A COMPARATIVE STUDY OF LIQUIDITY DETERMINANTS OF PRIVATE AND PUBLIC SECTOR BANKS

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Abstract

India is one of the few countries in the world, which follows a prescriptive regulatory policy for liquidity management in banks. These policies affect different groups of banks in different ways. The main objective of this study is to examine the liquidity determinants of private and public sector banks in India on a comparative basis to assess the effectiveness of liquidity management policies for each type of bank in India. For this purpose, this study analyses the long-term effect of various macroeconomic, microeconomic, and regulatory policies on liquidity management by both groups of banks from 1996 to 2016. The findings of the study show that public sector banks rely on asset-based liquidity, and private sector banks also rely on asset-based liquidity. In the case of both private and public sector banks, this study found a significant relationship between the liquidity and several explanatory variables – call rate, discount rate, cash reserve ratio, capital to total assets, foreign exchange reserve with RBI and Size (LogTA). It also observed that in private banks some factors – LogTA (in L1); CapitalTA (in L1 & L4) and SLR (in L3 & L4) – had a significant positive effect while other factors – Fxreserve and ROE (in L2) – had a significant negative relationship with the liquidity. Similarly, in public banks, some factors – discount rate (in L4); ROE (in L2 & L3) and NPA/Advances (in L4) – had a significant positive effect while other factors – CapitalTA (in L3 & L4); CRR (in L4); NPA/Advances (in L3), and LogTA (in L1) – had a significant negative relationship with the liquidity. The findings of this study question the appropriateness of applying a similar type of regulatory measures for all groups of banks by the regulators for liquidity creation.

Keywords: Monetary Policy, Indian Banks, Liquidity, Central Bank Policy, Panel Data

Authors' individual contribution: Conceptualization – S.B.; Methodology – S.B., A.D., and W.J.; Resources – S.B., A.D., and W.J.; Writing – S.B. and A.D.; Formal Analysis – S.B., A.D., and W.J.; Supervision – S.B.

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1. INTRODUCTION

Liquidity creation is one of the essential roles of banks. It involves banks converting their assets into liquid cash or financing their liquid assets with liquid liabilities for creating liquidity for their customers (Berger & Bouwman, 2017). However, despite its importance and increasing attention since

the Global Financial Crisis (GFC), which paved the way for the Bank for International Settlements (BIB) to create liquidity guidelines for banks, a comprehensive measure of liquidity creation is still not available. As liquidity creation affects banks in their day to day operation, it has become important to examine the issues such as how much liquidity is created by banks, how liquidity changes over time, what implications are resulted from a bank using different strategies for liquidity creation, and what are the differences between different groups of banks in their strategy of liquidity creation and management. In response, considerable literature on the creation of liquidity by banks has emerged, especially after the GFC. These studies have examined various aspects of liquidity management such as liquidity measurement using liquidity ratios (Valla, Saes-Escorbiac, & Tiesset, 2007; Berger & Bouwman, 2009); the effectiveness of various microeconomic factors on liquidity creation (Vodová, 2011); the efficacy of various bank-specific factors on liquidity creation (Sopan & Dutta, 2018), and the effect of regulatory intervention and capital support provided by the regulators on banks (Berger, Bouwman, Kick, & Schaeck, 2016). Recently, there has been an increasing interest in examining liquidity creation in different types of banks, especially among banks in different countries. For example, Berger, Boubakri, Guedhami, and Li (2019) have studied liquidity creation in Islamic banks and conventional banks and found a considerable difference in liquidity creation between the two groups of banks. Furthermore, Berger and Bouwman (2017) highlighted the need for expanding the research in this area to include comparative cross-country studies covering emerging markets to understand the differences arising due to the way different types of banks are organised within a country.

In India, the financial health of private sector banks is perceived to be very different from that of public sector banks. Therefore, it is pertinent that the liquidity characteristics of these banks are studied on a comparative basis to gain insights about the differences between private and public sector banks so that the policymakers can develop appropriate policies to address the issues identified. Therefore, this study aims to examine the liquidity management of private sector banks in comparison to that of public sector banks in India. More specifically, it examines the effect of various microeconomic, bank-specific, and regulatory factors on liquidity management by Indian banks. An examination of the impact of regulatory factors on liquidity creation is particularly important as India is one of the few countries in the world with a regulation on banks in the context of cash reserve ratio (CRR) and statutory liquidity ratio (SLR) which affect the liquidity performance of banks. This paper aims to contribute to the literature by studying the liquidity determinants of private and public sector banks of India on a comparative basis. For this purpose, this study examines the role of regulatory factors such as discount rate, cash reserve ratio along with the role of macroeconomic and bank-specific factors. This paper is organised as follows: following the introduction in Section 1, Section 2 of the paper reviews the literature on comparative studies, which have examined liquidity creation by different banks. Section 3 discusses the methodology used in this study. Section 4 provides the results and discussion on the findings of this research. Lastly, Section 5 concludes the findings on the examination of the differences between private and public sector banks in India.

2. THE INSTITUTIONAL ENVIRONMENT IN INDIA

India is an emerging market in Asia with a well-functioning banking sector, consisting of both private sector banks and public-sector banks in which the government directly or indirectly holds an ownership interest. The substantial liberalisation reforms that took place in India since the 1990s, have enhanced the banking sector competition by expanding the financial system to include the entrance of private and foreign banks (Ghosh, 2016). In 2019, the Indian banking sector consisted of 27 public sector banks, 21 private sector banks, and 49 foreign banks. Currently, the Indian banking sector is regulated by two key legislations: the Reserve Bank of India Act 1934 (RBI Act) and the Banking Regulation Act 1949. India's central bank, The Reserve Bank of India (RBI), issues various guidelines, notifications, and policies from time to time to regulate the banking sector. In addition, RBI also administers the cross-border transactions and related activities through a comprehensive framework such as external commercial borrowing (ECB) regulations and the Foreign Exchange Management Act (FEMA). The ECB regulations affect banking liquidity as it sets limits on borrowings, the procedure for raising funds, reporting requirements, etc.

The Indian banking system is prone to many problems. Since the nationalisation of a number of banks in 1969 and 1980, banks in India have faced a prescriptive regulatory policy in terms of cash reserve ratio and statutory liquidity ratio. After the liberalisation of financial markets in India in 1992, several private sector banks have emerged in competition with public sector banks. Many foreign banks have also started their operations in India. In recent years, a number of frauds have occurred in many Indian banks such as Punjab National Bank, Industrial Credit and Investment Corporation of India Bank (ICICI Bank), and Allahabad Bank. As per a report of The Reserve Bank of India in 2019, the frauds worth Rs 71,500 crore (Rs 7.5 billion) were detected in Indian banks during 2018-19 (RBI, 2019b, pp. 123-124). Together with these issues, Indian banks have also experienced considerable problems in liquidity management by banks. For example, it has been reported that many non-banking financial institutions in India faced liquidity problems in 2018. Since many of these non-banking financial institutions depend on banks for lending and liquidity support, some banks also faced a liquidity crisis (Ghosh, 2019). According to RBI report (2019b, pp. 82-86), the banking system in India faced a Rs 700 billion worth of liquidity shortfall in April 2019 alone. To address the issues confronted by Indian banks, recently the Government of India has taken steps to merge some large banks with public sector banks affected by non-performing assets with the expectation that the merged banks will function well in the future.

3. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

The literature on liquidity covers many aspects of liquidity creation. There have been several studies in different group settings and countries in the context of liquidity creation. These studies address different aspects of liquidity. These studies can be classified into four themes depending on the context of liquidity these studies address.

The first theme is on the determinants of one category of financial institutions. The major study in this category was done by Fecht, Nyborg, and Rocholl (2008), which throws light on the relation between the price of liquidity, bank characteristics, and market conditions. This study focused on liquidity creation by German banks and focused on examining 2,520 German financial institutions for the period from May 2000 to December 2001. Banks in the sample were those holding reserve requirements with the central bank. The findings of this study suggest that "the price of liquidity influences the liquidity positions of the banks. The banks with less liquidity are adversely affected by the imbalance in liquidity" (Fecht et al., 2008, p. 29). It also found a relationship between bank size and the price of liquidity. More specifically, the study showed smaller banks were paying more for their liquidity support in comparison to larger banks as they are more vulnerable to liquidity crunches as compared to larger banks. Another significant finding of this study was that the strength of the lending networks showed no relationship with the price of the liquidity. This is because the liquidity crunches are felt by all banks irrespective of the period. In a crisis period, the liquidity problems of the banks increase than in a regular period. Despite these significant findings, this study was limited by the shorter time period it covered from May 2000 to 2001 and also by specific functional aspects of reserve requirement holdings of the banks that it examined. This study highlights the regulatory aspect of liquidity and emphasises the role of reserve requirements in liquidity creation by banks in addition to examining the differences in liquidity creation by smaller and larger banks (Fecht et al., 2008).

The second group of studies addresses the theme of comparison of liquidity creation by different banks and by a different group of banks. The first such study in this context is the comparative study conducted by Qin and Pastory (2012) which analysed the liquidity of commercial banks in Tanzania across three banks for the period from 2000 to 2009. The three banks used for this study were: National Bank of Commerce (NBC), CRDB, and National Microfinance Bank. For this study, the liquidity was measured using total deposits to core funding, liquid assets to total liabilities, and gross loans to total deposits. The data collected was analysed using analysis of variance (ANOVA). The study found that the liquidity of commercial banks examined was not uniform as banks showed a strong liquidity position in some years and weaker liquidity positions in other years. Among the three banks, the National Microfinance Bank was found to have a better liquidity position than the other two banks. The study, however, failed to examine the determinants of liquidity relating it to microeconomic, bank-specific, or regulatory factors. It is also limited by the small sample size of just three banks, making it difficult to draw conclusions about the banking system of the country (Qin & Pastory, 2012). The important issue emphasised by Qin and Pastory (2012) is the measurement of liquidity using liquidity assets to total liabilities. We have also used a similar measure of liquidity in the present study in the Indian context.

Using the secondary data from 2001 to 2010 and OLS linear regression model, Abdullah and Khan (2012) investigated liquidity risk management of domestic and foreign banks of Pakistan with a view to examine the factors that influence the liquidity in these banks. The study found that the bank size has a significant relationship with liquidity risk in the case of domestic banks and insignificant relationship in the case of foreign banks. The study observed that the debt to equity ratio having a significant negative relationship with the liquidity ratio in both domestic and foreign banks in Pakistan (Abdullah & Khan, 2012, p. 70). The relationship between investment to asset ratio and liquidity risk was also found to be negative and significant in both domestic and foreign banks. In contrast, a profitability measure of ROE was found to have a negative and insignificant relationship with liquidity in both types of banks. While the relationship between liquidity risk and liquid assets was found to be negative and insignificant for domestic banks, it was found to have a positive and significant relationship in the case of foreign banks (Abdullah & Khan, 2012). Similar to the previous study of Fecht et al. (2008), this study also suggests that different groups of banks within a country can have different factors that can influence liquidity in banks. (Abdullah & Khan, 2012). This study has also emphasised ROE as one of the bank-specific factors which can have a significant relationship with liquidity.

Using data from 2006 to 2013 across seven countries, Kuttner and Yetman (2016) conducted a study comparing the liquidity issues of the banks in these countries. The countries covered by this study were: China, India, Singapore, Hong Kong, Korea, Thailand, Indonesia, and the Philippines. The study found that reducing reserve requirements for banks helps in loan growth and profitability of banks and the "smaller and weaker banks are affected more by changes in reserve requirements of a country" (Kuttner & Yetman, 2016, p. 57). The main focus of this study was on the use of central bank bills, term deposits, and reserve requirements as liquidity tools and viewed the central bank bills as market-based instruments. The study highlighted the role of quantitative easing (QA) in terms of central bank rate as it may affect the liquidity and balance sheet of central banks. It also underlines the need for the central banks to exercise some caution in implementing quantitative easing as a policy tool as in normal times. This is because of the effect it may have in increasing liquidity, forcing central banks to absorb the excess liquidity. The study suggests that the implications of the liquidity management tools used by the banks in these countries to soak up the surplus liquidity are likely to extend beyond the banks in Asia (Kuttner & Yetman, 2016). The important aspect of this study

is to emphasise the role of central bank instruments and policies in the liquidity creation of banks and the role of reserve requirements.

Singh and Shahid (2016) investigated the liquidity performance of Oman banks with that of multinational banks for the period from 2012 to 2014. The findings of their study revealed that the National Bank of Oman is managing its liquidity better than Bank Muscat – the other Oman bank in the sample, which was also found to be sensitive to withdrawal risk. The study observed that banks in Oman keep a close eye on the liquidity of banks by frequent monitoring their liquidity through stress testing related to market conditions and the condition of the bank. In addition, the banks in Oman are subjected to the monitoring of liquidity risk carried out by the Central Bank of Oman. However, when compared with international banks, the banks in Oman were found to be weaker in managing liquidity as compared to international banks. The main reason for this is the fact that they operate in different markets. The findings of this study, however, are constrained by the small sample size which consisted of just four banks – two Oman banks and two international banks – and the shorter period of three years from 2012 to 2014 (Singh & Shahid, 2016).

The third group of studies focuses on the theme of comparison between liquidity in conventional banks and Islamic banks. Milhem and Istaiteyeh (2015) conducted a study to compare the performance of Islamic banks and conventional banks in Jordan from 2009 to 2013 with a sample consisting of 16 banks – 13 conventional and 3 Islamic banks. In this study, they examined and compared the profitability, liquidity, risks, solvency, and efficiency of these banks. The liquidity performance was studied using cash deposit ratio, loan deposit ratio, and current ratio. The results of this study revealed that the liquidity performance of Islamic banks, measured in terms of cash deposit ratio, current ratio, and current asset ratio was better than that of conventional banks. The loan deposit ratio of most banks was similar in the two groups. In terms of liquidity, the study found that Islamic banks were more liquid than conventional banks. The reason why Islamic banks are considered more liquid is that Islamic banks have limited opportunities for investment. Also, Islamic banks do not depend on central banks for borrowing money during the time of distress as they follow interest prohibition. However, Islamic banks were considered less risky and more solvent than other banks in comparison to conventional banks, which were found to be more efficient than Islamic banks. Nevertheless, the study did not observe a significant difference between the profitability of conventional banks and Islamic banks (Milhem & Istaiteyeh, 2015).

In a study that compared the liquidity risk between Islamic banks and conventional banks, Effendi and Disman (2017) analysed the micro-economic and bank-specific factors that affect the liquidity risk of these banks. They have used secondary data from 20 Islamic banks and 10 conventional banks across seven countries, namely Albania, Saudi Arabia, Bahrain, Malaysia, Dubai, Qatar, and Indonesia from 2009 to 2015. The panel data regression analysis they conducted in the study identified capital adequacy (CAR), financial expansion (FEXP), financing quality (FLP), and non-performing financing (NPF) as major factors contributing to liquidity risk in Islamic banks. It also identified financial expansion (FEXP), financing quality (FLP), non-performing loans (NPL), and return on assets (ROA) as the major factors affecting the liquidity risk of conventional banks. However, Net income margin, return on assets, and size were not found to affect liquidity risk in Islamic banks while the capital adequacy ratio, net interest margin (NIM), and size were not found to affect liquidity risk in conventional banking (Effendi & Disman, 2017).

The paper by Sahyouni and Wang (2019) on liquidity in the MENA region compared the liquidity performance of Islamic banks with those of conventional banks. The study used two measures of liquidity – one based on category-based loans and off-balance sheet items to total assets and another based on category-based loans to total assets – to examine the liquidity creation in banks and its relationship with the financial performance of the banks. For this purpose, data from 491 banks across 18 MENA region countries were obtained for 6 years from 2011 to 2016. The results of the study found that conventional banks created more liquidity in comparison to Islamic banks, contradicting the results obtained by Milhem and Istaiteyeh (2015). It also found that liquidity creation had a negative relationship with ROE and no relation with ROA. The results of the study revealed that the liquidity of banks in the MENA region showed an increase in liquidity during the 2011-2014 and 2015-2016 periods. However, the amount of their liquidity was smaller than that of banks in the USA and China. Referring to these trends, the authors state that "Liquidity as a percentage of total assets was more in Islamic banks as compared to conventional banks. Large banks created more liquidity as compared to smaller banks. There are, however, disadvantages of creating more liquidity as bank performance in terms of return on assets may be affected with more liquidity" (Sahyouni & Wang, 2019, p. 41). Considering the fact that different levels of liquidity creation were observed in different countries, the study identified country differences as an important factor affecting liquidity creation. However, the study failed to explore the relationship between bank capital and liquidity creation; cyclicality in liquidity creation; and the role of corporate governance in liquidity creation (Sahyouni & Wang, 2019).

The fourth group of studies is the study on the theme of the comparison of liquidity in a different group of banks in India. In the Indian context, there have been several studies that examined the liquidity issues. These studies have explored various aspects of liquidity creation and compared them among Indian banks. One of such studies was the study conducted by Meena and Dhar (2014) which provides an analysis and comparison of liquidity ratios and asset and liabilities management of banks in India. For this purpose, the authors have selected three banks each from the public, private, and foreign banks operating in India, covering the period from 2002 to 2011. Their analysis is based on the calculations of liquidity ratios and determining the maturity gap between the assets and liabilities of the banks. The authors have studied the gap between rate sensitive assets and rate-sensitive liabilities by identifying their sensitivities to changes in interest rates. Although

the study concluded that the liquidity structure of banks in India is stable, it identified the amount of cash maintained as problematic due to the long-run impact of profitability on liquidity. The top banks by assets in India, such as State Bank of India and nationalised banks are in a position to influence the maturity gap in their group of banks due to their size. However, the authors view that overall, "banks in India have a good short-term liquidity position and are found to be financing their short-term liabilities by their long term assets" (Meena & Dhar, 2014, p. 347). Consequently, banks in India are facing a considerable liquidity risk as they do have sufficient short-term assets to pay for short-term liabilities.

In another comparative study conducted on the liquidity of private and public sector banks of India, Pushkala, Mahamayi, and Venkatesh (2017) have studied the liquidity, solvency, and profitability of these banks in India. This study utilised several ratios to measure the liquidity, solvency, and the effect of off-balance sheet items (OBS). As for the liquidity, the measures used were: deposit ratio; liquid assets to total assets ratio; a liquid asset to total deposit ratio; government securities to total asset ratio; and demand deposit to total asset ratio. Solvency was measured using capital adequacy ratio; equity capital to total asset ratio; and debt-equity ratio while the effect of off-balance sheet items was measured using liquid assets to OSB; equity share capital to OBS; and government securities to OBS. The study observed that the public sector banks are more liquid due to the higher loan deposit ratio while the private sector banks are more liquid when meeting the demand of paying depositors. When focused on profitability, both the private sector and public sector banks were found to have less liquid assets than required. Based on these findings, the study concluded that in case of a liquidity contingency such as the one that arose during GFC, either the public sector banks or private sector banks are unable to fulfil the liquidity requirements of the banks. The study also found that as against public banks, private sector banks had better CAR and are more solvent. However, private sector banks are likely to face higher risks due to higher off-balance sheet items as compared to public sector banks (Pushkala et al., 2017, p. 92). Overall, the authors found that both the private and public sector banks were poor in long-term solvency and faced high solvency risk. Although Pushkala et al. (2017) have highlighted the differences between liquidity management of private and public sector banks in India, they have not considered the effect of macroeconomic and regulatory factors on the liquidity of these banks (Pushkala et al., 2017).

The study conducted by Mohanty and Mehrotra (2018) on liquidity management of 27 public sector banks and 20 private sector banks in India, investigated the relationship between profitability and liquidity of these banks for the period from the financial year 2011/12 to the financial year 2015/16. The liquidity measures utilised by this study were: cash deposit ratio (CDR); credit deposit ratio (CBDR); and investment deposit ratio (IDR). As for profitability measures of the banks, the study used return on assets (ROA) and return on equity (ROE). The results of the study revealed that the ROA of banks is found to have a significant negative association with the liquidity measures of CDR and IDR. However, the ROE of banks is not found to have any significant relationship with the liquidity. The results were uniform across private and public sector banks. One of the limitations of this study is that their examination was limited to study the relationship between liquidity and profit while disregarding the effect of other micro-economic, bank-specific, or regulatory factors may have on liquidity.

The paper by Arora and Kohli (2018) on Indian banks has examined the liquidity position of selected private and public sector banks using two approaches: stock and flow approach and flow approach. The stock and flow approach uses the loan to deposit ratio and a liquid asset to total asset ratio for measuring liquidity, while the flow approach uses risk-sensitive assets and risk-sensitive liabilities of private and public sector banks. The study concluded that "public sector banks have a lesser loan to deposit ratio as compared to private sector banks. Also, public sector banks are more exposed to liquidity risk as compared to private sector banks due to their negative mismatches" (Arora & Kohli, 2018, p. 31). A key finding of the study was that the private sector banks are managing their liquidity in a better way as compared to public sector banks. This finding is in contradiction with that of Meena and Dhar (2014) who found that banks in India had a good short-term liquidity position and all banks in India were found to be financing their short-term liquidity by long-term assets. The study also found that the large private sector banks like ICICI Bank, HDFC Bank (Housing Development Finance Corporation Bank), and Axis Bank are the creation by banks in India (Arora & Kohli, 2018).

Sinha and Grover (2019) have estimated the national value of liquidity created by commercial banks in India from 2015 to 2018, using four measures of liquidity following Berger and Bouwman (2009). The results of their study found that the liquidity in India was 27.2 per cent of the total assets of all commercial banks in India. It also found that the off-balance sheet activities are playing an important role in liquidity creation in India, contributing to 25 per cent of the total liquidity created in India. In comparison to small-sized private banks such as the Federal Bank and J&K Bank, the nationalised banks in India were found to be managing their liquidity in a better way. As in some previous studies on bank liquidity in India, this study is also limited by the small size of their sample and also a shorter observation period of only three years (Sinha & Grover, 2019).

This paper argues that due to the unique characteristics of private and public sector banks in India, the factors affecting the liquidity of public sector banks and private sector banks vary significantly between the two types of banks. Thus, the following hypothesis is framed:

H1: Factors affecting liquidity in private sector banks in India are significantly different from those in the public sector banks in India.

4. METHODOLOGY AND DATA

This research argues that the liquidity of Indian private and public banks are determined by key micro-economic, regulatory, and bank-specific factors. In order to test this argument, this study conducted a panel data regression analysis on 27 public sector banks and 20 private sector banks in India over 21 years from 1996 to 2016. The data

on the balance sheet of banks and the data on macroeconomic and regulatory variables were obtained from the Reserve Bank of India database (RBI, 2019a) and their website. Some of these banks were merged together and, therefore, data needed to be cleaned for missing values. Only banks with complete data were included in this study. Table A.1 (Appendix) shows the descriptive statistics of the variables in the model for private and public sector banks from 1996 to 2016.

This study uses panel data regression with fixed effects for the analysis. The justification for the fixed-effect model could be in terms of time-invariant characteristics of banks such as risk management, lending regulations, etc., and Hausman specification test. The fixed-effect model considers the individuality of each bank in the sample by allowing intercept to vary for each bank yet assuming that the slope coefficients are constant across banks. The Hausman (1978) specification test is employed to determine whether the fixed or random effect approaches should be used to estimate the models. All results are computed by using heteroscedasticity-robust standard errors clustered by firm. The model used for panel data analysis is given as under:

$$L_{it} = \alpha_i + \beta_1 Discrate_{it} + \beta_2 Callrate_{it} + \beta_3 CRR_{it} + \beta_4 SLR_{it} + \beta_5 Fxreserve_{it} + \beta_6 CapitalTA_{it} + \beta_7 LogTA_{it} + \beta_8 ROE_{it} + \beta_9 NPA/Adv_{it} + \mu_{it} \quad (1)$$

where,

Discrate - Reserve Bank of India discount rates for bills (Valla et al., 2007; Rauch, Steffen, Hackethal, & Tyrell, 2009),
Callrate - lending rate for money at call and short notice (Vodová, 2011; Munteanu, 2012),
CRR - cash reserve ratio of RBI Bhati (De Zoysa & Jitaree, 2019),
SLR - SLR (Bhati et al., 2019),
Fxreserve - foreign exchange reserve with RBI (Bhati et al., 2019),
CapitalTA - capital/total assets (Singh & Sharma, 2016; Al-Homaidi, Tabash, Farhan, & Almaqtari, 2019),
LogTA - the logarithm of total assets (Sinha & Grover, 2019; Sopan & Dutta, 2018),
ROE - return on equity (net profit/total equity) (Sopan & Dutta, 2018; Vodová, 2011),
NPA/Adv. - non-performing loans/Total loans (Vodová, 2011; Berrospide, 2010),
α_i - is a constant,
β_i - are coefficients,
μ_{it} - is an error term,
L_{it} - liquidity factors from *L1* to *L4* are defined as under (Vodová, 2011; Bhati et al., 2019):

$$L1 = \frac{Liquid\ Assets}{Total\ Assets} \quad (2)$$

$$L2 = \frac{Liquid\ Assets}{Deposits + Short\ term\ borrowings + Bills\ Payable} \quad (3)$$

$$L3 = \frac{Loans}{Total\ Assets} \quad (4)$$

$$L4 = \frac{Loans}{Deposits + Short\ term\ borrowings + Bills\ Payable} \quad (5)$$

The methodology used in this study follows our previous papers (Bhati, De Zoysa, & Jitaree, 2015; Bhati et al., 2019). Considering the time-invariant characteristics of banks such as risk management, lending regulations, etc., and the results of the Hausman specification test, this study utilises a panel data regression model with a fixed effect to explore the association described in the model. The fixed-effect model considers the individuality of each bank in the sample by allowing intercept to vary for each bank, but still assuming that the slope coefficients are constant across banks. The model was run using Stata 15 software. Before running the model, a multicollinearity test was conducted to ensure that there is no significant multicollinearity between the explanatory variables in the model. The results in Table A.2, which indicates the correlation coefficient between variables and the variance inflation factor (VIF) confirm that there were no significant multicollinearity issues between the variables.

5. RESULTS AND DISCUSSION

As defined above, L1 and L3 are based on assets, while L2 and L4 are based on liabilities. The comparative results of panel data regression for the private and public sector banks in India are presented in Table A3 (Appendix) which displays the results across four liquidity parameters of L1, L2, L3, and L4 for both types of banks. This study uses heteroscedasticity-robust standard errors clustered across banks to ensure the validity of the results. All results remain valid when using heteroscedasticity-robust standard errors clustered across firms. Table A.4 presents the regression results of the panel data regression with robust standard errors.

The results in Table A.3 in Appendix show that the coefficients of the regressors for all the independent variables were mixed, indicating that there is a positive or negative relationship between liquidity and the explanatory variables in the case of

both public and private sector banks. Although each of the four models consists of nine explanatory variables, a comparison of the four models across two groups of banks shows that L1 and L2 models consist of a fewer number of statistically significant determinants for both private and public sectors banks while the L3 model consists of the highest number of statistically significant determinants for both the private and public sector banks. On the other hand, Model L4 consists of eight statistically significant determinants for public sector banks in comparison to five statistically significant determinants for private sector banks, showing that the effect of explanatory variables in this model is substantially different between the two types of banks. The relationship between the liquidity and nine explanatory variables in the models is discussed in the next section.

In the case of Model L1, the cash reserve ratio was found to have a statistically significant positive effect on liquidity, indicating that higher CRR results in higher liquidity for both private and public banks. On the other hand, foreign exchange reserve (*Fxreserve*) and the logarithm of total assets (*LogTA*) were found to have a statistically significant negative effect on liquidity indicating that higher *Fxreserve* and *LogTA* results in lower liquidity for both private and public sector banks. The other significant determinant of L1 liquidity is the capital to total assets ratio (*CapitalTA*) which was found to have a significant positive relationship with L1 liquidity only for private banks indicating that the higher level of capital in private banks generates a higher level of liquidity. In contrast, the capital was not found to be a key determinant of liquidity in the case of public banks. The other five explanatory variables in the model (*Discrate, Callrate, SLR, ROE*, and *NPA/Adv.*) were not found to have any significant relationship with the L1 liquidity for both private and public sector banks.

In the case of Model L2, *CapitalTA* has a significant positive effect on L2 liquidity, indicating an increase in the level of capital will have an increase in liquidity in both types of banks. On the other hand, return on equity (*ROE*), has a significant negative effect on L2 liquidity in the case of private banks and a significant positive effect on the L2 liquidity in public banks. In addition, *Fxreserve* is found to have a negative effect on liquidity in both the private and public banks, only the effect it has on liquidity in the private bank is statistically significant. The other six explanatory factors considered (*Discrate, Callrate, CRR, SLR, LogTA, and NPA/Adv.*) were not found to have any significant relationship with the L2 liquidity for both private and public sector banks.

In the case of L3, which is based on loans to total assets, five explanatory variables were found to be significantly related to the L3 liquidity for both types of banks. While four of these variables (i.e., *Discrate, Callrate, Fxreserve,* and *LogTA*) have a significant positive effect on L3 liquidity, the other variable (i.e., *CRR*) has a significant negative effect on L3 liquidity. In addition, *SLR* has a significant positive effect on the liquidity of private banks and no significant effect on public banks. Furthermore, *CapitalTA* and *NPA/Adv.* have a significant negative effect on the liquidity only in public banks. The only explanatory variable in the model that was found to be a determinant is *ROE*, which has a negative effect on liquidity in private banks and a positive effect on liquidity in public banks although these effects are not statistically significant.

In the case of L4, which is based on loans to liabilities, the relationship between liquidity and explanatory variables were found to be contrastingly different between the private and public banks. Three explanatory variables (*Callrate, Fxreserve,* and *LogTA*) have shown a significantly positive relationship with the liquidity for both private and public banks. Another variable (*CapitalTA*), has a significant positive effect on the L4 liquidity in private banks a negative effect on L4 liquidity in public banks. On the other hand, *SLR* has a significant positive effect on the liquidity in private banks and has no significant effect on the liquidity of public banks. Interestingly, four other variables (*Discrate, CRR, ROE*, and *NPA/Adv.*) also found to be having a statistically significant relationship with the liquidy in public banks but not in private banks. In summary, in the case of L4 liquidity in public banks, eight of the nine explanatory variables were found to be having a statistically significant relationship with the liquidity while six of those variables showing a positive and the other two showing a negative relationship.

Finally, a comparison of liquidity determinants of private and public banks across four models reveal similarities as well as differences in the way each explanatory factor affect the liquidity. Table A.5 (Appendix) summarises the significant relationship observed between the liquidity and the explanatory variables from the results of panel data regress analysis.

As shown in Table A.5, there were no significant differences between private and public sector banks in relation to the relationship between liquidity and the following explanatory variables: *Fxreserve* (L3 and L4 – positive and L1 – negative); *LogTA* (L3 and L4 – positive); *CapitalTA* (L2 – positive); *CRR* (L1 – positive and L3 – negative); *Callrate* (L3 and L4 – positive); *Discrate* (L3 – positive). However, as shown in Table A.5, this study has observed significant differences in the way explanatory variables impact liquidity in private and public sector banks. More specifically, *LogTA* (& L1), *CapitalTA* (& L1, L4), and *SLR* (& L3, L4) have a significant positive relationship in private banks but not in the public banks. Also, *Discrate* (& L4) and *NPA/Adv.* (& L4) have a significant positive relationship in public banks but not in private banks. As for the differences in negative effects, *Fxreserve* (& L2) and *ROE* (& L2) have a significant negative relationship in private banks but not in public banks. Also, *LogTA* (& L1); *CapitalTA* (& L3, L4); *CRR* (& L4); *NPA/Adv.* (& L3) have a significant negative relationship in public banks but not in private banks. On the basis of this finding, the null hypothesis of "factors affecting liquidity in public sector banks in India are not significantly different from those in the private sector banks in India" is rejected and the alternative hypothesis (*H1*) is accepted.

Overall, from the view point of being significant determinant across all eight models, the most significant determinant of liquidity for both private

and public sector banks from the highest significance to lowest significance are: 1) *Fxreserve* – 87.5%, 2) *CapitalTA* – 75%, 3) *LogTA* – 75%, 4) *CRR* – 62.5%, 5) *Callrate* – 50%, 6) *Discrate* – 37.5%, 7) *ROE* – 37.5%, 8) *NPA/Adv.* – 25%, and 9) *SLR* – 25%.

6. CONCLUSION

This paper contributes to the literature by studying the liquidity determinants of private and public sector banks in India on a comparative basis. It examined the effect of macroeconomic factors, microeconomic factors, and regulatory factors on the liquidity of private and public sector banks on a long term basis. We have used the liquidity determinants observed in prior studies to make this comparison as it provides insights on various liquidity relationships.

This study provides useful insight for policymakers by highlighting the similarities and differences between private and public sector banks concerning liquidity determinants. These need to be taken into consideration by the regulators who generally apply similar policies to both sectors on the assumption that these factors affect liquidity similarly in both sectors. As revealed in this study, both the private sector banks and public sector banks in India rely on asset-based liquidity. The public sector banks in India are larger banks and have ready access to market borrowings as well as borrowings from the Reserve Bank of India. On the other hand, the private sector banks in India are smaller banks and have limited access to borrowings. However, as observed in this study, the liquidity behaviour of private banks seems to have some similarities to those of public banks and some differences.

The factors that affect the liquidity of both private and public sector banks are call rate, discount rate, cash reserve ratio, capital to total assets, foreign exchange reserve with RBI, and Size (*LogTA*). While the call rate, discount rate, and size have a positive effect on the liquidity of both types of banks, foreign exchange reserve, and size (*LogTA*) have a mixed relationship with liquidity.

However, the most significant finding of this study is that it observed some explanatory variables only had a significant effect on the liquidity of either private or public banks but not for both banks. The factors that only had a significant positive effect on the liquidity of private banks are *LogTA* (in L1); *CapitalTA* (in L1 & L4) and *SLR* (in L3 & L4) while *Fxreserve* and *ROE* had a significant negative relationship with the L2 liquidity of private banks. Similarly, the factors that only had a significant positive effect on the liquidity of public banks are discount rate (in L4); *ROE* (in L2 and L3), and *NPA/Adv.* (in L4). Conversely, *CapitalTA* (in L3 & L4); *CRR* (in L4); *NPA/Adv.* (in L3), and *LogTA* (in L1) had a significant negative relationship with the liquidity of public banks but not with the private banks. Given the above findings, it can be concluded that applying the same type of regulatory measures for all groups of banks by the regulators for liquidity creation may not be appropriate.

Given the contrasting relationship between the liquidity and some explanatory factors in our models, our results contradict the results of several previous studies. For example, our results regarding reserve requirements do not support the findings of Kuttner and Yetman (2016), who argue that there is a positive relationship between liquidity and reserve requirements. However, we observed a negative relationship between the liquidity and reserve requirements in relation to L3 and L4. Our results on the relation between size and liquidity are also largely in agreement with the results of Sinha and Grover (2019) who have argued that the size of banks is a significant factor in liquidity creation.

This research is limited by the constraints such as time frame, the context of a single country India and the regulatory, macroeconomic environment in which Indian banks operate. Future research may look into extending this study to other countries with a different regulatory environment to generalise the findings of this study further. Also, due to the significant effect the COVID-19 pandemic had on the operations of banks around the world, future researchers may also need to examine the impact that the COVID-19 pandemic had on the relationship between liquidity and its determinants.

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APPENDIX

Table A.1. Descriptive statistics of variables

Variable	Private bank					Public bank					Public & Private bank				
	Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max
L1	537	0.172	0.088	0.044	0.651	571	0.131	0.056	0.047	0.520	1,108	0.151	0.076	0.044	0.651
L2	536	0.202	0.230	0.052	4.994	571	0.160	0.284	0.011	6.693	1,107	0.180	0.260	0.011	6.693
L3	537	0.496	0.102	0.117	0.686	571	0.518	0.113	0.079	0.706	1,108	0.507	0.108	0.079	0.706
L4	536	0.569	0.173	0.153	3.297	571	0.587	0.199	0.110	4.404	1,107	0.578	0.187	0.110	4.404
Discrate	537	7.80	2.07	6.00	12.00	571	7.64	1.94	6.00	12.00	1,108	7.71	2.01	6.00	12.00
Callrate	537	8.41	5.76	3.51	28.75	571	8.25	5.26	3.51	28.75	1,108	8.33	5.51	3.51	28.75
CRR	537	7.01	2.88	4.00	14.00	571	6.51	2.67	4.00	14.00	1,108	6.75	2.78	4.00	14.00
SLR	537	25.31	2.58	21.25	31.50	571	24.93	2.41	21.25	31.50	1,108	25.11	2.50	21.25	31.50
CPI	537	602	264	319	1225	571	662	280	319	1225	1108	633	274	319	1225
CapitalTA	536	0.07	0.05	0.02	0.79	571	0.06	0.05	0.01	0.91	1,107	0.07	0.05	0.01	0.91
LogTA	536	5.64	0.63	3.63	7.60	571	6.56	0.50	4.05	8.13	1,107	6.12	0.73	3.63	8.13
ROE	536	0.20	1.46	-3.04	31.26	571	0.13	0.14	-1.26	1.15	1,107	0.16	1.02	-3.04	31.26
NPA/Adv.	536	4.27	4.56	0.00	31.05	571	4.59	4.20	0.00	26.01	1,107	4.43	4.38	0.00	31.05

Table A.2. Multicollinearity matrix of variables (Part 1)

Private bank													
Variable	L1	L2	L3	L4	Discrate	Callrate	CRR	SLR	Fxreserve	CapitalTA	LogTA	ROE	NPA/Adv.
L1	1												
L2	0.510***	1											
L3	-0.579***	-0.295***	1										
L4	-0.303***	0.0533	0.578***	1									
Discrate	0.433***	0.130**	-0.287***	-0.145***	1								
Callrate	0.335***	0.0751	-0.167***	-0.0947*	0.449***	1							
CRR	0.609***	0.103*	-0.607***	-0.376***	0.643***	0.612***	1						
SLR	0.486***	0.0784	-0.532***	-0.329***	0.546***	0.476***	0.763***	1					
Fxreserve	-0.549***	-0.0815	0.843***	0.532***	-0.289***	-0.264***	-0.701***	-0.680***	1				
CapitalTA	0.258***	0.725***	-0.256***	-0.0330	0.0905*	0.0129	-0.0232	-0.0410	0.0714	1			
LogTA	-0.285***	-0.274***	0.444***	0.273***	-0.394***	-0.193***	-0.300***	-0.193***	0.318***	-0.305***	1		
ROE	-0.0374	-0.0275	0.112**	0.305***	-0.248***	-0.204***	-0.150***	-0.0394	-0.0460	-0.179***	0.187***	1	
NPA/Adv.	0.290***	0.0224	-0.513***	-0.341***	0.519***	0.214***	0.505***	0.286***	-0.417***	-0.00352	-0.420***	-0.508***	1
VIF	N/A	N/A	N/A	N/A	2.52	2.00	4.88	2.88	3.07	1.15	1.58	1.06	1.53

Table A.2. Multicollinearity matrix of variables (Part 2)

	Public bank												
Variable	***L1***	***L2***	***L3***	***L4***	***Discrate***	***Callrate***	***CRR***	***SLR***	***Fxreserve***	***CapitalTA***	***LogTA***	***ROE***	***NPA/Adv.***
L1	1												
L2	0.510***	1											
L3	-0.579***	-0.295***	1										
L4	-0.303***	0.0533	0.578***	1									
Discrate	0.433***	0.130**	-0.287***	-0.145***	1								
Callrate	0.335***	0.0751	-0.167***	-0.0947*	0.449***	1							
CRR	0.609***	0.103*	-0.607***	-0.376***	0.643***	0.612***	1						
SLR	0.486***	0.0784	-0.532***	-0.329***	0.546***	0.476***	0.763***	1					
Fxreserve	-0.549***	-0.0815	0.843***	0.532***	-0.289***	-0.264***	-0.701***	-0.680***	1				
CapitalTA	0.258***	0.725***	-0.256***	-0.0330	0.0905*	0.0129	-0.0232	-0.0410	0.0714	1			
LogTA	-0.285***	-0.274***	0.444***	0.273***	-0.394***	-0.193***	-0.300***	-0.193***	0.318***	-0.305***	1		
ROE	-0.0374	-0.0275	0.112**	0.305***	-0.248***	-0.204***	-0.150***	-0.0394	-0.0460	-0.179***	0.187***	1	
NPA/Adv.	0.290***	0.0224	-0.513***	-0.341***	0.519***	0.214***	0.505***	0.286***	-0.417***	-0.00352	-0.420***	-0.508***	1
VIF	N/A	N/A	N/A	N/A	2.64	1.87	5.15	3.27	3.51	1.21	1.57	1.67	2.62

*Note: * p < 0.05, ** p < 0.01, *** p < 0.001.*

Table A.3. Panel data fixed effect regression

Variables	***Private bank***				***Public bank***			
	L1	***L2***	***L3***	***L4***	***L1***	***L2***	***L3***	***L4***
Discrate	0.000184	-0.00358	0.00807***	0.00320	0.000791	-0.00230	0.00588***	0.0291***
	(0.0997)	(-0.712)	(4.002)	(0.917)	(0.636)	(-0.302)	(3.918)	(4.960)
Callrate	-0.000265	0.000513	0.00180***	0.00215**	-0.000266	0.00182	0.00267***	0.00842***
	(-0.497)	(0.353)	(3.087)	(2.130)	(-0.774)	(0.864)	(6.443)	(5.196)
CRR	0.00759***	0.00747	-0.00453**	-0.00247	0.00898***	0.00374	-0.00590***	-0.0207***
	(4.533)	(1.642)	(-2.475)	(-0.780)	(7.764)	(0.529)	(-4.237)	(-3.809)
SLR	-0.00210	-0.00383	0.00475***	0.00639**	0.000260	0.00202	0.000263	-0.00539
	(-1.427)	(-0.959)	(2.959)	(2.303)	(0.259)	(0.328)	(0.217)	(-1.137)
Fxreserve	-3.06e-07***	-6.39e-07***	5.00e-07***	4.43e-07***	-9.75e-08***	-1.38e-07	6.92e-07***	6.25e-07***
	(-8.340)	(-6.396)	(12.46)	(6.379)	(-4.334)	(-1.004)	(25.53)	(5.895)
CapitalTA	0.302***	3.852***	0.0166	2.488***	0.00508	4.509***	-0.330***	-0.436*
	(5.250)	(24.41)	(0.263)	(22.71)	(0.0926)	(13.46)	(-4.990)	(-1.687)
LogTA	-0.0296***	-0.0136	0.0234***	0.0499***	-0.0299***	-0.0168	0.0305***	0.237***
	(-3.755)	(-0.628)	(2.723)	(3.323)	(-4.475)	(-0.412)	(3.790)	(7.524)
ROE	0.000501	-0.0254**	-0.00271	-0.000394	0.0184	0.222***	0.0116	0.574***
	(0.321)	(-2.242)	(-1.590)	(-0.0500)	(1.450)	(2.857)	(0.756)	(9.602)
NPA/Adv.	-0.00111	0.00260	-0.00118	0.00187	-0.000641	0.00303	-0.00360***	0.0124***
	(-1.499)	(1.284)	(-1.455)	(1.332)	(-1.120)	(0.867)	(-5.227)	(4.601)
Constant	0.366***	0.149	0.128**	-0.156	0.276***	-0.0894	0.199***	-1.200***
	(6.401)	(0.954)	(2.047)	(-1.437)	(6.107)	(-0.324)	(3.651)	(-5.645)
Observations	536	535	536	535	571	571	571	571
R-Squared	0.511	0.620	0.506	0.642	0.613	0.291	0.885	0.483
F-Statistic	55.88	87.16	54.69	95.72	93.81	24.28	455.27	55.21
P-Value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of sid	46	46	46	46	30	30	30	30
Hausman test – Chi ($\chi 2$)	6.35	110.96	11.58	2.31	43.13	21.80	14.07	33.74
Prob.	0.6084	0.0000	0.1710	N/A	0.0000	0.0053	0.0800	0.0000

*Note: 1) t-statistics are reported in parentheses; 2) * statistically significant at 10%, ** statistically significant at 5%, *** statistically significant at 1%.*

Table A.4. Panel data fixed effect regression (Cluster robust by firms)

Variables	*Private bank (Cluster robust by firms)*				*Public bank (Cluster robust by firms)*			
	L1	*L2*	*L3*	*L4*	*L1*	*L2*	*L3*	*L4*
Discrate	0.000184	-0.00358	0.00807***	0.00320	0.000791	-0.00230	0.00588***	0.0291
	(0.0907)	(-0.596)	(3.028)	(0.747)	(0.828)	(-0.477)	(5.136)	(1.437)
Callrate	-0.000265	0.000513	0.00180***	0.00215***	-0.000266	0.00182	0.00267***	0.00842**
	(-0.394)	(0.332)	(3.371)	(2.946)	(-0.984)	(1.093)	(9.805)	(2.091)
CRR	0.00759**	0.00747	-0.00453*	-0.00247	0.00898***	0.00374	-0.00590***	-0.0207*
	(2.604)	(1.484)	(-1.869)	(-0.761)	(8.415)	(0.657)	(-4.518)	(-1.954)
SLR	-0.00210	-0.00383	0.00475**	0.00639**	0.000260	0.00202	0.000263	-0.00539
	(-1.089)	(-1.059)	(2.376)	(2.551)	(0.257)	(0.524)	(0.273)	(-0.934)
Fxreserve	-3.06e-07***	-6.39e-07***	5.00e-07***	4.43e-07***	-9.75e-08***	-1.38e-07*	6.92e-07***	6.25e-07***
	(-6.636)	(-3.500)	(10.10)	(4.180)	(-3.775)	(-1.776)	(18.62)	(6.500)
CapitalTA	0.302***	3.852**	0.0166	2.488***	0.00508	4.509	-0.330**	-0.436
	(2.706)	(2.479)	(0.255)	(2.896)	(0.0235)	(1.154)	(-2.302)	(-0.671)
LogTA	-0.0296**	-0.0136	0.0234*	0.0499*	-0.0299***	-0.0168	0.0305***	0.237
	(-2.581)	(-0.420)	(1.816)	(1.838)	(-5.195)	(-0.527)	(3.080)	(1.539)
ROE	0.000501	-0.0254	-0.00271	-0.000394	0.0184	0.222	0.0116	0.574
	(0.540)	(-1.481)	(-0.880)	(-0.0269)	(1.671)	(1.559)	(0.619)	(1.320)
NPA/Adv.	-0.00111	0.00260	-0.00118	0.00187	-0.000641	0.00303	-0.00360**	0.0124
	(-1.360)	(1.239)	(-1.003)	(1.110)	(-0.939)	(0.629)	(-2.658)	(1.063)
Constant	0.366***	0.149	0.128	-0.156	0.276***	-0.0894	0.199**	-1.200
	(4.838)	(0.734)	(1.263)	(-0.766)	(6.081)	(-0.284)	(2.558)	(-1.108)
Observations	536	535	536	535	571	571	571	571
R-Squared	0.511	0.620	0.506	0.642	0.613	0.291	0.885	0.483
F-Statistic	33.62	5.93	15.05	14.73	47.97	6.19	123.91	93.88
P-Value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of sid	46	46	46	46	30	30	30	30

*Note: 1) robust t-statistics are reported in parentheses, 2) * statistically significant at 10%, ** statistically significant at 5%, *** statistically significant at 1%.*

Table A.5. Relationship between liquidity and explanatory variables

Variables	*Significantly positive*									*Significantly negative*									*All*
	L1		*L2*		*L3*		*L4*		*Total*	*L1*		*L2*		*L3*		*L4*		*Total*	
	Pri	*Pub*	*Pri*	*Pub*	*Pri*	*Pub*	*Pri*	*Pub*		*Pri*	*Pub*	*Pri*	*Pub*	*Pri*	*Pub*	*Pri*	*Pub*		
Fxreserve					***	***	***	***	4	***	***	***						3	7
LogTA	***				***	***	***	***	5		***							1	6
CapitalTA	***		***	***			***		4						***		*	2	6
CRR	***	***							2					**	***		***	3	5
Callrate					***	***	**	***	4									0	4
Discrate					***	***		***	3									0	3
ROE				***		***			2			**						1	3
SLR					***		**		2									0	2
NPA/Adv.								***	1						***			1	2
									27									11	38

*Note: * statistically significant at 10%, ** statistically significant at 5%l, *** statistically significant at 1%.*