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Analyzing the liquidity of commercial banks in India: Study on different bankgroups

Ekta Kasana[1+]
Renu Singh[2]
Bibhu Prasad Sahoo[3]

[1]*Jagannath International Management School, Kalkaji, Guru Gobind Singh Indraprastha University, India.*
Email: ekta.kasana@jagannath.org
[2]*Fintech, ISDC Global, UK.*
Email: renu_rsingh@yahoo.in
[3]*Department of Commerce, SGTB Khalsa College, University of Delhi, India.*
Email: bibhusahoodu@gmail.com

(+ Corresponding author)

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ABSTRACT

The present study investigates how macroeconomic and bank-specific determinants affect the liquidity of public, private, and foreign banks in India. Bank liquidity is crucial for maintaining financial stability, supporting economic growth, and preserving public trust in the banking system. Bank liquidity is critically significant for bank success. Since 2008, this study has taken 49 banks for analysis purposes. We have employed the fixed and random effect models to examine the impact of bank-specific and macroeconomic variables on the liquidity of diverse bank groups. The results show that deposits and capital have a positive influence, whereas interest rate, statutory liquidity ratio, and cash reserve ratio negatively influence public, private, and foreign banks. Profitability has an insignificant effect on all types of banks. Gross domestic product has a positive, significant influence on public and private banks, but an insignificant impact on foreign banks. Bank size significantly impacts private banks, whereas it has negligible influence on other banks. The findings can assist bank managers, policymakers, and academics in formulating policies that maintain bank liquidity without incurring any losses or undefined costs. The present research is useful for other countries with a similar economic framework, like India, to improve their bank liquidity structure.

Contribution/Originality: The current study focused on the liquidity of different types of banks in India. The ownership of banks can impact liquidity in various ways. Few studies have examined the impact of CRR and SLR on the liquidity of different bank types.

1. INTRODUCTION

Managing sufficient liquidity is an essential requirement for banking institutions. A bank must continuously maintain a significant cash reserve and a portfolio of readily tradable securities continuously to execute its contractual duties, including the ease of cash withdrawals (Subramoniam, 2018). There are three fundamental problems with bank liquidity management—first, the trade-off between liquidity and profitability. Banks maintain liquidity to protect themselves against liquidity issues; though, maintaining high liquidity levels to offset such risk carries an opportunity cost in the form of lost interest income from low-yielding liquid funds. Second, as noted by Diamond and Dybvig (1983); banks are susceptible to failure because their balance sheets are inherently weak. Thirdly, the interconnection of banks and other financial institutions makes bank liquidity issues contagious. Promptly addressing a single bank's liquidity problems can quickly spread to other banks and harm the broader economy (Van Rixtel & Gasperini, 2013).

The importance of liquidity extends beyond a single bank, as unique liquidity issues can rapidly spread to other financial intermediaries and the real economy (Mashamba, 2022). According to Bindseil and Fotia (2021) insignificant liquidity can be disastrous for banks with solid capitalization, as shown in the 2008 financial crisis. Banks have adequate capital and profitability, but creditors losing faith in the bank's capacity to make payments on schedule can result in abrupt and substantial mass withdrawals, which may lead to the collapse of a financially solvent institution.

The 2008 financial crisis encouraged investigators to reconsider liquidity issues, which had played a significant role in the financial contagion and credit crisis. Numerous studies have found that maintaining adequate liquidity levels in the banking sector is critical for guaranteeing robust financial stability. (El-Chaarani, 2019) suggests that well-managed institutions should have an efficient system for identifying, monitoring, and mitigating liquidity risks. Basel Committee on Banking Supervision (2010) the 2007-2009 monetary crisis revealed the problems faced by financial institutions as a result of poor liquidity management and focused on the importance of liquidity for the efficient financial sector's operations, specifically the banking industry. Numerous studies have explored bank liquidity in various nations during diverse periods (Delechat, Henao Arbelaez, Muthoora, & Vtyurina, 2012; El-Chaarani, 2019; Mashamba, 2022; Moussa, 2015; Sopan & Dutta, 2018). This research indicated that a thorough understanding of the factors influencing bank liquidity is required to reduce and manage the banking industry's liquidity problem. They emphasized that profitability, capital, bank size, deposits, interest rate, GDP, and other factors impact liquidity. Despite conducting these studies in the context of other nations, Indian banking companies may not find their conclusions and implications relevant. Studies conducted after the 2007-2009 financial crisis suggest that the circumstances also influenced commercial banks in India.

However, such research is limited. We aim to bridge a void in the existing literature by conducting empirical research on the influence of liquidity on commercial banks in India. The study looks at how capital, deposits, size, interest rate, cash reserve ratio (CRR), statutory liquid ratio (SLR), and gross domestic product (GDP) affect India's liquidity. It does this using a fixed and random effect model. The regression shows that deposits and capital have a substantial favorable impact on all types of banks. In contrast, the interest rate, cash reserve ratio, and statutory liquid ratio have a significant negative impact on all types of bank liquidity. GDP has a substantial impact on public and private influence, whereas it has an insignificant impact on foreign banks. Return on assets has an irrelevant impact on public, private, and foreign banks. Bank size has a substantial influence on private banks and is insignificant on other types of banks. The investigation aims to examine how various factors affect bank liquidity. The study's findings thoroughly explain the link between bank liquidity and specified variables. This research would help bank managers, researchers, and regulators devise appropriate measures to maintain enough bank liquidity without incurring losses.

The study's distinctive contributions are highlighted below:

Few studies have examined the factors affecting bank liquidity in India. Most research has ignored how different types of banks manage liquidity. Liquidity may be impacted in a variety of ways depending on who owns the banks.

In particular, few researchers have looked at the influence of CRR and SLR on the liquidity of different types of banks. This study explores how these variables influence the liquidity of public, private, and foreign banks in India, providing a comprehensive understanding of their impact.

1.1. Research Question

How do changes in the monetary policy (repo rate, CRR, and SLR) affect the liquidity tactics of public, private, and foreign banks in India?

How does bank size affect the liquidity of private banks compared to public and foreign banks in India?

How do deposits and capital impact the liquidity of public, private, and foreign banks, and what approaches do they use to manage liquidity in different situations?

We organize the present study as follows: Section II provides a review of literature on bank liquidity determinants and their impact on the liquidity of banks in different countries. Section III presents the research

methodology, including design, sample, data sources, and empirical model. Section IV demonstrates the findings of regression results. Lastly, Section V offers the conclusion, policy implications, limitations, and future research directions.

2. LITERATURE REVIEW

Numerous studies on bank liquidity determinants have been undertaken in various nations. We can categorize past research into three sections. First, we conducted an empirical study on the factors influencing bank liquidity in various nations worldwide. Mashamba (2022) investigated eleven emerging countries, Umar and Sun (2016) investigated five countries, and Bonner, van Lelyveld, and Zymek (2015) investigated 30 OECD countries. Second, studies examine the bank liquidity characteristics of several banks in the same region. El-Chaarani (2019) investigated the Middle East region; Cucinelli (2013) investigated the Euro area, Delechat et al. (2012) investigated Central America. Third, studies on bank liquidity factors worked in a single country. For example, researchers investigating in India include Singh and Sharma (2018) and Umar and Sun (2016). Pham and Pham (2021) study Vietnam, and Trabelsi (2015) study Bahrain. Table 1 summarizes past bank liquidity studies, their methodology, and whether the investigations focused on a particular country or a group of countries.

Research by Toh and Jia (2023) analyzes whether and how Islamic banks' liquidity creation differs from typical commercial banks, considering a panel dataset of 45 Malaysian banks participating in the dual banking system from 2001 to 2017. The finding indicates that macroeconomic factors have less impact, whereas bank size, capital, risk, and market power are crucial determinants of bank liquidity creation. Al-Matari (2023) analyzes the factors affecting bank profitability in Gulf Corporation Council (GCC) countries. GCC banks provide data from 2000 to 2018 for the ordinary least squares (OLS) regression analysis. The findings demonstrate that asset management and bank size have a significant impact GCC banks' performance. Furthermore, bank liquidity has a moderating effect on capital adequacy and asset quality, as well as the performance of GCC banks. Abdo, Noman, and Hanifa (2023) compare the short- and long-term changes in liquidity holdings made by conventional banks (CBs) and Islamic banks (IBs) and how quickly they are changed. From 2010 to 2018, 445 banks from 17 organizations of Islamic Cooperation countries were sampled, and the partial adjustment model (PAM) was applied. The results indicate that IBs place a larger short-term liquidity cushion, and they have a lower net stable fund ratio (NSFR) in the long run than CBs. According to the study, IBs' speed of adjustment (SOA) for NSFR was higher in the long run and lower in the short term, respectively.

Mashamba (2022) examined 91 banks from 11 different nations as a sample to study the bank liquidity dynamics in emerging markets. Transaction deposits, bank size, loan growth, and business cycle significantly impact the liquidity ratio, according to this study. Conversely, asset quality, profitability, and saving have significant negative impacts. In emerging markets, bank liquidity is unaffected by monetary policy. Loan, Van, and Ha (2021) explored the factors influencing commercial liquidity of banks in Vietnam from 2007 to 2017 using a dynamic panel of 20 banks. Profitability, assets, and inflation are negatively correlated with bank liquidity, whereas financial market liquidity and national saving are positively correlated. Pham and Pham (2021) investigated the different elements of bank liquidity in Vietnam using 30 banks from 2007 to 2018. Capital, bank size, and return on equity (ROE) have an adverse influence on bank liquidity, whereas loss loan provision, ROA, inflation, and GDP have a substantial impact. Al-Homaidi, Tabash, Farhan, and Almaqtari (2019) studied the liquidity factors of banks in India using a different statistical approach. They identified a favorable relationship between liquidity, bank size, capital, deposit ratio, and operational efficiency. On the other hand, asset management, asset quality, and net interest margin had a negative impact on liquidity.

According to Singh and Sharma (2018) deposits, profitability, and cost of profitability positively impact bank liquidity in India, whereas non-performing assets (NPA), size, and net-interest margin (NIM) have a negative impact.

The study's weakness was that it did not consider macroeconomic variables such as statutory liquidity ratios, cash reserve ratios, client behaviors, and the financial crisis.

Sopan and Dutta (2018) examined the macroeconomic and bank-specific variables influencing liquidity risk in India. They found that bank characteristics like profitability, asset quality, funding costs, and bank size were negatively associated with liquidity. Among macroeconomic variables, inflation had a positive effect, while GDP harmed liquidity. The absence of liquidity indicators such as the cash reserve ratio was a notable weakness. Al-Harbi (2017) used ordinary least squares regression to inspect key factors affecting bank liquidity in emerging nations from 1989 to 2008. The study discovered that credit risk, foreign ownership, capital ratio, monetary policy, deposit insurance, and inflation negatively impacted liquidity, while there was a positive relationship between liquidity and concentration, off-balance-sheet activities, and bank size.

Trabelsi (2015) examined the impact of the financial crisis on bank profitability during the recovery period, as well as the impact of liquidity issues on bank profitability in Bahrain. Factors such as GDP, capital, deposits, and financial leverage positively influenced profitability, whereas the financial crisis and bank size had a negative effect. The study suggested that bankers should manage these factors effectively to maintain adequate liquidity. Bonner et al. (2015) investigated whether profitability, bank size, and deposit holdings influence liquidity. Their research, which covered 7,000 institutions from 30 OECD countries over ten years from 1998 to 2007, found a nonlinear relationship between bank size and liquidity. The capital ratio had a negligible impact on liquidity, where as deposits and profits positively impacted bank liquidity.

Table 1. Previous research studies examine different economies.

Author	Period	Country	Methodology	Findings
Al-Matari (2023)	2000 to 2018	GCC countries	Ordinary least squares (OLS)	Asset management and bank size significantly influence bank performance in the GCC. Bank liquidity also has a moderating influence on the performance of GCC banks, capital adequacy, and asset quality.
Toh and Jia (2023)	2001 to 2017	Malaysia	Regression	In the dual banking system, macroeconomic variables have less of an impact on the creation of bank liquidity than bank size, risk, capital, and market power.
Mashamba (2022)	2011 to 2016	11 countries	Generalized method of moments (GMM) estimates	Bank size, loan growth, transaction deposits, and business cycle have significant positive influences on liquidity ratio, while profitability, asset quality, and saving have negative significant impacts. Bank liquidity in emerging countries is unaffected by monetary policy.
Pham and Pham (2021)	2007–2017	Vietnam	Fixed effect estimates	The result suggests that a monetary policy tightening may lead banks to create less liquidity. Open market operations may have little effect, the required reserve ratio proves to be an ineffective tool, and a rise in base rate is linked to a reduction in bank liquidity creation.
Singh and Sharma (2018)	2000 to 2014	India	Fixed effect estimates	Deposits, profitability, and cost of profitability impact positively, whereas NPA, size, and NIM negatively impact liquidity in India. This study did not take into account external factors such as CRR, SLR, GDP, and so on.
Sopan and Dutta (2018)	2005 to 2016	India	Regression	Bank size, asset quality, profitability, and funding costs negatively relate to liquidity risk. In contrast to macroeconomic factors, inflation has a positive influence, and GDP harms liquidity.
Umar and Sun (2016)	2002 to 2014	Brazil, Russia, India, China, and	Multiple linear regression	The results showed that when banks operate poorly, economies do not perform well. They also suggest that the smooth and effective running of an economy depends on bank liquidity.

Author	Period	Country	Methodology	Findings
		South Africa (BRICS) countries		
El-Chaarani (2019)	2014 to 2016	Middle East Region	Weighted least square regression	Omani banks have low levels of liquidity compared to those of Lebanese banks. In 2016, the bank experienced a reduction in its liquidity. Liquidity and capital, economic growth, asset quality, and bank size are significantly correlated.
Moussa (2015)	2000-2010	Tunisia	Dynamic panel	Capital, financial performance, operating cost to total assets, GDP, and inflation, substantially influence bank liquidity. In contrast, size, deposits, loans over total assets, and financial cost over total credits have an irrelevant association with liquidity.

2.1. Conceptual Framework and Hypothesis Formulation

This section provides the study hypotheses examined to see the significant association between independent and dependent variables.

2.1.1. Dependent Variables

2.1.1.1. Bank Liquidity

The present study treats bank liquidity as a predictor variable. We measure it as a ratio of liquid assets to total assets. Some studies also measure liquidity as the ratio of liquid assets to total assets (Delechat et al., 2012; Mashamba, 2022; Singh & Sharma, 2018). This ratio shows the bank's capability to quickly convert its assets into cash. The bank recognizes these assets as liquid, readily convertible into cash to meet financial requirements. All banks must hold sufficient liquid assets to meet their short-term financial needs.

2.1.2. Independent Variables

2.1.2.1. Deposits and Liquidity

Deposits are considered deposits over total assets. According to Arif and Anees (2012) the mainstay of the banking industry is deposits. However, in other circumstances, like the 2007-2009 financial crisis, clients increase their withdrawals, which may result in liquidity calamity in banks and force them to borrow money at a higher rate.

H_1: Deposits have a positive impact on the bank liquidity.

2.1.2.2. Capital and Liquidity

Adequate capital to meet the bank's needs is the goal of an idle capital adequacy ratio. Capital serves as a safety net to protect from unanticipated losses. According to Ghosh (2016) a high capital ratio improves a bank's capacity to generate liquidity.

H_2: Capital has a positive impact on the bank liquidity.

2.1.2.3. Size and Liquidity

We measure bank size using the log of total assets. Banks with large assets can obtain external funding relatively quickly. In contrast, banks with smaller assets need sufficient liquidity, as such banks do not have simple access to alternative sources of financing. Delechat et al. (2012) established that smaller banks preserve more liquidity due to less access to capital markets.

H_3: Bank size bears a negative impact on the bank liquidity.

2.1.2.4. Profitability and Liquidity

The return on assets serves as a gauge of profitability. It illustrates the profitable and efficient use of assets. Profitable banks can raise capital more quickly, which encourages them to hold less liquidity (Delechat et al., 2012). Research suggests that profitability negatively impacts bank liquidity (Aspachs, Nier, & Tiesset, 2005; Delechat et al., 2012).

H_4: Profitability has a negative impact on the bank's liquidity.

2.1.2.5. Interest Rate and Liquidity

According to Vodová (2013), the interest rate negatively influences bank liquidity. Some other studies also indicate a negative link between bank liquidity and monetary policy (Bhati & De Zoysa, 2012). The repo rate is considered an interest rate. Repo rate is the interest rate at which reserve bank of India provides funds to commercial banks against the approved securities under the liquidity adjustment facility (LAF).

H_5: Interest rate bears a negative impact on the bank liquidity.

2.1.2.6. Cash Reserve Ratio and Liquidity

The cash reserve ratio may have a negative impact on bank liquidity because banks must maintain some percentage of net demand time liability (NDTL) with the reserve bank without receiving any interest.

H_6: CRR has a negative impact on the bank liquidity.

2.1.2.7. Statutory Liquidity Ratio and Liquidity

Since banks are required to retain a portion of NDTL in the form of liquid cash, gold, and other approved securities, the statutory liquidity ratio may have a negative impact on liquidity.

H_7: SLR has a negative impact on the bank liquidity.

2.1.2.8. Gross Domestic Product and Liquidity

GDP growth is an indicator of the nation's economic activity. According to Moussa (2015) bank liquidity and GDP are positively correlated. Bank liquidity rises in response to increased economic activity. Other research indicates that bank liquidity and GDP are negatively associated (Aspachs et al., 2005; Chen, Phuong, & Lin, 2014).

H_8: GDP has a positive impact on the bank liquidity.

Figure 1 summarizes the expected sign impact of bank-specific and macroeconomic variables on the bank liquidity based on the available literature review.

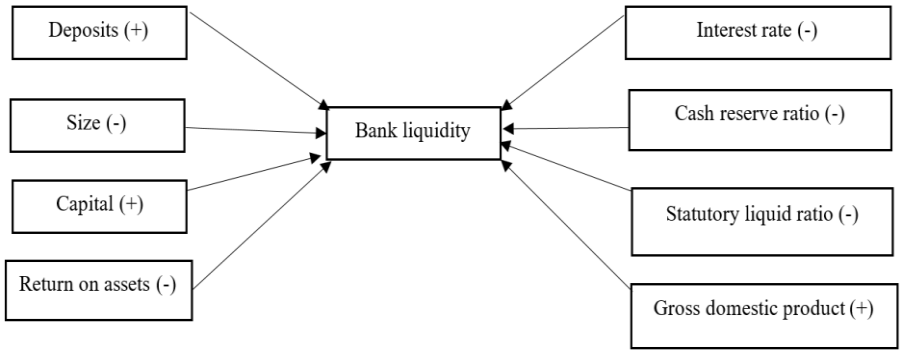

Figure 1. Hypothesis developed.

3. RESEARCH METHODOLOGY

3.1. Study Period

In the present study, we gathered the sample bank-wise over a period of thirteen years, from 2008 to 2021. We

have gathered all the bank-specific and macroeconomic data for the thirteen years from 2008 to 2021.

3.2. Sample Size

The study has selected 49 commercial banks, comprising 12 public, 19 private, and 18 foreign banks. During the study timeframe, the selection criteria were based on branches, year of establishment, and data availability. Every selected bank must have a minimum of three branches in India. Banks incorporated before 2008 possessed complete data sets without any missing values for the variables under investigation in this study.

3.3. Data

This section presents the details of the selected data that were used to analyze the specified hypothesis. The present study includes 49 commercial banks during the timeframe of 13 years from 2008 to 2021. All the selected variables considered in the regression model were extracted from the reserve bank database and centre for Monitoring Indian Economy (CMIE) economic outlook. The variables such as deposits, capital, size, ROA, NIM, NPA, CRR, SLR, and interest rate were obtained from the Reserve Bank of India (RBI) database. The other variable, GDP, was collected from the CMIE economic outlook. The bank consists of 12 public banks, 19 private banks, and 18 foreign. The banks were selected depending on data availability during the study timeframe.

Table 2. Description of variables.

Variable	Measurement	Notation	Expected sign
Liquidity	Liquid asset to total assets	LIQ	……..
Independent variables			
Bank size	Log of total assets	BS	Negative
Profitability	Return on asset	PR	Negative
Capital	Capital adequacy ratio	CAP	Positive
Deposits	Deposits to total assets	DEP	Positive
Interest rate	Repo rate	INT	Negative
Gross domestic product	GDP growth rate	GDP	Positive
Reserve ratio	Cash reserve ratio	CRR	Negative
Reserve ratio	Statutory liquidity ratio	SLR	Negative

3.4. Empirical Model

This study examines public, private, and foreign banks operating in India from 2008 to 2021 using balanced panel data. This study implements a panel data fixed effect model and a random effect model. The regression model for the investigation has been presented in the equation as follows:

$$LIQ_{it} = \alpha + \beta_1 INT_{it} + \beta_2 CRR_{it} + \beta_3 SLR_{it} + \beta_4 GDP_{it} + \beta_5 CAP_{it} + \beta_6 ROA_{it} + \beta_7 LAS_{it} + \beta_8 DP_{it} + \varepsilon_{it} \quad (1)$$

Where LIQ is a proxy of liquid assets to total assets, INT shows interest rate, CRR is cash reserve ratio, SLR is statutory liquid ratio, GDP is gross domestic product, CAP is capital adequacy, ROA is return on assets, LAS is log of total assets and DP is deposits, it indicates a constant term. i is the bank entity, t denotes the years, t = 1. β denotes the coefficient of variables, and ε represents the error term. Table 2 provides descriptions for each variable specified in the regression equation. In the above specification, bank liquidity is a dependent variable. The independent variables are considered the interest rate, cash reserve ratio, statutory liquid ratio, GDP, capital adequacy, return on assets, bank size, and deposits.

3.4.1. Fixed Effect Model

The fixed effect model allows each cross-sectional unit to have its own intercept value, allowing for heterogeneity or uniqueness across all the units. This infers that a cross-sectional unit's intercept may vary but remains constant over time. It is time-invariant and permits a correlation between the regressors and the cross-sectional effect. This model is often referred to as the "Least Squares Dummy Variable." The fixed effect model framework can be presented as

follows: $y_{it} = \alpha + \beta' X_{it} + u_{it}$ where i is the bank entity (cross-section), i = 1, 2,.., N, and T is the period of the bank entity, t = 1, 2, 3,..., T. u_{it} is represented the error term. It can be broken down into two components: v_{it} and μ_{it}.

3.4.2. Random Effect Model

The individual effects (u_i) in the random effects model are presumed to be independently distributed (IID) and also independent of (v_{it}). Furthermore, x_{it} is independent of v_{it} and u_i for every t and i (Baltagi, 2005). The random effect model can be presented as $y_{it} = \alpha + \beta' X_{it} + u_{it}$, where $u_{it} = \mu_i + v_{it}$. The random effects do not employ a dummy variable to describe individual effects, rather, it considers individual effects to be random variables. The fixed effects model treats individual effects (u_i) as fixed parameters to be estimated, whereas, random effects model assumes (u_i) are random and allowed to vary, following an independent and identically distributed (IID) pattern.

3.4.3. Hausman Test

We use the Hausman specification test to determine whether to use the fixed effects estimator or the random effects estimator (Hausman, 1978; Hausman & Taylor, 1981). The null hypothesis assumes that the random effects estimator fits the regression model, and a high Hausman test statistic supports fixed effects estimators over random effects estimators.

3.5. Descriptive Data

Table 3 reports the summary statistics of all dependent and independent variable. This table shows the observations, mean, standard deviation, maximum, and minimum. By following Vodová (2013) and Moussa (2015), the present study measured the bank liquidity as liquid assets to total assets. The liquidity ratio significantly varies among public banks from 0.10 to 1.37. Public banks hold an average of 23 percent liquidity buffer over the study timeframe. Profitability considered by ROA came out to be 21 percent. The other explanatory variables show that SLR has a higher mean, i.e., 21.9; after that, CAR, INT, BS, GDP, CRR, DEP, and ROA at 12.4, 6.52, 5.50, 5.43, 4.55, .882, and .211 respectively.

Over the study period, private banks held a liquidity buffer of an average of 21 percent. Profitability considered by ROA came out to be 86 percent. A high standard deviation has been reported by capital adequacy, showing that selected bank capital adequacy ratios vary. The explanatory variables show that SLR has a higher mean, i.e., 21.9; after that, CAR, INT, GDP, BS, CRR, DEP, and ROA at 15.1, 6.52, 5.43, 4.78, 4.55, 0.86, and 0.82 respectively.

Foreign banks hold a liquidity buffer of an average of 4.13 percent over the study timeframe. The ROA's profitability was found to be 1.28 percent. A high standard deviation has been reported by capital, showing that selected bank capital varies. The explanatory variables show that the capital adequacy ratio has a 23.43 higher mean, i.e., after that, SLR, INT, GDP, CRR, BS, ROA, and DP at 21.9, 6.52, 5.43, 4.55, 4.13, 1.28, 0.53, respectively.

Table 3. Summary statistics.

Variable	Observation	Mean	Standard deviation	Minimum	Maximum
Macroeconomic factors					
CRR	156	4.550	1.098	3.25	7.325
SLR	156	21.91	2.237	18	24.5
INT	156	6.526	1.140	4.2	7.94
GDP	156	5.438	3.849	-6.6	8.5
Public banks					
CAR	156	12.45	1.458	9.04	17.06
BS	156	5.509	0.396	4.62	6.66
ROA	156	0.211	0.892	-3.01	1.67
LIQ	156	0.233	0.125	0.100	1.373
DP	156	0.882	0.252	.308	3.273
Private banks					
CAR	247	15.17	4.236	7.51	56.41
BS	247	4.788	0.639	3.232	6.242

Variable	Observation	Mean	Standard deviation	Minimum	Maximum
ROA	247	0.863	1.087	-5.39	2.02
LIQ	247	0.217	0.069	0.125	0.993
DP	247	0.828	0.250	0.013	2.833
Foreign banks					
CAR	234	23.43	11.91	11.05	87.25
ROA	234	1.289	1.554	-9.62	4.92
BS	234	4.136	0.745	1.626	5.361
LIQ	234	0.255	0.096	0.0453	0.662
DP	234	0.530	0.344	0.007	3.438

Source: Reserve bank of India.

3.6. Correlation Matrix

Tables 4, 5, and 6 present a pairwise correlation matrix that shows the degree of relationship between the predicted variables. None of the independent variables had a high correlation, as shown in the tables. Kennedy (2003) suggests that the multicollinearity issue arises if the correlation between the explanatory variables is more significant than 0.80 or 0.90. In the present dataset, none of the independent variables is above 0.80. The variation inflation factor (VIF) has also been used to examine the issue of multicollinearity. The highest VIF value is 3.86, suggesting no multicollinearity problem in the present dataset.

Table 4. Public banks correlation matrix.

Variables	INT	CRR	SLR	GDP	CAR	ROA	BS	DP
INT	1.000							
CRR	0.221	1.000						
SLR	0.488	0.792	1.000					
GDP	0.458	0.202	0.478	1.000				
CAR	-0.38	0.241	0.046	-0.470	1.000			
ROA	0.190	0.555	0.668	0.040	0.436	1.000		
BS	-0.10	-0.409	-0.387	-0.145	0.017	-0.083	1.000	
DP	0.123	0.204	0.1233	-0.060	0.106	0.0862	-0.097	1.000
VIF	1.40	1.22	3.86	2.13	1.91	2.92	1.37	1.19

Table 5. Private banks correlation matrix.

Variables	INT	CRR	SLR	GDP	CAR	ROA	BS	DP
INT	1.000							
CRR	0.221	1.000						
SLR	0.488	0.792	1.000					
GDP	0.458	0.202	0.478	1.000				
CAR	-0.191	0.096	0.012	-0.157	1.000			
ROA	0.151	0.127	0.248	0.078	0.303	1.000		
BS	-0.105	-0.336	-0.348	-0.115	-0.024	0.053	1.000	
DP	0.084	0.1261	0.144	0.205	0.004	-0.052	-0.400	1.000
VIF	1.86	3.02	1.09	1.19	1.21	1.51	1.46	1.08

Table 6. Foreign banks correlation matrix.

Variables	INT	CRR	SLR	GDP	CAR	ROA	BS	DP
INT	1.000							
CRR	0.221	1.000						
SLR	0.488	0.792	1.000					
GDP	0.458	0.202	0.478	1.000				
CAR	0.063	0.007	0.136	0.069	1.000			
ROA	0.123	0.247	0.230	-0.053	-0.190	1.000		
BS	-0.049	-0.26	-0.281	-0.108	-0.600	0.234	1.000	
DP	-0.102	0.046	-0.081	0.004	-0.131	0.060	-0.102	1.000
VIF	1.03	2.66	1.21	2.74	1.22	1.10	1.40	1.10

3.7. Diagnostic Tests

This study ran a few diagnostic tests to determine the suitability of all three models. The Breusch Pagan Test has been used to assess the presence of heteroscedasticity. According to the findings in Table 7, heteroscedasticity is present in all three models of bank liquidity. To get over the heteroscedasticity problem, robust standard error results have been presented. The Wooldridge test results show that the data do not exhibit first-order autocorrelation (Wooldridge, 2010). Multicollinearity has been investigated using the variation inflation factor (VIF). The mean VIF for the predicted variables is less than 8, suggesting that there is no issue of multicollinearity. Finally, Hausman test was performed to determine the appropriate model between the random and fixed effect models. For public and private banks, the Hausman test recommends a fixed effect model to investigate bank liquidity, while foreign banks utilize the random effect model.

Table 7. Diagnostic test and model selection.

Public banks		
Breusch-Pagan test	χ^2 (8) = 1073.62	P> χ^2= 0.00
Wooldridge test	F(1,11) = 1.488	P> F = 0.2480
Mean VIF	2.00	
Hausman test	χ^2 = 31.10	P>χ^2 = 0.0001
Model	Fixed effect model	
Private banks		
Breusch-Pagan test	χ^2 (8) = 690.61	P> χ^2= 0.00
Wooldridge test	F(1,18) = 0.435	P> F = 0.5177
Mean VIF	1.55	
Hausman test	χ^2 = 40.58	P>χ^2 = 0.00
Model	Fixed effect model	
Foreign banks		
Breusch-Pagan test	χ^2 (8) = 400.00	P> χ^2= 0.00
Wooldridge test	F(1,17) = 1.082	P> F = 0.3127
Mean VIF	1.56	
Hausman test	χ^2 = 3.06	P>χ^2 = 0.9306
Model	Random effect model	

4. REGRESSION ANALYSIS

The regression analysis investigates the influence of bank-specific and monetary policy variables on the liquidity models of public, private, and foreign banks. Following the Hausman test, the outcomes are obtained from fixed-effect and random-effect models. Table 8 presents robust standard error results to address the heteroscedastic issue. The results demonstrate that the fitness model has a significant F value at a 5 percent level. During the study period the r square values of public, private, and foreign banks were 77.19, 68.46, and 15.68, respectively indicating the model's explanatory powers. The findings suggest that some independent variables considerably impact bank liquidity.

The regression result suggests that interest rates, CRR, and SLR, have a significant negative relationship with the liquidity of public, private, and foreign banks. Capital adequacy and deposits have a positive association with public, private, and foreign banks, whereas ROA has a positive, insignificant impact. GDP has a substantial positive impact on public and private bank liquidity but an insignificant impact on foreign bank's liquidity. Bank size (BS) has a negative relationship with public, private, and foreign banks but significant impact on private banks.

Table 8. Regression results.

Variables	Public bank				Private bank				Foreign banks			
	Coefficient	Robust std. error	T	P value	Coefficient	Robust std. error	t	P value	Coefficient.	Robust std. error	Z	P value
Repo	-0.013	0.004	-3.09	0.010	-0.019	0.005	-3.69	0.002	-0.003	0.001	-2.62	0.009
CRR	-0.021	0.005	-4.00	0.002	-0.053	0.019	-2.75	0.013	-0.009	0.004	-2.10	0.036
SLR	-0.017	0.004	-3.88	0.003	-0.001	0.000	-2.33	0.032	-0.017	0.004	-3.45	0.001
GDP	0 .001	0.000	2.68	0.021	0.002	0.001	2.36	0.030	0.000	0.001	0.12	0.905
CAR	0.003	0.001	2.24	0.047	0.010	0.003	2.66	0.016	0.001	0.000	2.07	0.038
ROA	0.011	0.006	1.76	0.107	0.006	0.004	1.51	0.148	0.006	0.006	1.04	0.298
BS	-0.034	0.030	-1.12	0.287	-0.265	0.108	-2.45	0.025	-0.003	0.008	-0.41	0.678
DP	0 .217	0.063	3.44	0.006	0.135	0.059	2.27	0.036	0.000	0.000	3.02	0.003
_cons	0.722	0.224	3.21	0.008	1.838	0.685	2.68	0.015	0.766	0.110	6.97	0.000
Model fit	F- value = 7.68				F statistic = 8.71				Wald χ^2 = 915.32			
R square (Within)	0.771				0.684				0.1568			

Note: Significance at 5 percent.

4.1. Discussion

The repo rate, often known as the repurchase rate, is the primary monetary policy instrument. As seen in Table 8, the interest rate has a significant adverse effect on public, private, and foreign bank liquidity at a level of 5%. The interest rate coefficient sign indicates a negative association between bank liquidity and interest rates. The bank's borrowing costs frequently increase due to an increase in interest rates. Banks might pay higher interest rates, lowering their profitability and limiting their ability to attract fresh funding. Higher interest rates discourage borrowing and decrease consumer and company demand for credit. Al-Homaidi et al. (2019) revealed a similar finding, indicating that interest rates had an adverse substantial impact on the liquid ratio. Some studies by Vodová (2013), Bhati and De Zoysa (2012) and Chen et al. (2014) also demonstrate a substantial negative influence on liquidity.

CRR has a significant negative impact on public, private, and foreign bank's liquidity. Banks are required to keep some percentage of NDTL with reserve banks, which reduces the amount of money available for lending and investing activities. It reduces the fund's accessibility, which limits a bank's capability to produce interest income and impacts its overall liquidity situation. Bhati, De Zoysa, and Jitaree (2019) studies the factors influencing bank liquidity in India. The results revealed an adverse impact between cash reserve ratio and liquidity. At 5 percent, the statutory liquid ratio has a significant negative impact on all types of bank liquidity. The coefficient sign reveals an inverse relationship between liquidity and statutory liquid ratio. Banks must keep some percentage of NDTL with themselves in liquid assets. Therefore, banks have limited funds to provide loans and investment. Bhati et al. (2019) demonstrate an adverse influence between statutory liquid ratio and liquidity in the Indian context.

GDP has a substantial positive influence on both public and private banks but it has an insignificant impact on foreign banks' liquidity at 5 percent. The GDP coefficient sign reveals a positive link between GDP and liquidity. Increased economic activity may result in higher bank deposits as individuals and businesses save and invest more money. Economic activity may increase loan demand as individuals and companies seek financing for consumption and investments. As a result, banks may see an increase in lending activity and deposits, which could improve their liquidity position. The results are consistent with Loan et al. (2021) and Moussa (2015) who demonstrate a positive association between GDP and bank liquidity. The findings are contradictory to Aspachs et al. (2005), Vodova (2011) and Chen et al. (2014) which indicate an inverse link between GDP and bank liquidity. Foreign banks often conduct business in numerous countries and jurisdictions. The rules and conditions of the particular markets where a foreign bank operates impact its liquidity. Therefore, the impact of GDP growth in one nation may not necessarily disturb the foreign bank's liquidity working in another country with diverse economic conditions.

Capital adequacy significantly and positively impacts public, private, and foreign banks' liquidity. Capital serves as a financial buffer to deal with unexpected losses. The result is similar to other empirical studies Vodova (2011), and Vodová (2013). Higher capital adequacy provides banks with increased liquidity and safety. However, financial fragility theory implies that maintaining a high capital ratio reduces the liquidity of banks (Diamond & Rajan, 2001). The regression result shows that bank size negatively influences private banks and has an insignificant negative impact on public and foreign banks. Larger banks often work more complexly and engage in a wider range of activities than smaller banks. Due to the complexity of these operations, larger banks may find it more challenging to maintain high levels of liquidity throughout their business. Previous studies such as Bonner et al. (2015) and Moussa (2015) reveal the negative link between bank size and liquidity. During liquidity problems, public banks usually have access to a safety net, which include potential financing or guarantee options. This government support can mitigate the liquidity issues associated with bank size, thereby reducing the impact of size on liquidity levels. Foreign banks usually operate in several nations and regions to diversify their operations. The relationship between size and liquidity may become less significant due to this diversification, which can help stabilize their overall liquidity situation.

Bank profitability has an insignificant and positive impact on the public, private, and foreign bank's liquidity. Profitability has a favorable influence on bank liquidity, as revealed in the regression analysis. Bank profitability may be improved by investment in risky projects. Vodová (2013) shows a positive link between profitability and bank

liquidity, whereas some studies demonstrate a negative relationship between bank liquidity and profitability (Aspachs et al., 2005; Delechat et al., 2012). deposits have a substantially positive impact on liquidity of public, private, and foreign banks at 5 percent. Deposits are a crucial source of funds that banks use to generate their profit. However, banks must maintain enough liquidity to fulfill their customer's demands. Arif and Anees (2012) and Bonner et al. (2015) disclose a positive relationship between deposits and liquidity.

5. CONCLUSION

The present study examined the influence of deposits, capital, bank size, profitability, statutory liquid ratio, interest rate, cash reserve ratio, and GDP on bank liquidity. Bank liquidity is essential for the banking industry's smooth operation. When a bank has a liquidity problem for an extended period, it can impact other institutions and the economy. Therefore, exploring these factors' effect on banks' liquidity is significant. The result analysis shows that DEP and CA have a positive impact, while INT, CRR, and SLR negatively influence public, private, and foreign banks. ROA has an insignificant influence on all types of banks. GDP has positive, significant influence on public and private banks but an insignificant impact on foreign banks. Bank size significantly impacts private banks only while having an insignificant influence on other types of banks.

5.1. Policy Implications

The study's findings have implications for policymakers, bankers, and researchers. The study's implications and significant findings are listed below.

The interest rate has a significant negative impact on bank liquidity and profitability for public, private, and foreign banks. Decreased repo rates increase the bank's ability to borrow more funds. The repo rate is one of the effective tools of monetary policy to control bank liquidity, loan supply, and credit expansion in the country.

The cash reserve ratio is an imperative tool of monetary policy in India. The cash reserve ratio has a significant negative impact on liquidity of public, private, and foreign banks as they have to keep some percentage of NDTL with the reserve bank. The central banks use CRR instruments to control the bank liquidity and volume of credit in the country.

The statutory liquid ratio significantly negatively influences all types of bank liquidity. Banks must maintain a higher percentage of their liabilities in liquid assets when the SLR is raised. It could reduce the funds available for investment and lending, restricting the bank's liquidity position. Banks used their large portion of funds to meet SLR requirements, which would harm bank liquidity. Policymakers must carefully assess the effect of the SLR on bank liquidity and profitability while framing monetary policy actions. They should periodically evaluate the aptness of SLR levels because of market dynamics, financial stability, and economic conditions. Adjustments to the SLR can be considered to find a balance between maintaining sufficient liquidity buffers and encouraging lending and investment activity.

The association between bank liquidity and GDP positively influences the public and private banks but has an insignificant impact on foreign banks. The effect of economic growth in one nation might not disturb the foreign bank's liquidity operating in another country with different economic situations. The result is similar to Loan et al. (2021) and Moussa (2015) which indicate a positive link between liquidity and GDP. An upsurge in economic activity may lead to an increase in the bank liquidity.

Profitability exhibited a positive, insignificant impact on bank liquidity. Investing in risky assets could enhance bank profitability. However, such investments have a high risk of loss, which may endanger bank operations.

The analysis showed a positive relationship between capital and liquidity. The finding is consistent with Ghosh (2016) which reveals that a higher capital ratio improves a bank's capability to create liquidity.

Regression analysis shows that the relationship between bank liquidity and size is significantly negative for private banks, while it is insignificant for public and foreign banks. The negative relationship shows that small banks

must maintain a higher level of liquidity as small banks do not have alternate funding sources compared to large banks. Public banks usually have access to the government's safety net, which includes potential financial aid or guarantees during liquidity crises. This government aid could potentially alleviate the liquidity issue associated with bank size, reducing the influence of size on the liquidity level. By spreading out geographically, foreign banks may reduce the liquidity risks associated with a single market or jurisdiction.

Deposits are significant funds for banks to produce profit and income. Sometimes, customers withdraw their money abruptly, and banks borrow funds from other sources at a high interest rate. Banks must keep sufficient liquidity to avoid such situations. As a result, all types of banks must retain more liquidity or seek an inexpensive source of capital during a liquidity crisis.

5.2. Limitations of the Study

The present study has examined the Indian banking sector, in which only public, private, and foreign banks have been considered. Other types of banks, like regional rural banks, small finance banks, payments banks, and nonbanking financial companies, have been kept out of the scope of the present work.

5.3. Future Research Suggestions

The present study has focused on one determinant of bank liquidity (liquid assets to total assets). Other indicators of bank liquidity, such as loans to total assets, can be considered in future studies. A cross-country study can be executed to compare the Indian situation with other developing economies by taking India as one of the sample countries. Previous studies show both positive and negative relationships between capital and bank liquidity. Future research may address this discrepancy in outcomes.

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