying that assets liquidity weights for these assets were set to $0 < \lambda_t A_k < 1$.

2.2 Liability-Side Liquidity Weights

Liability-side liquidity is synonymous with funding liquidity, which is defined by Drehmann and Nikolaou (2009) as the ability of the organisation to settle its obligations as they fall due. The weights of liability-side liquidity is based on computation proposed by Brunnermeier et al. (2012) in which they model access to liquidity as following a Poisson process (Meeker, Hahn & Escobar, 2017). There is a probability θ that represents the ability of an institution to raise capital in any given day. Then, the BLMI is based on the expected liquidity outflow going forward. This leads to the following function: $f(s,\theta) \in [0,1]$, which measures the probability that the firm is unable to access free liquidity by date s, where s = 1 corresponds to one day and s = 30 to corresponds to thirty days. The probability is decreasing in *s* at a decay rate governed by the parameter θ. The asymptotic liquidity weight is modulated by transforming the funding liquidity factor that captures variation in θ, and the resulting function is as follows:

$$\lambda_t, L_{k^{'}} = \overline{\lambda}_{L_{k^{'}}} - (1 + \overline{\lambda}_{L_{k^{'}}})(1 - \ell^{\beta_{L_{k^{'}}} . FL_t}) \tag{2.3}$$

where $\overline{\lambda}_{L_{k^{'}}}$ is the asymptotic liquidity weight and FL_t is the state-dependent funding factor and $\beta_{L_{k^{'}}}$ controls the exposure of the debt entity. To capture to feedback between BLMI and liquidity stress, the endogenous funding liquidity factor is computed as follows:

$$FL_t = (1-\alpha)TOIS_t + \alpha(\upsilon LMI_t) \tag{2.4}$$

where υ represent a weighting parameter that weighs down the scale of aggregate BLMI to a similar level of spread between the treasury bills rate and the South African benchmark overnight rate (SABOR). Nagel (2014) argues that SABOR accurately measures the time variation of a money market instrument. In this study, the liability weights were captured through the adjustment of the state-dependent funding factor and produced equation 2.5.

$$FL_t = [1 - STBS_t]\pi' \tag{2.5}$$

where π' is the coefficient allocated to the liability depending on the level of liquidity. When substituting for liquidity sensitivity weights and aggregate bank level LMI and then linearising the exponential term, the closed-form solution for the aggregate liquidity mismatch index (ALMI) was as follows:

$$\frac{\sum_i \sum_k x_t^i, \mathrm{A}_k (1 - \frac{1}{LIX_{K,t}}) + \sum_i \sum_{k'} x_t^i, L_{k'} \left(\bar{\lambda}_{L_K^{'}} + (1 + \bar{\lambda}_{L_K^{'}}) \beta_{L_K^{'}} (1-\alpha) STBS_t \right)}{1 - \sum_i \sum_{K^{'}} x_t^i, L_{K^{'}} (1 + \bar{\lambda}_{L_K^{'}}) \beta_{L_K^{'}}} \tag{2.6}$$

The ALMI can be used as barometer for market wide liquidity condition and this measure satisfies all the conditions the satisfies a good measure of bank liquidity as argued in Section 1. Table 3 presents the dependent and control variables.

Table 3. Summary of dependent and independent variables and proxies

Variables	Proxies and definitions	Proxies by	Expected sign of coefficient
Dependent variables			
Bank performance	ROA – is calculated as the operating profit divided by total assets. ROE – is calculated as net profit over total equity NIM – is calculated as the difference between interest received from interest bearing assets less interest paid to interest bearing liabilities Economic Value Added (EVA) – is calculated as the operating profits after tax minus capital charge. EVA is then normalised by dividing by factor inputs (operating costs and interest costs)	Aspachs, Nier and Tiesset (2005); Bonner, Van Lelyveld and Zymek (2015), Marozva (2015)	
Control variable			
Capital ratio (CR)	CR – is reflected by equity as percentage of total assets	Tseganesh (2012); Choon, Hooi, Murthi, Yi and Shven (2013); Vodová (2013); Bonner and Eijffinger (2016)	Positive/negative
Non-performing loans (NPL)	NPL – loans that are outstanding both in principal and interest for a long time contrary to the terms and conditions in the loan contract	Vodová (2013); Choon et al. (2013); Audo (2014)	Negative

3. Econometric Model Specification

As a preliminary to the detailed empirical analysis, the study presents the descriptive statistical analysis of all the variables under investigation. The data used in this sample of South African Banks was readily available from published financial statements and BA900 forms filed by banks to the central bank. Since all the banks were in South Africa, policy difference between countries was not a problem. The panel data analysis approach was employed primarily using the generalised method of moments (GMM) model. This approach meant that the study could account for whether there were bank-specific variations or time-specific variations. The fixed effects model (FEM) is presented for robustness and hence no details analysis is provided for it. Neither are the pre-diagnostic statistics discussed for this model.

3.1 The Generalised Method of Moments (GMM)

GMM estimation was formalized by Hansen (1982). The method is widely used method of estimation for economics and finance models. Distribution of the data does not matter when using this method, what is required is the specified moments obtained from an underlying model. However, challenges are faced when the dependent variable is persistent that is a lagged dependent variable is part of the regressors, particularly when N is greater than T (Nickell, 1981). Bank performance is persistent hence need to employ the Dynamic GMM approach.

Also, the challenge of a dynamic model is that coefficients may also be biased if the regressors are correlated with the lagged dependent variable to some degree. This challenge through employing Arellano and Bond’s (1991) differenced GMM model where all the regressors are differenced. The differenced GMM was augment by Arellano and Bover (1995) and Blundell and Bond (1998) system GMM estimator which includes lagged levels as well as lagged differences.

The system GMM estimator assumes that first differences of instrumental variables are uncorrelated with the fixed effects. It allows the introduction of more instruments and can substantially improve efficiency. Roodman (2006), among others, argues that both difference and system GMM estimators are more appropriate for a short panel that is when N>T; were independent variables are not strictly exogenous; were there is fixed individual effects; heteroskedasticity and autocorrelation among the subjects being analysed. Since the sample in this paper shares many of these features, this study employs the system GMM model to assess the determinants of South Africa bank profitability.

The optimal lag length was determined using the moment selection criteria and downward testing procedures developed by Andrews and Lu (2001). In this paper the optimal lag length was found to be one year as per Hansen test statistic. The exogenous variables, the lagged dependent variable and the difference of the lagged dependent variable were used as instruments. Given the limited number of banks under consideration meant only two lags could be tested if the instruments were not to exceed the number of subjects (banks). Employing the system GMM approach, the estimation models are expressed in equations 1 to 8.

$$\Delta NIM_{it} = (\phi - 1)\Delta NIM_{it-1} + \lambda_1 \sum_{i=1}^{n} \Delta BLMI_{it} + \lambda_2 \sum_{i=1}^{n} \Delta CR_{it} + \lambda_3 \sum_{i=1}^{n} \Delta NPL_{it} + \Delta\mu_{it} \quad (1)$$

$$\Delta ROA_{it} = (\phi - 1)\Delta ROA_{it-1} + \lambda_1 \sum_{i=1}^{n} \Delta BLMI_{it} + \lambda_2 \sum_{i=1}^{n} \Delta CR_{it} + \lambda_3 \sum_{i=1}^{n} \Delta NPL_{it} + \Delta\mu_{it} \quad (2)$$

$$\Delta ROE_{it} = (\phi - 1)\Delta ROE_{it-1} + \lambda_1 \sum_{i=1}^{n} \Delta BLMI_{it} + \lambda_2 \sum_{i=1}^{n} \Delta CR_{it} + \lambda_3 \sum_{i=1}^{n} \Delta NPL_{it} + \Delta\mu_{it} \quad (3)$$

$$\Delta EVA_{it} = (\phi - 1)\Delta EVAE_{it-1} + \lambda_1 \sum_{i=1}^{n} \Delta BLMI_{it} + \lambda_2 \sum_{i=1}^{n} \Delta CR_{it} + \lambda_3 \sum_{i=1}^{n} \Delta NPL_{it} + \Delta\mu_{it} \quad (4)$$

$$\Delta NIM_{it} = (\phi - 1)\Delta NIM_{it-1} + \lambda_1 \sum_{i=1}^{n} \Delta ALMI_{it} + \lambda_2 \sum_{i=1}^{n} \Delta CR_{it} + \lambda_3 \sum_{i=1}^{n} \Delta NPL_{it} + \Delta\mu_{it} \quad (5)$$

$$\Delta ROA_{it} = (\phi - 1)\Delta ROA_{it-1} + \lambda_1 \sum_{i=1}^{n} \Delta ALMI_{it} + \lambda_2 \sum_{i=1}^{n} \Delta CR_{it} + \lambda_3 \sum_{i=1}^{n} \Delta NPL_{it} + \Delta\mu_{it} \quad (6)$$

$$\Delta ROE_{it} = (\phi - 1)\Delta ROE_{it-1} + \lambda_1 \sum_{i=1}^{n} \Delta ALMI_{it} + \lambda_2 \sum_{i=1}^{n} \Delta CR_{it} + \lambda_3 \sum_{i=1}^{n} \Delta NPL_{it} + \Delta\mu_{it} \quad (7)$$

$$\Delta EVA_{it} = (\phi - 1)\Delta EVA_{it-1} + \lambda_1 \sum_{i=1}^{n} \Delta ALMI_{it} + \lambda_2 \sum_{i=1}^{n} \Delta CR_{it} + \lambda_3 \sum_{i=1}^{n} \Delta NPL_{it} + \Delta\mu_{it} \quad (8)$$

Where $\boldsymbol{BLMI_{it}}$ *represents the bank liquidity mismatch index for bank i in time t,*

$\boldsymbol{ALMI_{t}}$ *is the aggregate liquidity mismatch index for the market in time t,*

$\boldsymbol{EVA_{it}}$ *represents the economic value added for bank i in time t,*

$\boldsymbol{ROA_{it}}$ *represents the return on assets for bank i in time t,*

$\boldsymbol{ROE_{it}}$ *measures the return on equity for bank i in time t,*

$\boldsymbol{NIM_{it}}$ *is the interest margin for bank i in time t,*

$\boldsymbol{NPL_{it}}$ *is the non performing loan for bank i in time t,*

$\boldsymbol{CR_{it}}$ *is the capital ratio for bank i in time t,*

ϕ *is an auto-regression coefficient,*

$\boldsymbol{\lambda}$ is *coefficient which represents the sensitivity of independent variables,*

$\boldsymbol{\mu_{it}}$ is a disturbance term which is independent across banks.

The fixed effects model is also estimated to allow comparison of results, and as a robustness check. The results from the estimation are discussed in the following section.

4. Empirical Results and Discussion

The research techniques were used to test the nexus between bank performance and liquidity in the presence of control variables which included NPL and CR. The study carried out the data analysis and presents the empirical results here and discusses them. This Section begins with presentation and brief discussion of descriptive statistics in Sub-section 4.1. An analysis of correlations and presentation of cross-sectional dependence results is done in Sub-section 4.2 and 4.3 respectively. Lastly, the presentation and discussion of the results from the main models is done in Sub-section 4.4.

4.1 Descriptive Statistics

In this section, the summary statistics of the variables used in the estimations for the entire sample of the banks were considered. Three bank performance measures of ROE, ROA and NIM were used in this article as dependent variables. There are two liquidity measures and two control variables that were used. The descriptive statistics for all the variables are presented in Table 4.

Table 4

Variables	Mean	Median	Maximum	Minimum	Std. Dev.	Jarque-Bera
ALMI	12.4043	12.5954	12.2524	11.5518	0.2380	22.72
BLMI	(0.1472)	0.1508	0.8453	(39.6110)	3.4641	90,923.08
CR	0.1404	0.0839	0.4374	0.0373	0.0990	49.52
EVA	0.2340	0.0795	8.9126	(1.6855)	0.9431	17,380.36
NIM	0.0718	0.0437	1.3764	0.0007	0.1360	23,591.86
NPL	0.0138	0.0072	0.1234	(0.0011)	0.0220	379.44
ROA	0.0522	0.0229	1.3274	0.0003	0.1295	29,430.95
ROE	0.3986	0.2294	9.0869	0.0045	0.9180	21,651.00

4.2 Cross-Correlation Analysis

Table 5 contains the cross-correlation analysis between the four performance measures, two liquidity measures and two control variables. The two liquidity measures of BLMI and ALMI have a negative correlation with EVA, the relationship is significant at the 1% level. The cross-correlation between liquidity and other performance measures indicates a negative relationship and the relationship is not significant. Therefore, the a priori expectation is that a negative relationship should hold. As expected, the performance measures exhibit a very strong and significant cross-correlation with each other. Non-performing loans contrary to expectation is positively correlated to all performance measures. Lastly, we observe a positive and significant cross-correlation between bank capital ratio and two performance measures, NIM and ROA.

Table 5. Cross-correlation analysis – Dependent and independent variables

Variables	ALMI	BLMI	CR	EVA	NIM	NPL	ROA	ROE
ALMI	1.00							
BLMI	0.2765***	1.00						
CR	(0.0972)	-0.3100***	1.00					
EVA	(0.0611)***	(0.0240)***	(0.0561)	1.00				
NIM	(0.0942)	(0.1163)	0.1621*	0.8836***	1.00			
NPL	(0.0638)	(0.0862)	0.1526*	0.4372***	0.6364***	1.00		
ROA	(0.1046)	(0.1027)	0.1475*	0.9464***	0.9662***	0.5148***	1.00	
ROE	(0.0937)	(0.0480)	(0.0415)	0.9820***	0.9122***	0.4780***	0.9675***	1.00

Where: (*), (**) and (***) indicate 10%, 5% and 1% significance level, respectively.

4.3 Econometric Model Estimation Results, Discussion and Analysis

Due to the strong persistent nature of bank performance, the estimation models were specified as a dynamic panel model which includes a lag of the dependent variable. Therefore, before running the models, the test for cross sectional dependence was done as part of initial diagnostic tests. Table 6 details the results of cross sectional dependence tests.

Table 6. Test for cross-sectional dependence – Pesaran CD test

Models	Pesaran CD test statistic	Probability	Inference
1	0.584	0.4409	Cross-sections are independent
2	0.283	0.2228	Cross-sections are independent
3	1.608	0.1079	Cross-sections are independent
4	0.099	0.9212	Cross-sections are independent
5	0.297	0.2338	Cross-sections are independent
6	0.372	0.7098	Cross-sections are independent
7	0.374	0.8304	Cross-sections are independent
8	0.474	0.6352	Cross-sections are independent

Results from Table 6 confirm the notion that cross-sectional dependence is not a problem with micro panels as we fail to reject the null hypothesis of cross-sectional inter-dependence. The empirical results for the relationship between bank performance and bank liquidity (BLMI) are presented in Table 7. The post estimation diagnostic statistics for the main model i.e. GMM are shown in Table 8.

Table 7. Empirical results for Models 1 to 4: BLMI as the liquidity measure

Variables	2 Step System GMM **ROA**	Fixed effects Model **ROA**	2 Step System GMM **ROE**	Fixed effects Model **ROE**	2 Step System GMM **EVA**	Fixed effects Model **EVA**	2 Step System GMM **NIM**	Fixed effects Model **NIM**
L.ROA	0.517^{***}	0.404^{***}						
	(0.0230)	(0.0123)						
BLMI	-0.00531^{**}	-0.00718	-0.0437^{*}	-0.00248	0.0111	0.0461^{***}	-0.00802^{*}	-0.00152
	(0.00197)	(0.00436)	(0.0206)	(0.00132)	(0.0197)	(0.00295)	(0.00422)	(0.00208)
NPL	-1.523^{***}	-0.239	-1.871	1.233	-0.912	2.542	-2.982^{***}	0.248
	(0.119)	(0.286)	(1.119)	(1.191)	(1.247)	(2.001)	(0.178)	(1.309)
CR	-0.141	0.200^{**}	-4.390	0.0230	-3.984	0.302	0.0749	0.332^{*}
	(0.190)	(0.0583)	(2.180)	(0.161)	(2.141)	(0.169)	(0.426)	(0.137)
L.ROE			0.512^{***}	0.394^{***}				
			(0.0293)	(0.00707)				
L.EVA					0.510^{***}	0.373^{***}		
					(0.0239)	(0.0205)		
L.NIM							0.553^{***}	0.382^{***}
							(0.0386)	(0.0586)
_cons	0.0523^{**}	-0.00477	0.755^{**}	0.153^{***}	0.613^{*}	0.0179	0.0442	-0.0169
	(0.0152)	(0.00659)	(0.213)	(0.0173)	(0.245)	(0.0330)	(0.0431)	(0.0216)
N	120	120	120	120	120	120	120	120
R^2		0.870		0.737		0.756		0.803

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8. Post estimation diagnostic statistics for GMM model results presented in Table 7

	2 Step System GMM **ROA**	2 Step System GMM **ROE**	2 Step System GMM **EVA**	2 Step System GMM **NIM**
Arellano-Bond AR(1)	-1.29	-1.04	-1.05	-1.60
Prob>z	0.196	0.298	0.293	0.110
Arellano-Bond AR(2)	1.07	1.13	-1.18	-0.86
Prob>z	0.286	0.259	0.237	0.390
Sargan test of overid	104.64	148.01	115.65	37.39
Prob>χ^2	0.000	0.000	0.000	0.000
Hansen test of overid	11.19	10.59	9.31	8.25
Prob>χ^2	0.13	0.158	0.231	0.311
Instruments	12	12	12	12

The BLMI is intended to measure the exposure of a bank to a liquidity spirals and contagion effects. If the BLMI can capture these dimensions, it is expected that it will affect bank performance as the BLMI varies with time and across market-wide liquidity events. According to Bai et al. (2018), banks with low BLMI are to perform worse under a negative liquidity shock and bank performance improves when there is a positive liquidity shock.

The results of this study reveal a significant impact of BLMI on performance as measured by ROA, ROE and NIM. The relationship is negative implying that as the bank liquidity condition improved its performance deteriorated. This is in line with the hypothesis that liquidity represent and opportunity cost, holding huge volume of liquid assets crowds out more profitable loan portfolio. Therefore, hoarding liquidity is costly, and may only generates benefits in crises periods. Also, an increase in deposits (more liquid liabilities) other things being equal will help the banks to increase their profitability as demand deposits are cheaper. These results are line with Al-Jafari and Alchami (2014) and Marozva (2017) who finds that banks tend to be more profitability measured by return on asset (ROA) when they have lower scaled liquidity. Berger and Bouwman (2012) argue that, banking sector actively build liquidity buffers at the expense of building performance.

The results showed that bank profitability (ROA and NIM) is negatively affected by an increase in NPLs. An increase in non-performing means more bad debts written off thereby pushing up the cost of banks. This increase in the impairment of loans ultimately affected the performance of the banks. However, capital ratio is negatively related with bank performance measures (ROA ROE and EVA) but the relationship is not significant. The net interest margin is positively related to capital ratio and also the relationship is insignificant. Finally bank performance was found to be persistent as the lagged performance measures were found to be positive and significant.

Table 9. Empirical results for Models 5 to 8: ALMI as the liquidity measure

	2 Step System GMM **ROA**	Fixed effects Model **ROA**	2 Step System GMM **ROE**	Fixed effects Model **ROE**	2 Step System GMM **EVA**	Fixed effects Model **EVA**	2 Step System GMM **NIM**	Fixed effects Model **NIM**
L.ROA	0.515***	0.392***						
	(0.0184)	(0.0131)						
ALMI	0.00199	0.00368	0.0537	-0.0184	0.0237	-0.0104	-0.00512	0.0100
	(0.0137)	(0.00225)	(0.0724)	(0.0251)	(0.0683)	(0.0235)	(0.0262)	(0.00669)
NPL	-1.578***	-0.128	-6.422***	1.670	-4.310***	-4.224	-2.852***	0.499
	(0.150)	(0.291)	(0.575)	(0.996)	(0.520)	(4.428)	(0.532)	(1.029)
CR	-0.106	0.235***	-2.561	0.186	-2.669*	-2.240	-0.00554	0.403**
	(0.154)	(0.0465)	(1.711)	(0.128)	(1.970)	(1.123)	(0.325)	(0.112)
L.ROE			0.526***	0.394***				
			(0.0201)	(0.00419)				
L.EVA					0.530***	0.439***		
					(0.0226)	(0.0146)		
L.NIM							0.555***	0.353***
							(0.0305)	(0.0381)
_cons	0.0473**	-0.0130*	0.522*	0.139***	0.428	0.444*	0.0594*	-0.0351**
	(0.0117)	(0.00443)	(0.171)	(0.0180)	(0.222)	(0.159)	(0.0261)	(0.0107)
N	120	120	120	120	120	120	120	120
R^2		0.870		0.737		0.690		0.807

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10. Post estimation diagnostic statistics for GMM model results presented in Table 9

	2 Step System GMM	2 Step System GMM	2 Step System GMM	2 Step System GMM
	ROA	**ROE**	**EVA**	**NIM**
Arellano-Bond AR(1)	-1.35	-1.34	-1.44	-1.19
Prob>z	0.175	0.184	0.151	0.234
Arellano-Bond AR(2)	1.33	1.14	-0.12	0.37
Prob>z	0.183	0.254	0.905	0.715
Sargan test of overid	46.69	95.92	112.28	14.88
Prob> χ^2	0.000	0.000	0.000	0.038
Hansen test of overid	10.84	8.21	3.19	9.31
Prob>χ^2	0.14	0.315	0.867	0.231
Instruments	12	12	12	12

Models 5 to 8 were employed to investigate the nexus between the broad market liquidity as measured by ALMI and bank performance. The empirical results are presented in Table 9. The aggregate liquidity mismatch index is used as the barometer to measure the market wide liquidity condition. It is expected that banks perform better or worse when the market is awash with money. Bank performance will depend on the bank portfolio and liquidity position, if the bank is illiquid it performs better as it funds its profitable illiquid loans cheaply. When the bank is more liquid it implies it will invest its liquid assets in short term or long-term investments at a lower interest. Our results confirm the former notion as the relationship was found to be positive but not significant (where ROA, ROE and EVA were used as performance measures). There is a negative relationship between net interest margin and aggregate liquidity.

The results here confirm the results in Table 6 that bank performance is persistent, bank performance is negatively related to NPL and CR. Among other determinants of bank performance, NPLs play a central role because a significant part of banks' revenue accumulates from loans from which interest is derived (Kolapo, Ayeni, & Oke, 2012). Our results are consistent with those by Williams (2007) which showed a negative association between credit risk and bank performance. Also, Fungáčová and Poghosyan (2011) find a negative relationship between credit risk and net interest margin. The negative relationship could emanate from the banks' failure to appropriately price credit risk.

The negative and significant linear relationship between EVA and capital ratio indicate that increase in capital has a negative influence on bank's profitability. This is contrary to the results by Arias (2011) and Yilmaz (2013), who finds that, an improvement in bank capital ratio is associated with a reduction in costly external borrowing and consequently increasing bank performance.

5. Conclusion and Policy Implications

Thus far, the determinants of bank performance have been studied widely. However, the effects of bank liquidity on bank performance have been studied scantly in both emerging and developed markets, and such studies were done using standard liquidity measures. Amongst the known empirical studies on liquidity phenomenon, liquidity was explored within the segments of market liquidity and funding liquidity; yet, these two are profoundly interconnected (Marozva, 2017). Liquidity standard measures also failed to grasp the banking sector important characteristic of liquidity spirals (Berger and Bouwman, 2009). Therefore, main aim of this article was to investigate the nexus between bank performance and bank liquidity (as measured by BLMI and ALMI).

Using a panel of 12 banks over a period of 11 years and GMM as the primary method used in the analysis, several interesting deductions from the results were exposed. First, there is a negative relationship between BLMI and bank performance (ROA, ROE and NIM), and the association is both statistically and economically significant. The observation that bank liquidity mismatch index is has a negative effect on bank performance is in line with the liquidity preference theory, where highly liquid assets tend to generate less returns. Banks are encouraged to monitor closely the banks liquidity developments because BLMI measure was found to negatively affect bank performance. Despite findings in this article, liquidity is highly desired during crisis as Bai et al. (2018) argue that banks with high LMI tend to perform better during crisis. When banks forecast and deterioration in market liquidity they should hold more liquid assets and more long-term liabilities. However, there is a positive relationship between ALMI and bank performance, but the relationship is insignificant.

Second, bank performance is significantly negatively related to both capital ratio and credit risk as measured by non-performing loans. The higher the NPL the higher the bank cost and therefore the lower the bank's profitability. Banks should diligently manage their loan book. They should carry out thorough credit checking before they extend any credit. Capital ratio significantly affects bank profitability in a negative way this is contrary to theory and other empirical studies findings. I appear as if banks tend to practise reckless lending when they are well capitalised and therefore suffer significant impairment losses. Third, the bank performance was found to be persistent as all the previous period profitability measures were positively and significantly related to current period bank performance. Finally, the nature and strength of relationship between bank performance and liquidity is dependent on the type of performance measure under consideration.

The limitations of the current study emanate from the measures of performance used. ROA, ROE and EVA do not directly impact shareholder wealth. Also, the study was country specific over a period that included the global financial crisis of 2007-2009. However, the period of analysis was not split between crisis and stable period. Therefore, stock returns or share price should be used instead to supplement performance measurements. Future studies should test the nexus between bank liquidity and bank stock returns as it is established that bank liquidity is critical in the performance of the bank. The performance of the bank is directly linked to enhancement of shareholder's wealth hence need to investigate the impact of BLMI on bank stock returns. Since countries may be structurally different a cross country analysis may be required. Finally future studies should look at the nexus under distinct economic periods that is during the global financial crisis and /or during pandemic periods for example COVID-19 period.

References

Al-Jafari, M. K., & Alchami, M. (2014). Determinants of bank profitability: Evidence from Syria. *Journal of Applied Finance and Banking, 4*(1), 17.

Alshatti, A. S. (2015). The effect of the liquidity management on profitability in the Jordanian commercial banks. *International Journal of Business and Management, 10*(1), 62. https://doi.org/10.5539/ijbm.v10n1p62

Andrews, D. W., & Lu, B. (2001). Consistent model and moment selection procedures for GMM estimation with application to dynamic panel data models. *Journal of Econometrics, 101*(1), 123-164. https://doi.org/10.1016/S0304-4076(00)00077-4

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies, 58*(2), 277-297. https://doi.org/10.2307/2297968

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics, 68*(1), 29-51. https://doi.org/10.1016/0304-4076(94)01642-D

Arias, J. C. (2011). Banking profitability determinants. *Business Intelligence Journal, 4*(2), 209-230.

Aspachs, O., Nier, E., & Tiesset, M. (2005). Liquidity, banking regulation and the macroeconomy: Evidence on bank liquidity holdings from a panel of UK-resident banks. *Unpublished manuscript*, Bank for International Settlements, Basel. https://doi.org/10.2139/ssrn.673883

Audo, P. N. (2014). The relationship between inflation rates and liquidity of commercial banks in Kenya (*Unpublished PhD dissertation*). University of Nairobi, Nairobi.

Bai, J., Krishnamurthy, A., & Weymuller, C. H. (2018). Measuring liquidity mismatch in the banking sector. *The Journal of Finance*, *73*(1), 51-93. https://doi.org/10.1111/jofi.12591

Berger, A. N., & Bouwman, C. H. (2009). Bank liquidity creation. *The review of financial studies, 22*(9), 3779-3837. https://doi.org/10.1093/rfs/hhn104

Berger, A. N., & Bouwman, C. H. (2013). How does capital affect bank performance during financial crises?. *Journal of Financial Economics, 109*(1), 146-176. https://doi.org/10.1016/j.jfineco.2013.02.008

Berger, A. N., & Bouwman, C. H. (2017). Bank liquidity creation, monetary policy, and financial crises. *Journal of Financial Stability, 30*, 139-155. https://doi.org/10.1016/j.jfs.2017.05.001

Berrios, M. R. (2013). The Relationship between Bank Credit Risk and Profitability and Liquidity. *The International Journal of Business and Finance Research*, *7*(3), 105-118.

Bhasin, M. L. (2017). A study of economic value added disclosures in the annual reports: is EVA a superior measure of corporate performance. *East Asian Journal of Business Economics, 5*(1), 10-26. https://doi.org/10.20498/eajbe.2017.5.1.10

Bhunia, A., & Khan, I. U. (2011). Liquidity management efficiency of Indian steel companies (a case study). *Far East Journal of Psychology and Business, 3*(3), 3-13. https://doi.org/10.5296/jmr.v3i2.574

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics, 87*(1), 115-143. https://doi.org/10.1016/S0304-4076(98)00009-8

Bonner, C., & Eijffinger, S. C. (2016). The impact of liquidity regulation on bank intermediation. *Review of Finance, 20*(5), 1945-1979. https://doi.org/10.1093/rof/rfv058

Bonner, C., Van Lelyveld, I., & Zymek, R. (2015). Banks' liquidity buffers and the role of liquidity regulation. *Journal of Financial Services Research, 48*(3), 215-234. https://doi.org/10.1007/s10693-014-0207-5

Bordeleau, É., & Graham, C. (2010). The impact of liquidity on bank profitability (No. 2010, 38). *Bank of Canada working paper.*

Bourke, P. (1989). Concentration and other determinants of bank profitability in Europe, North America and Australia. *Journal of Banking & Finance, 13*(1), 65-79. https://doi.org/10.1016/0378-4266(89)90020-4

Brunnermeier, M. K. (2009). Deciphering the liquidity and credit crunch 2007-2008. *Journal of Economic Perspectives, 23*(1), 77-100. https://doi.org/10.1257/jep.23.1.77

Brunnermeier, M. K., Eisenbach, T. M., & Sannikov, Y. (2012). Macroeconomics with financial frictions: A survey (No. w18102). *National Bureau of Economic Research*. https://doi.org/10.3386/w18102

Brunnermeier, M. K., Gorton, G., & Krishnamurthy, A. (2012). Risk topography. *NBER Macroeconomics Annual, 26*(1), 149-176. https://doi.org/10.1086/663991

Brunnermeier, M., Gorton, G., & Krishnamurthy, A. (2013). Liquidity mismatch measurement. In *Risk topography: Systemic risk and macro modeling* (pp. 99-112). University of Chicago Press. https://doi.org/10.7208/chicago/9780226092645.001.0001

Castiglionesi, F., Feriozzi, F., & Lorenzoni, G. (2019). Financial integration and liquidity crises. *Management Science, 65*(3), 955-975. https://doi.org/10.1287/mnsc.2017.2841

Choon, L. K., Hooi, L. Y., Murthi, L., Yi, T. S., & Shven, T. Y. (2013). The determinants influencing liquidity of Malaysia commercial banks, and its implication for relevant bodies: Evidence from 15 Malaysian commercial banks. (research project group 16). *Kampar: Universiti tunku abdul Rahman.*

Chowdhury, A. M. H., Siddiqua, A., & Chowdhury, A. S. M. M. H. (2016). Relationship between liquidity risk and net interest margin of conventional banks in Bangladesh. *Asian Business Review, 6*(3), 175-178. https://doi.org/10.18034/abr.v6i3.43

Chronopoulos, D. K., Liu, H., McMillan, F. J., & Wilson, J. O. (2015). The dynamics of US bank profitability. *The European Journal of Finance, 21*(5), 426-443. https://doi.org/10.1080/1351847X.2013.838184

Danyliv, O., Bland, B., & Nicholass, D. (2014). Convenient liquidity measure for financial markets. *SSRN 2385914*. https://doi.org/10.2139/ssrn.2385914

Diamond, D. W., & Dybvig, P. H. (1983). Bank runs, deposit insurance, and liquidity. *Journal of Political Economy, 91*(3), 401-419. https://doi.org/10.1086/261155

Erasmus, C. (2014). An empirical study of bank efficiency in South Africa using the standard and alternative approaches to data envelopment analysis (DEA). *Journal of Economics and Behavioral Studies, 6*(4), 310-317. https://doi.org/10.22610/jebs.v6i4.494

Fungáčová, Z., & Poghosyan, T. (2011). Determinants of bank interest margins in Russia: Does bank ownership matter?. *Economic Systems, 35*(4), 481-495. https://doi.org/10.1016/j.ecosys.2010.11.007

Hansen, L. P. (1982). Large sample properties of generalized method of moments estimators. *Econometrica: Journal of the Econometric Society, 50*(4), 1029-1054. https://doi.org/10.2307/1912775

Holden, C. W., Jacobsen, S., & Subrahmanyam, A. (2014). The empirical analysis of liquidity. *Foundations and Trends® in Finance, 8*(4), 263-365. https://doi.org/10.1561/0500000044

Holmström, B., & Tirole, J. (1998). Private and public supply of liquidity. *Journal of political Economy, 106*(1), 1-40. https://doi.org/10.1086/250001

International Monetary Fund. (2011, April). How to address the systemic part of liquidity risk. In Author, (Ed.), *Global Financial Stability* (2011). Washington, DC: Author.

Kolapo, T. F., Ayeni, R. K., & Oke, M. O. (2012). Credit risk and commercial banks' performance in Nigeria: A panel model approach. *Australian Journal of Business and Management Research*, *2*(2), 31. https://doi.org/10.52283/NSWRCA.AJBMR.20120202A04

Krishnamurthy, A., Bai, J., & Weymuller, C. H. (2016). Measuring liquidity mismatch in the banking sector (*Working paper no. w22729*). Cambridge, MA: National Bureau of Economic Research. https://doi.org/10.3386/w22729

Lartey, V. C., Antwi, S., & Boadi, E. K. (2013). The relationship between liquidity and profitability of listed banks in Ghana. *International Journal of Business and Social Science, 4*(3).

Marozva, G. (2015). Liquidity and bank performance. *International Business & Economics Research Journal (IBER), 14*(3), 453-562. https://doi.org/10.19030/iber.v14i3.9218

Marozva, G. (2017). An empirical study of liquidity risk embedded in banks' asset liability mismatches (*Doctoral dissertation*). University of South Africa. Pretoria

Marozva, G. (2020). Liquidity Mismatch Index and Banks’ Stock Returns. *International Journal of Economics & Business Administration (IJEBA), 8*(4), 930-945. https://doi.org/10.35808/ijeba/641

Marozva, G., & Makina, D. (2020). Liquidity risk and asset liability mismatches: evidence from South Africa. *Studies in Economics and Econometrics, 44*(1), 73-112. https://doi.org/10.1080/10800379.2020.12097357

Maudos, J., & De Guevara, J. F. (2004). Factors explaining the interest margin in the banking sectors of the European Union. *Journal of Banking & Finance, 28*(9), 2259-2281. https://doi.org/10.1016/j.jbankfin.2003.09.004

Maudos, J., & Solís, L. (2009). The determinants of net interest income in the Mexican banking system: An integrated model. *Journal of Banking & Finance, 33*(10), 1920-1931. https://doi.org/10.1016/j.jbankfin.2009.04.012

Meeker, W. Q., Hahn, G. J., & Escobar, L. A. (2017). *Statistical intervals: A guide for practitioners and researchers* (Vol. 541). New Jersey: John Wiley & Sons. https://doi.org/10.1002/9781118594841

Molyneux, P., & Thornton, J. (1992). Determinants of European bank profitability: A note. *Journal of Banking & Finance*, *16*(6), 1173-1178. https://doi.org/10.1016/0378-4266(92)90065-8

Nagel, S. (2014). The liquidity premium of near-money assets (*Working paper no. w20265*). Cambridge, MA: National Bureau of Economic Research. https://doi.org/10.3386/w20265

Nickell, S. (1981). Biases in dynamic models with fixed effects. *Econometrica: Journal of the Econometric Society*, 1417-1426. https://doi.org/10.2307/1911408

Nikolaou, K., & Drehmann, M. (2009). Funding liquidity risk: definition and measurement (No. 1024). *European Central Bank.* https://doi.org/10.2139/ssrn.1645261

Oberholzer, M., & Van der Westhuizen, G. (2004). An empirical study on measuring efficiency and profitability of bank regions. *Meditari: Research Journal of the School of Accounting Sciences, 12*(1), 165-178. https://doi.org/10.1108/10222529200400009

Okeahalam, C. C. (2006). Production efficiency in the South African banking sector: A stochastic analysis. *International Review of Applied Economics*, *20*(1), 103-123. https://doi.org/10.1080/02692170500362819

Owusu-Antwi, G., Mensah, L., Crabbe, M., & Antwi, J. (2015). Determinants of Bank Performance in Ghana, the Economic Value Added (EVA) Approach. *International Journal of Economics and Finance, 7*(1), 204-215. https://doi.org/10.5539/ijef.v7n1p203

Pradhan, R. S., & Shrestha, D. (2016). Impact of liquidity on bank profitability in Nepalese commercial banks. *SSRN 2793458*. https://doi.org/10.2139/ssrn.2793458

Repullo, R. (2004). Capital requirements, market power, and risk-taking in banking. *Journal of Financial Intermediation, 13*(2), 156-182. https://doi.org/10.1016/j.jfi.2003.08.005

Roodman, D. (2006). How to do xtabond2: An introduction to 'difference' and 'system. In GMM in Stata (*Working paper no. 103*.). Washington, DC: Center for Global Development. https://doi.org/10.2139/ssrn.982943

Tseganesh, T. (2012). Determinants of banks liquidity and their impact on financial performance: Empirical study on commercial banks in Ethiopia (*Unpublished PhD dissertation*). Addis Ababa University, Addis Ababa.

Van Vuuren, G., & Visser, D. (2014). Evaluating illiquidity and systemic contagion in South African banks. *Journal of Economic and Financial Sciences, 7*(3), 697-720. https://doi.org/10.4102/jef.v7i3.234

Vodová, P. (2013a). Determinants of commercial bank liquidity in Hungary. *Finansowy Kwartalnik Internetowy e-Finanse, 9*(3), 64-71.

Williams, B., & Prather, L. (2010). Bank risk and return: the impact of bank non−interest income. *International Journal of Managerial Finance*. https://doi.org/10.1108/17439131011056233

Yılmaz, A. A. (2013). Profitability of banking system: Evidence from emerging markets. In *WEI International Academic Conference Proceedings*. Antalya.