

Roy, Sudipa; Misra, Arun Kumar; Padhan, Purna Chandra; Rahman, Molla Ramizur

Article

Interrelationship among Liquidity, Regulatory Capital and Profitability- A Study on Indian Banks

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*Corresponding author: Purna Chandra Padhan, Vinod Gupta School of Management, Economics, XLRI Jamshedpur, India.
E-mail: pcpadhan@xlri.ac.in

Reviewing editor:
Vassilios Papavassiliou, University College Dublin, Ireland

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FINANCIAL ECONOMICS | RESEARCH ARTICLE

Interrelationship among Liquidity, Regulatory Capital and Profitability- A Study on Indian Banks

Sudipa Roy¹, Arun Kr Misra¹, Purna Chandra Padhan^{*2} and Molla Ramizur Rahman¹

Abstract: Liquidity is the ability of a bank to fund assets and meet obligations, as they become due, at reasonable costs. Technological and financial innovations have impacted the management of liquidity in banks. Declining ability to rely on core deposits, increased reliance on capital markets and recent turmoil in financial markets have created new challenges for banks in managing liquidity. The current study has discussed theories, indicators, factors influencing bank liquidity, and its implications on bank's capital and profitability. It has empirically analyzed the determinants of liquidity through Arellano-Bond estimates and studied the interrelationship of liquidity, regulatory capital, and profitability through 2-SLS system equations. It has found that bank size, profitability, leverage, net interest margin, CRAR, gross non-performing loans, and Central Bank Policy Rate are the significant determinants of banks' liquidity. The interactive effects among liquidity, profitability, and regulatory capital convey that banks can be more liquid with less profit, but less risky with more liquidity.

Subjects: Economics; Econometrics; Finance; Banking; Credit & Credit Institutions

Keywords: Bank liquidity; regulatory capital; bank profitability; 2SLS; panel data

ABOUT THE AUTHOR

Sudipa Roy is a research scholar in VGSoM, IIT Kharagpur. She has 15 years of consulting experience in Banking and Financial Markets domain. Her research interest lies in financial analysis and application of emerging technologies in banking and financial domain.

Arun Kr Misra is an Associate Professor of Finance at VGSoM, IIT, Kharagpur. Prior academic experience was a banker in a leading public sector bank, working in the domain of Risk Management, Asset-Liability Management and Basel-II implementation. Currently pursuing research broadly in areas of banking, capital markets, and corporate finance.

Purna Chandra Padhan is Associate Professor, Economics at XLRI, Jamshedpur. His primary research area is monetary policy transmission mechanism, liquidity adjustment facility, applied finance, and time series econometrics.

Molla Ramizur Rahman is a Research Scholar in Finance at VGSoM, IIT, Kharagpur. His research interest includes financial stability, banking, corporate finance, and capital markets.

PUBLIC INTEREST STATEMENT

As creators of money, depositories of public savings, allocators of credit and conduits of the payment system, banks have unique position in the economy of any country. Banks are systemic financial institutions, and faith upon banking system decides the ability of an economy in mobilizing surplus funds for economic development. As liquidity providers, banks should be liquid in nature. Liquidity of banks depends upon the productive use of depositors' money and prudent risk management practices on the part of banks. Hence, an empirical study on factors influencing banks' liquidity and the relationship of liquidity, profitability, and capital of banks would shed light on management liquidity risk in banks.

1. Introduction

Banks are liquidity providers of financial system. As systemic financial institutions, banks supposed to be liquid and hence management of liquidity is one of the primary objectives of banks. As evident from the recent financial crisis, many banks struggled to maintain adequate liquidity and unprecedented levels of liquidity support were required from central banks to sustain the financial system. Basel III has proposed a new regulatory framework that includes liquidity requirements. In addition to that, the Basel III has tightened the rules for regulatory capital as it also contains a move from Value-at-Risk to Expected Shortfall (Kinatader, 2016). There is a large volume of theoretical literature dealing with bank liquidity creation, liquidity risk and impact of liquidity on regulatory capital and profitability (Bryant, 1980; Diamond & Dybvig, 1983; Diamond & Rajan, 2001; Holmstrom & Tirole, 1998; Kashyap, Rajan, & Stein, 2002; Kashyap et al., 2002). Most researchers focus on measuring the amount of liquidity created by the banking system (Deep & Schaefer, 2004 and Berger and Bouwman, 2008) and some also shed light on the determinants of bank liquidity creation (Aspachs, Nier, & Tiesset, 2005; Moore, 2010; Vodova, 2011). Banking regulation, as per Basel capital standards, impacted liquidity creation. According to the modern theory of financial intermediation, liquidity creation and maturity transformation are the important functions of banks. "Liquidity creation" refers to the fact that banks provide loans against illiquid mortgage collaterals while giving depositors the ability to withdraw funds *at par* value at a moment's notice. Maturity transformation that is conversion of short-term deposits into long-term loans makes banks inherently vulnerable to liquidity risk and at the same time, liquidity creation makes banks more vulnerable to default risk.

Although the reason why banks hold capital is motivated by their risk transformation role, recent theories suggest that bank capital may also affect banks' ability to create liquidity (Diamond & Rajan, 2001). Recent studies have provided conflicting results on the impact of liquidity on bank performance (Berger & Bouwman, 2009; Bordeleau & Graham, 2010; Bourke, 1989; Kosmidou, Tanna, & Pasiouras, 2005; Lartey et al., 2013). Banks hold short-term assets to manage their liquidity requirements. If a bank is more reliant on short-term funding, it needs to hold more liquid assets to manage its liquidity, which in turn affects its return on assets (ROA) and net interest margin (NIM).

Indian Banking System has undergone major structural transformation after the implementation of financial sector reforms in 1991. Reforms were initiated to impart efficiency and dynamism to the financial system. With a view to improving the health of the banking sector, internationally accepted Basel prudential norms relating to income recognition, asset classification, provisioning and capital adequacy were introduced in April 1992 in a phased manner. Asset-Liability Management, Liquidity Management, and Basel III norms have been implemented for aligning the Indian Banks with international best practices.

As evident from the recent financial crisis, many banks struggled to maintain themselves as solvent and many required unprecedented levels of support from central banks to sustain themselves in the financial system. Declining ability to generate revenue from traditional banking activities, rely more on investment banking activities, increased reliance on securitization market, and recent turmoil in financial markets, pose new challenges for banks to remain as systemic financial institutions. After a long spell of economic slump due to Lehmann crisis, the market began to take an upsurge during mid-2011. However, two years later, during early 2013, Indian banking system suffered from NPA crisis. There were a large number of corporate defaults during the period of 2013–16. Several banking frauds came to notice and huge amount of loans were declared as NPA. Thus, question has been raised on the stability of banking system in India.

This study has initiated extensive review of literature with primary focus on the theories, indicators, factor influencing liquidity of banks, and its implications on bank's profitability and capital. The sample space of the study is the Indian banking system, which has undertaken banking sector reforms as per Basel recommendations. The finding on liquidity determinants and

the interactive effect of liquidity, profitability, and capital standards would help managers to understand and manage bank balance sheet more effectively.

1.1. Literature review

Liquidity is an elusive concept. Bank for International Settlements (BIS) defines liquidity as the ability of a bank to fund assets and meet obligations as they become due, without incurring unacceptable losses (BCBS, 2008). Liquidity is a financial institution's capacity to readily meet its cash and collateral obligations at a reasonable cost (Brunnermeier & Pedersen, 2009).

Bryant (1980) and Diamond and Dybvig (1983) mentioned that banks create liquidity by investing in illiquid loans and financing them with liquid liabilities like demandable deposits. Banks also provide borrowers liquidity support on off-balance sheet activities through loan commitments and similar claims to liquid funds (Boot, Greenbaum, & Thakor, 1993; Holmstrom & Tirole, 1998; Kashyap et al., 2002; Thakor, 2005). However, this structure is the source of a potential fragility of banks, in case of an unexpected high number of depositors deciding to withdraw their funds.

As per "Originate-to-hold" model, banks fund relationship loans with core deposits and keep the loans in their balance sheets through maturity. According to the theory of financial intermediation, banks develop proprietary information of their borrowers both during the loan origination process and subsequent monitoring. Bhattacharya and Thakor (1993) conclude that informational frictions— asymmetric and proprietary information—provide the most fundamental explanation for the existence of financial intermediaries. As part of their core operations, banks develop considerable expertise in screening and monitoring of their borrowers to minimize the costs of adverse selection and moral hazard (Diamond, 1984; Ramakrishnan & Thakor, 1984; Winton, 1995).

The "Originate-to-distribute" (OTD) model of lending, banks do not hold the assets they originate until maturity, but distribute them through the process of securitization of financial products. The OTD model of lending gives banks the flexibility to change the volume of mortgages they make quickly without having to make large adjustments to their equity capital or asset portfolio. Banks' increasing use of the originate-to-distribute model could lead to some weakening of lending standards. In case of OTH model banks add value through the process of screening & monitoring of borrowers (Pennacchi, 1988; Gorton & Pennacchi, 1995; Petersen & Rajan, 1994; Parlour & Plantin, 2008; Ramakrishnan & Thakor, 1984; Diamond, 1984; and Holmström and Tirole, 1993). Banks increasing use of OTD model leads to a transfer of important portions of credit risk out of the banking system (Bord et al., 2012) and reduce the liquidity burden on the banks, but it contributes to the growth of unregulated "shadow banking" institutions which is harmful for the stability of the financial system (Pozsar et al., 2010).

Aspachs et al. (2005) studied bank and macroeconomic-specific determinants of liquidity of UK-resident banks and found that Lender of Last Resort (LOLR), interest margin, loan growth, Tobin's Q, bank size, GDP growth and short-term interest rate are the prime determinants of liquidity. In case of commercial banks of Czech Republic, Vodova (2011) found capital adequacy, inflation rate, inter-bank interest rate were positive and non-performing loans, bank profitability, GDP growth, interest rate, interest rate margin, monetary policy interest rate/repo rate and unemployment rate were negative impact on bank liquidity. Bonner et al. (2015) posits the banks' liquidity buffers are determined by a combination of bank-specific (business model, profitability, deposit holdings, size), and country-specific (disclosure requirements, concentration of the banking sector) factors.

According to Berger and Bouwman (2009), liquidity is created if a bank holds illiquid items and grants liquid items to the economy. Rauch, Steffen, Hackethal, & Tyrell (2011) study the liquidity created by Germany's state-owned savings banks and identify potential influential factors. They measure absolute and relative liquidity creation following Berger and Bouwman (2009) and Deep and Schaefer (2004) methods respectively. To investigate the possible bank specific and macro-economic factors, the authors use two sets of independent variables (1) macroeconomic variables

(unemployment rate, savings quota, interest rate and yield curve spread) and (2) bank specific factors (Operating Profit, Return on Equity, Average loan size, Provision, Income and Interest income, and Bank size). They found that banks with a higher ratio of interest to provision income create more liquidity. Other bank specific variables, such as size and performance are not statistically significant.

Theories on the relationship between bank capital and liquidity creation postulate two opposing hypotheses to link between banks capital to liquidity creation. The financial fragility hypothesis predicts that increased capital impedes liquidity creation as it makes the capital structure less fragile (Diamond & Rajan, 2000, 2001). Through the process of monitoring of loans, banks obtain private information about their borrowers. This informational advantage creates an agency problem, whereby banks extract rents from its depositors by demanding a greater share of the loan income. Banks hold capital to reduce the probability of financial distress and higher capital tends to decrease liquidity creation. Optimal bank capital structure trades-off effects on liquidity creation, costs of bank distress, and forces borrower to repay. As per Gorton and Winton (2000), a higher capital ratio can reduce liquidity creation through the effect of “crowding-out of deposits.” Thus, the higher is the bank’s capital ratio, the lower is its liquidity creation.

The “risk absorption hypothesis,” based on bank’s role as risk transformers, predicts that capital enhances the ability of banks to absorb risk and hence ability to create liquidity. Liquidity creation increases the bank’s exposure to risk because banks that create more liquidity face greater losses when they are forced to sell illiquid assets to satisfy the liquidity demands of customers (Allen & Gale, 2004; Allen & Santomero, 1998). Beyond a threshold level, capital allows banks to absorb greater risk (Bhattacharya & Thakor, 1993; Coval & Thakor, 2005; Repullo, 2004; Von Thadden, 2004), so higher capital ratios may allow banks to create more liquidity. On the other hand, “illiquidity risk hypothesis” contends that greater liquidity creation increases the risk of illiquidity for banks because illiquid assets occupy a larger share of their total balance sheets (Jokipii and Milne, 2011; Lindquist, 2004).

1.2. Literature gaps & objectives of the study

Literatures have discussed multiple proxies and indicators to assess liquidity and have identified bank and macroeconomics specific factors, which are probable determinants of liquidity. The impact these factors on liquidity are inconclusive. Studies have reported conflicting results on the impact liquidity on regulatory capital and profitability. Banks hold capital to manage their risks but recent theories suggest that bank capital also affect banks’ ability to create liquidity. In the Indian context, Meena and Dhar (2016) compare liquidity ratios of top three Indian Banks and mentioned that big size banks are relatively illiquid.)

The interrelationships among liquidity, regulatory capital, and profitability have not been examined as per Basel norms. Assessment, determinants, and impact of liquidity on Indian banks have not been rigorously studied. The article put forward following objectives to examine in the Indian context:

- (a) Assess liquidity of banks using various proxies and empirically establish various macroeconomic and banks’ specific factors, which influence it.
- (b) Assess the interrelationship among liquidity, regulatory capital, and profitability as per Basel norms.

2. Empirical design

2.1. Liquidity proxies and indicators

Various authors have provided different liquidity ratios, as indicators of liquidity (Kashyap et al., 2002; Aspachs et al., 2005; Vodova, 2011; Deléchat et al., 2012; Bonner, van Lelyveld, & Zymek, 2015; Vodova, 2013). Some of the most commonly used liquidity ratios are outlined in Table 1

Table 1. Liquidity ratios

Liquidity Ratio	Information about the liquidity
$(LR1) = \frac{\text{Liquid Assets}}{\text{Total Assets}}$	The general liquidity shock absorption capacity of a bank.
$(LR2) = \frac{\text{Liquid Assets}}{\text{Total Deposits}}$	It captures the bank's vulnerability related to these funding sources
$(LR3) = \frac{\text{Loans}}{\text{Total Assets}}$	It measures the share of loans in total assets
$(LR4) = \frac{\text{Loans}}{\text{Total Deposits}}$	It relates illiquid assets with liquid liabilities
$LTgap = \frac{\text{Total Deposits} - \text{Liquid Assets}}{\text{Total Assets}}$	It calculates to which degree a bank turns liabilities into assets with greater maturity than the liabilities.

(Table 1: Measures of Liquidity through Ratios/Proxies/Indicators, mentioned in various literatures)

2.2. Liquidity determinants

Aspach et al. (2005), Distinguin, Roulet, and Tarazi (2013) and Vodova (2011) analysed bank and macroeconomic specific factors, which impact liquidity creation. As per the discussed literature, following hypotheses have been designed to test the relationship between liquidity proxy and its determinants. Table 2 discussed about various control variables and their impact on liquidity

The above-discussed hypotheses are tested with the following equation, estimated through Arellano-Bond dynamic panel method. The ratio of Liquid Assets to Total Deposits is used as liquidity proxy in the above equation.

$$\begin{aligned} \text{Liquidity} = & \alpha_{j0} + \alpha_{j1} LA_{t-1} + \alpha_{j2} \text{Loan GR} + \alpha_{j3} \text{Size} + \alpha_{j4} \text{Leverage} + \\ & \alpha_{j5} \text{GNPA Ratio} + \alpha_{j6} \text{GDP Growth} + \alpha_{j7} \text{GSec Yield} + \alpha_{j8} \text{NIM} + \\ & \alpha_{j9} \text{CRAR} + \alpha_{j10} \text{Call Rate} + \alpha_{j11} \text{Repo Rate} + \alpha_{j12} t_{2008-10} + \\ & \alpha_{j13} t_{2011-14} + \alpha_{j14} t_{2015-16} + \varepsilon_i \end{aligned} \quad (1)$$

2.3. Interactive effect of liquidity, regulatory capital, and profitability

As discussed in the literature review section, there exists interdependency among regulatory capital, liquidity, and profitability (Berger & Bouwman, 2009; Distinguin et al., 2013). Endogeneity issue makes the conventional OLS estimator biased and inconsistent. The article has captured the interrelationship of regulatory capital, liquidity, and profitability through instrumental variables regression method.

2.4. Two-stage least squares estimator

The two-stage least squares (2SLS) estimator is a special type of IV estimator. It involves two successive applications of the OLS estimator, given by the following two-stage procedure. In stage one, we get predicted values of Y_1 and Y_2 ($Y_1\text{hat}$ & $Y_2\text{hat}$) from the reduced form equations. Thereafter, final equations are estimated (stage two) by replacing Y_2 and Y_1 with $Y_2\text{hat}$ and $Y_1\text{hat}$, respectively. Z_1 and Z_2 represent matrices of instrument(s) for respective equations.

System equation set:

$$Y_1 = a_0 + a_1 Y_2 + a_2 X_1 + a_3 Z_1 + u_1$$

$$Y_2 = b_0 + b_1 Y_1 + b_2 X_1 + b_3 Z_2 + u_2$$

Stage 1: Reduced form equations:

$$Y_1 = c_0 + c_1 X_1 + c_2 Z_1 + c_3 Z_2 + e_1$$

$$Y_2 = d_0 + d_1 X_1 + d_2 Z_1 + d_3 Z_2 + e_2$$

Table 2. Liquidity determinants

Variable Description	Control Variables	Impact on Liquidity	Explanation
NIM	Net Interest Margin	Negative	Funds mobilized by banks are deployed to maximize the earnings. Hence, NIM is the measure of opportunity cost of holding liquid assets.
RoA	Return on Assets	Negative	Liquid assets generally earn less interest and hence less profitable. Hence, profitability and liquidity are negatively related.
Loan GR	Loan Growth	Negative	During growth in lending, banks contract more long-term illiquid assets therefore, growth in lending negatively influences liquidity.
Size	Log of Total Assets	Indifferent	If banks contract more long-term loan, then bank size will have negative effect on liquidity. If banks invest more in bonds, equity and contract short-term assets like working capital loan, then bank size and liquidity will have positive relation.
Leverage	Networth to Risk Weighted Assets	Negative	With leverage, banks may create more illiquid assets and hence, liquidity problems may arise for banks.
CRAR	Capital Adequacy Ratio	Negative	If a bank is adequately capitalized, then its capacity to create loans will be more and hence liquidity may decline.
NPL	Non-performing Loans	Negative	When loans become bad, re-payment from such loan suffered and this lead to drying off liquidity.
GDP Growth	Gross Domestic Product Growth	Negative	With the growth in the economy, demand for loans will be more and hence, banks create more illiquid and long-term loan, which may pose liquidity problem for banks soon.
Repo Rate	Central Bank Policy Rate	Indifferent	With declining of policy rate availability of liquidity may increase but demand of loan also increases because of declining lending rate in the economy. Similarly, just opposite happens when policy rates are revised upward.

(Continued)

Variable Description	Control Variables	Impact on Liquidity	Explanation
Call Rate	Inter-Bank Rate	Indifferent	Inter-bank market provides collateral-free liquidity to banking sector in India. With the increase in inter-bank rate, though more funds will be available in the inter-bank market but costs of liquidity significantly rise.
GSec Rate	Government Bond Rate	Positive	Government Bond Rate (GSec Rate) acts opportunity cost of banks for long-term lending. Upward movement of GSec Rate lead to increase in lending rate and hence demand for loans may decline which may reduce liquidity risk. Similarly, just opposite would happen with the downward movement of WtGSec Rate.
$T_{2008-10}$, $T_{2011-14}$ & $T_{2015-16}$	Time Dummy	Indifferent	Study period spread over 2005 to 2017, covering the phases of financial turmoil of 2008–10, high credit-offtake during 2011–14 and domestic banking crisis of 2015–16.

(Table 2: Variables description and hypothesis for Control Variables for Liquidity Determinants)

Stage 2: Final Equations:

$$Y_1 = p_0 + p_1 Y_2 \text{hat} + p_2 X_1 + p_3 Z_1 + v_1$$

$$Y_2 = q_0 + q_1 Y_1 \text{hat} + q_2 X_1 + q_3 Z_2 + v_2$$

2SLS estimates are consistent, and reduction in bias is so large that 2SLS are typically downward biased, while in OLS, it is generally substantially upward biased.

The article estimates three equations, pertaining to regulatory capital, liquidity and profitability, using 2SLS simultaneous equations modeling approach. Regulatory capital, liquidity and profitability are inter-linked and may suffer from endogeneity problems, making OLS estimator biased and inconsistent. With the two interdependent variables, each equation has a set of explanatory variables that captures the material characteristics of a bank. Thus, the 2SLS model has three equations, one equation for each endogenous variable. The model includes control variables, common to all the three equations and set of instruments, specific to each equation. We have added a set of exogenous variables (instruments), specific to each system equation as required for structural system model. As per literature review, a set of bank-specific indicators and macro-economic variables have been identified which can interplay among liquidity, profitability and capital adequacy.

The study has taken into account the sub-prime financial crisis periods of 2008–2010, high credit off-take periods of 2011–2014 and the banking crisis of 2015–2016. During these periods, liquidity was affected and systemic effects were felt in the economy. The study has introduced three

dummies to capture the structural breaks in the empirical analysis so as to account for those turbulent periods.

2.4.1. Impact of liquidity & profitability on regulatory capital

Liquidity and RoA, along with a set of exogenous variables, influence CRAR (Regulatory Capital to RWA). Profitability of a bank depends upon the Net Interest Margin (NIM) and, liquidity on the other hand, depends upon Repo Rate. We have selected NIM and Repo Rate as instruments for Regulatory Capital, where RoA and Liquidity are instrumented variables. CRAR requirement would be more if a bank disburses higher margin-based loans and least liquid loans. Hence, liquidity and NIM are expected to have negative relation with CRAR. Table 3 discussed various control variables and their impact on CRAR.

CRAR equation

$$\begin{aligned} \text{CRAR} = & \beta_{10} + \beta_{11} \text{Loan Grh} + \beta_{12} \text{Size} + \beta_{13} \text{GNPL} + \beta_{14} \text{RRepo Rate} + \\ & \beta_{15} \text{GDP Grh} + \beta_{16} \text{RoA} + \beta_{17} \text{Call Rate} + \beta_{18} \text{Ln Reg Capital} + \beta_{19} \frac{\text{LA}}{\text{TD}} + \\ & \beta_{110} t_{2008-10} + \beta_{111} t_{2011-14} + \beta_{112} t_{2015-16} + k_i \end{aligned} \quad (2)$$

System equations

$$\text{ROA} = \beta_0 + \beta_1 \text{NIM} + \sum \beta_{2i} X_i + \mu_i$$

$$\frac{\text{LA}}{\text{TD}} = \theta_0 + \theta_1 \text{Repo Rate} + \sum \theta_{2i} X_i + \gamma_i$$

2.5. Impact of regulatory capital & profitability on liquidity

Regulatory capital and profitability along with a set of exogenous variables influence liquidity. CRAR of a bank depends upon Risk Leverage (Networth to RWA) and profitability (RoA). The study has considered NIM and Risk Leverage as instruments for liquidity where RoA and CRAR are instrumented variables. Liquidity requirement may be more if a bank disburses higher interest margin-based loans. If CRAR requirements are more, it would negatively affect liquidity. Similarly, if more capitalized banks create riskier and long-term loans, it would negatively affect liquidity. Hence, profitability and CRAR are expected to have negative relation with liquidity. Table 4 discussed various control variables and their impact on liquidity.

Liquidity equation

$$\begin{aligned} \text{Liquidity} = & \gamma_{10} + \gamma_{11} \text{Loan Gr} + \gamma_{12} \text{Size} + \gamma_{13} \text{GNPA Ratio} + \gamma_{14} \text{Repo Rate} + \\ & \gamma_{15} \text{GDP Gr} + \gamma_{16} \text{RoA} + \gamma_{17} \text{CRAR} + \gamma_{18} \text{Call Rate} + \gamma_{19} \text{Ln Reg Capital} + \\ & \gamma_{110} t_{2008-10} + \gamma_{111} t_{2011-14} + \gamma_{112} t_{2015-16} + \mu_i \end{aligned} \quad (3)$$

System equation

$$\text{ROA} = \beta_0 + \beta_1 \text{NIM} + \sum \beta_{2i} X_i + \mu_i$$

$$\text{CRAR} = \gamma_0 + \gamma_1 \text{Risk Leverage} + \sum \gamma_{2i} X_i + k_i$$

Table 3. Interactive effect on CRAR

Variable Description	Control Variables	Impact on CRAR	Explanation
RoA	Return on Assets	Negative	RoA is expected to contribute negatively to CRAR as more profitable loans are more risky.
Loan Gr	Loan Growth	Positive	More loans disbursement may generate more profit and hence capital base would improve.
Size	Ln of Total Assets	Positive	Bank Size (Log of Total Assets) is expected to have positive relation with CRAR as big size bank can contribute more to networth through diversification of assets.
LA/TA	Liquidity	Negative	Liquidity is expected to have negative relation with CRAR as demands for liquidity would reduce profitable investment and hence it affects networth and capital adequacy.
GNPL	Gross Non-performing Loans	Negative	Gross NPA is expected to have negative relation with CRAR as requirements of Capital Adequacy need to be done for lost assets also.
GDP Gr	Gross Domestic Product Growth	Positive	GDP Growth is expected to have positive relation with CRAR. Upward movements of business cycle create more lending opportunities and hence more loans disbursement.
RRepo Rate	Reverse Repo Rate	Indifferent	Reverse Repo Rate, if increases would reduce the lending activities through rising of general interest rate in the economy. Hence, repo rate is expected to have negative relation with CRAR.
Call Rate	Inter-Bank Rate	Negative	Interbank market provides immediate liquidity to banks. Increase in interbank rate would enhance liquidity cost and hence it is expected that interbank rate would have negative relation with CRAR.
LnRegCapital	Log of Regulatory Capital	Positive	More regulatory capital would enhance CRAR

(Table 3: Variables description and hypothesis for Control Variables for Interactive effects on CRAR)

2.6. Impact of regulatory capital & liquidity on profitability

Regulatory Capital and Liquidity along with a set of exogenous variables influence Profitability. Regulatory Capital to RWA (CRAR) of a bank depends upon Risk Leverage (Networth to RWA) and

Table 4. Interactive effect on liquidity

Variables Description	Control Variables	Impact on Liquidity	Explanation
RoA	Return on Assets	Negative	RoA is expected to contribute negatively to liquidity, as more profitable loans, in general, are longer maturity.
Loan Gr	Loan Growth	Negative	Loan Growth is expected to have negative relation with liquidity. With more disbursement of loans less liquid funds will be available.
Size	Bank Size	Positive	Bank Size (Log of Total Assets) is expected to have positive relation with liquidity as big size banks generally have more capacity to mobilize resources.
CRAR	CRAR	Negative	With reduction of CRAR requirement, more funds will be available for banks and CRAR is expected to have negative relation with liquidity.
GNPL	Non-performing Loans	Negative	Gross NPA is expected to have negative relation with liquidity as lost assets reduce the repayments and create liquidity problems.
GDP Gr	Gross Domestic Product	Negative	Upward movement of business cycle creates more lending opportunities and hence more loans disbursement would reduce liquid funds.
Repo Rate	Repo Rate	Negative	Repo Rate if increases would reduce the availability of funds in the economy and hence, repo rate is expected to have negative relation with liquidity.
Call Rate	Inter-Bank Rate	Negative	Interbank market provides immediate liquidity to banks and hence any increase in interbank rate would increase the liquidity cost. It is expected that interbank rate would have negative relation with liquidity.
LnRegCapital	Log of Regulatory Capital	Positive	More regulatory capital would enhance Liquidity

(Table 4: Variables description and hypothesis for Control Variables for Interactive effects on Liquidity)

liquidity, on the other hand, depends upon Repo Rate. The article has considered Risk Leverage (Networth to RWA) and Repo Rate as instruments for Liquidity equation. Liquidity and CRAR are instrumented variables. Liquidity, through rising interbank rate, would negatively influence profitability. Similarly, Capital through risk leveraging may positively contribute to profitability. Table 5 discussed various control variables and their impact on profitability.

Profitability equation

$$\begin{aligned} RoA = & \theta_{10} + \theta_{11} Loan\ Gr + \theta_{12} Size + \theta_{13} CRAR + \theta_{14} GNPA\ Ratio + \theta_{15} RRepo\ Rate + \\ & \theta_{16} \frac{LA}{TD} + \theta_{17} GDP\ Gr + \theta_{18} Call\ Rate + \theta_{19} Ln\ Reg\ Capital + \theta_{10} t_{2008-10} + \\ & \theta_{11} t_{2011-14} + \theta_{12} t_{2015-16} + \theta_i \end{aligned} \quad (4)$$

3. System equations

$$CRAR = \gamma_0 + \gamma_1 Risk\ Leverage + \sum \gamma_{2i} X_i + k_i$$

$$LA/TD = \theta_0 + \theta_1 Repo\ Rate + \sum \theta_{2i} X_i + \gamma_i$$

3.1. Data and period of study

The liquidity determinants and the interrelationship among liquidity, regulatory capital, and profitability are studied using a panel of 32 major banks which include government-owned banks, domestic private sector and foreign banks. Study period spread over 2005 to 2017, covering the phases of financial turmoil of 2008–10, high credit-offtake during 2011–14 and domestic banking crisis of 2015–16.

4. Results and discussions

4.1. Liquidity proxies and indicators

As per literatures, we have estimated liquidity proxies for eight major banks of India as shown in Figure 1. These eight banks constitute about 75% of banking sector assets in India.

Figure 2 highlights various liquidity proxies for major banks in India. There are no specific guidelines from Basel Committee on benchmark ratios of Liquid Asset to Total Deposits, Liquid Asset to Total Assets, Loan to Total Deposits and Loan to Total Assets; however, these ratios should not be less than 60%.

In the Indian context, these ratios have been hovering around 50% to 85% since 2005. Looking at the data for 2016–17, major Indian banks are well over the threshold level.

Figure 3 described LCR of major banks of India for the year 2016–17. As per Basel III guidelines, the Liquidity Coverage Ratio (LCR) should be above 100%. Looking at the data for 2016–17, HDFC Bank, Axis Bank, and Canara Bank are below the 100% requirement.

4.2. Liquidity determinants

The ratio of Liquid Assets to Total Deposits is used to measure the liquidity in banks. Arellano-Bond dynamic panel estimate is deployed to analyze liquidity determinants. Table 6 provides the estimated results for determinants of liquidity. RoA, Bank Size, Leverage (Networth to Total Assets), NIM, CRAR Loan Growth, GNPA, GDP and Repo Rate are the significant determinants which influence banks' liquidity. The lag-dependent variable is found to be significant indicating

Table 5. Interactive effect on profitability

Variables Description	Control Variables	Impact on Profitability	Explanation
LA/TD	Liquidity	Negative	Liquidity is expected to have negative relation with profitability as demands for liquidity would reduce profitable investment.
Loan Gr	Loan Growth	Positive	Loan growth is expected to have positive relation with profitability. With rising disbursement of loans leads to more generation of profit.
Size	Ln Total Assets	Positive	Bank Size is expected to have positive relation with profitability as big size bank can have diversified assets to improve their profit.
CRAR	CRAR	Negative	With reduction of CRAR requirement, more funds will be available for banks and CRAR is expected to have negative relation with profitability.
GNPL	Gross Non-performing Loans	Negative	Gross NPA is expected to have negative relation with profit, as lost assets required provisioning.
GDP Gr	Gross Domestic Product Growth	Positive	GDP Growth is expected to have positive relation with profitability. Upward movement of business cycle can create more lending opportunities and hence more profit.
RRepo Rate	Reverse Repo Rate	Negative	Reverse Repo Rate if increases would reduce the lending activities through rising of general interest rate in the economy and hence it is expected to have negative relation with profitability.
Call Rate	Inter-Bank Rate	Negative	Interbank market provides immediate liquidity to banks, and hence any increase in interbank rate would increase the liquidity cost and hence it would reduce the profitability of banks.
LnRegCapital	Log of Regulatory Capital	Positive	More regulatory capital would enhance profitability

(Table 5: Variables description and hypothesis for Control Variables for Interactive effects on Profitability)

Figure 1. Trends in liquidity.

(Figure 1: Trends in Liquidity Indicators measures through different proxies)

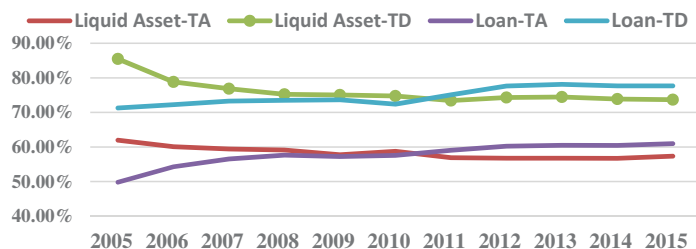


Figure 2. Liquidity proxies: 2016–17.

(Figure 2: Liquidity Indicators for major banks in India for the year 2016–17)

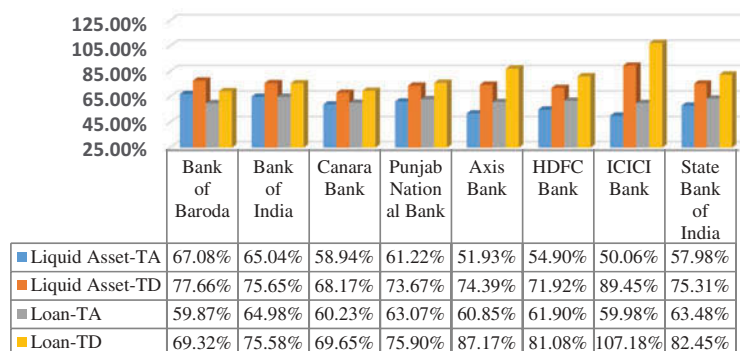
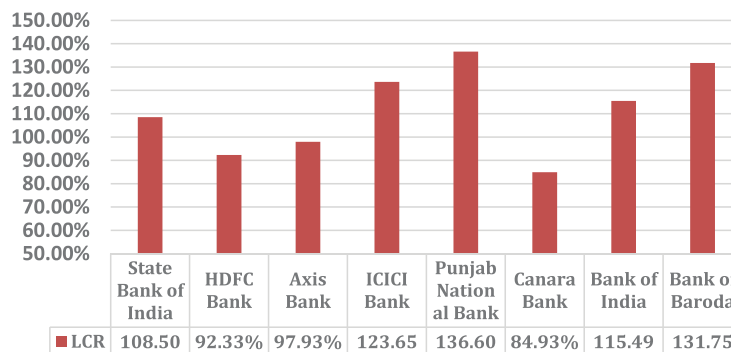


Figure 3. LCR ratio: 2016–17.

(Figure3: Liquidity Coverage Ratio for major banks in India for the Year 2016–17)



thereby any surplus or deficit liquidity in past influence the current state of liquidity. As per analysis, we accept the null hypothesis that profitability, in terms of RoA, is negatively influence liquidity. Banks manage their liquidity by investing on short-term maturity assets, which provide low return and hence, liquidity negatively influences profit of banks.

Maturity leverage provides more interest margin and hence it is hypothesized that NIM would have negative relation with liquidity. We accepted the hypothesis and thereby we can infer that maturity leverage is negatively affecting liquidity. As per our hypothesis bank size and liquidity have no relation which has been rejected in our analysis. Big Banks with their strength of diversified assets and branches can mobilize funds easily and hence size contributes positively to liquidity. We have also found that creation of assets through leveraging of network is contributing positively to liquidity. Our analysis has rejected the hypothesis that CRAR negatively contribute to liquidity and thereby we conclude that more capitalized banks absorb liquidity risk through capital adequacy. Central Bank's repo window provides liquidity support to banks and hence in the analysis we have accepted the hypothesis that increase in central bank policy rate contributes negatively to liquidity. The three period dummies are found to be significant and negative relation

Table 6. Determinants of liquidity Arellano-Bond estimates-dependent variable: liquid asset to total deposits

Parameters	Coefficient	Std. Error	t-ratio	p-value
Liquid to TD (-1)	-0.0916	0.0211	-4.341	1.34e-05
Intercept	0.2797	0.0957	2.923	0.004
Net Interest Margin	-0.0441	0.0058	-7.604	2.26e-014
RoA	-0.0197	0.0112	-1.759	0.077
Loan Growth	0.0029	0.0001	2.959	2.07e-14
Bank Size	0.0285	0.0047	6.064	6.76e-01
Leverage	0.0342	0.0023	14.869	2.09e-053
CRAR	0.0058	0.0023	2.522	0.011
GNPA Ratio	0.0084	0.0027	3.111	0.002
GDP Growth	-0.0072	0.0051	-1.412	0.154
Interbank Rate	0.0021	0.0047	0.447	0.657
Repo Rate	-0.0621	0.0087	-7.138	0.048
Wtg Avg. GSec Rate	-0.0071	0.0045	-1.578	0.118
t ₂₀₀₈₋₁₀	-0.0517	0.0181	-2.857	0.004
t ₂₀₁₁₋₁₄	-0.0878	0.0299	-2.937	0.004
t ₂₀₁₅₋₁₆	-0.1967	0.0427	-4.607	4.05e-06
Sargan over-identification test: Chi-square (301) = 856.098 [0.0000] Wald (joint) test: Chi-square(15) = 1582.54 [0.0000]		AR(1) errors: z = -8.5488[0.0000] AR(2) errors: z = 0.6365 [0.5244]		

(Table 6: Empirical Results for Liquidity Determinants)

with liquidity indicating thereby the phases of financial turmoil of 2008–10, high credit-offtake of 2011–14 and domestic banking crisis of 2015–16, have constraint the banks' liquidity.

The above empirical findings in the Indian context corroborate with the findings of Kosmidou et al. (2005), Bourke (1989), Lartey et al. (2013), Berger and Bouwman (2009), Bonner et al. (2015), Vodova (2011), Rauch et al. (2011), and Diamond and Rajan (2000), Diamond & Rajan (2001)). The estimated Arellano-Bond model is robust as the equation does not have auto-correlation at AR(2) level and Wald Test and Sargan over-identification test are statistically significant.

4.3. Interactive effect of liquidity, regulatory capital, and profitability

4.3.1. Impact of liquidity and profitability on regulatory capital

RoA and liquidity are instrumented and NIM & Repo Rates are instrumental variables for CRAR 2SLS system equation. Table 7 described the estimated 2SLS results for CRAR. In CRAR system equation, Bank Size, RoA, Liquidity Ratio Reverse Repo Rate are significant determinants of CRAR. The 2SLS system equation is robust as all instruments are valid and Hausman's test, for consistency of OLS estimates, is rejected.

Bank Size is negatively related to CRAR indicating thereby bigger banks with their large asset base face are not in a position maintain the required CRAR. CRAR is positively related to RoA, which indicates that profitable banks can improve their CRAR through performing loans. Reverse Repo Rate is negatively related to CRAR which means any upward movement in Central Bank Policy Rate would increase the general lending rate and hence loan creation would be hampered which directly affect the CRAR. Liquidity is positively related with CRAR indicating thereby more liquid banks might have invested significant funds in low risk and low return assets. The significant and positive sign of time dummy for the year 2011–14 indicates that the high credit-offtake during 2011–14 positively contributes to CRAR.

Table 7. Two SLS estimates-dependent variable: CRAR instrumented: liquidity & RoA

Parameters	Coefficient	Std. Error	t-ratio	p-value
Intercept	35.3843	2.1221	16.670	<0.000
Loan Growth	-0.0167	0.0211	-0.795	0.428
Bank Size	-7.9230	0.9058	-8.747	<0.000
Liquid/TD	7.3582	3.7026	1.978	0.049
Gross NPL Ratio	0.1449	0.1272	1.139	0.255
Reverse Repo Rate	-0.3911	0.1026	-3.813	0.000
GDP Growth	-0.1144	0.0793	-1.404	0.161
RoA	1.3477	0.6843	1.969	0.049
Interbank Rate	0.0988	0.0647	1.525	0.128
t ₂₀₀₈₋₁₀	0.2118	0.2859	0.741	0.459
t ₂₀₁₁₋₁₄	0.5518	0.2799	1.972	0.049
t ₂₀₁₅₋₁₆	-0.0839	0.3522	-0.238	0.812
Sargan over-identification test - Null hypothesis: All instruments are valid. LM = 0.0403 P(Chi-Square(1) > 0.0403) = 0.8409			Hausman test - Null hypothesis: OLS estimates are consistent Chi-square (2) = 11.6392 with p-value = 0.002969	
Weak instrument test - Cragg-Donald minimum Eigen value: 0.7053			Adjusted R²: 0.5994 F(12,338):36.7376 (P-Value:4.01e-54)	

(Table 7: Empirical Results for interactive effect of Liquidity & Profitability on CRAR)

The above findings contradict the financial fragility hypothesis, which predicts that increased capital impedes liquidity creation or loan creation as it makes the capital structure less fragile (Diamond & Rajan, 2000, 2001). The empirical findings corroborate with the findings of Lindquist (2004) and Jokippi and Milne (2011) who mentioned that more liquidity creation enhances the risk of illiquidity for banks as illiquid assets occupy a larger share of banks' balance sheets.

4.3.2. Impact of regulatory capital and profitability on liquidity

RoA and CRAR are instrumented in 2SLS system equation of liquidity and NIM and Risk Leverage are considered as instruments. Table 8 described the estimated 2SLS results for liquidity ratio. The 2SLS system equation on liquidity estimate is robust as all instruments are valid and Hausman's test, for OLS consistency of OLS estimates, is rejected.

Bank size is positively related to liquidity indicating thereby big banks have more capacity to mobilize resources to manage their liquidity. Repo rate is positively related to liquidity indicating thereby with the increase in policy rate liquidity management is hampered. RoA is negatively related to liquidity, which indicates more profitable banks are less liquid as profit is being generated with long-term maturity loans which creates constraint for liquidity. CRAR is positively related to liquidity, which indicates more capitalized banks are absorbing liquidity risk with capital. The significant and negative sign of time dummy for the year 2011-14 indicates that the high credit-offtake during 2011-14 might have hampered liquidity of banks.

Profitability and capital standards have inverse relations with banks' liquidity, which corroborate with the findings of Horváth et al. (2014) and Distinguin et al. (2013).

4.3.3. Impact of regulatory capital and liquidity on profitability

In the 2SLS profitability equation, risk leverage, and repo rate are considered as instrument and CRAR & liquidity are instrumented variables. Table 9 described the estimated 2SLS results for

Table 8. Two SLS estimates dependent variable: liquidity to total deposits instrumented: RoA & CRAR

Parameters	Coefficient	Std. Error	t-ratio	p-value
Intercept	-3.7313	0.6125	-6.092	<0.000
Loan Growth	0.0031	0.0003	10.740	<0.000
Bank Size	0.8721	0.1362	6.403	<0.000
Ln Reg.Capital	-0.8241	0.1321	-6.238	<0.000
Gross NPL Ratio	-0.0078	0.0087	-0.899	0.369
Repo Rate	0.0459	0.0159	3.003	0.003
GDP Growth	0.0048	0.0087	0.553	0.581
RoA	-0.0966	0.0463	-2.086	0.038
Interbank Rate	-0.0128	0.0078	-1.629	0.104
CRAR	0.1039	0.0163	6.370	<0.000
t ₂₀₀₈₋₁₀	-0.0289	0.0290	-0.998	0.319
t ₂₀₁₁₋₁₄	-0.0759	0.0365	-2.087	0.037
t ₂₀₁₅₋₁₆	-0.0014	0.0416	-0.034	0.973
Sargan over-identification test - Null hypothesis: All instruments are valid. LM = 25.14121 P(Chi-Square(2) > 25.1421) = 5.318e-006			Hausman test - Null hypothesis: OLS estimates are consistent Chi-square (2) = 46.5034 with p-value = 7.9787e-011	
Weak instrument test - Cragg-Donald minimum Eigen value: 20.538			Adjusted R²:0.3784 F(12,338):20.5438 (P-Value:1.09e-33)	

(Table 8: Empirical Results for interactive effect of CRAR & Profitability on Liquidity)

profitability. The 2SLS system equation rejects the null hypothesis of OLS estimate as consistent. The “Sargan over identification test” is accepted with validity of all instruments.

Bank size is positively related to profitability, which indicates big size banks with their diversified asset base contribute more to profit. Reverse Repo rate is positively related to profitability indicating thereby with the increase in policy rate banks are earning good return by parking their surplus liquidity with Central Bank. Liquidity is negatively related to profitability, which indicates more liquid banks are less profitable as their funds are invested in short-maturity assets. Gross NPL ratio is negatively related to profitability as more NPL hamper profit of banks. CRAR is positively related with RoA, which indicates that more capitalized banks can improve their profits by financing riskier projects. The significant and negative sign of time dummy for the year 2008–10 indicates that the financial crisis period of 2008–10 might have hampered profitability of banks.

The above findings contradict the empirical studies of Bordeleau and Graham (2010), Kosmidou et al. (2005) and Lartey et al. (2013), where it is mentioned that all other factors being equal, if a bank is more reliant on short-term funding, will need to hold more liquid assets in order to maximize profits and profitability is positively related to liquidity and CRAR.

5. Conclusions, policy recommendation, and contribution to literature

The article has carried out extensive literature review on liquidity assessment of banks, bank-specific and macroeconomic determinants of liquidity and the relationship among regulatory capital, liquidity, and profitability. Profitability, loan growth, bank size, CRAR and Gross NPL ratio are the major bank-specific determinants of liquidity which concur the findings of Vodova (2011, 2013) and Distinguin et al. (2013). In line with the findings of Aspachs et al. (2005) and Rauch et al. (2011), the article has found that cost and management of banks’ liquidity is influenced by the Central bank policy rate and interbank lending rate. The empirical evidence of the article has

Table 9. Two SLS estimates dependent variable: return on assets instrumented: liquidity & CRAR

Parameter	Coefficient	Std. Error	t-ratio	p-value
Intercept	-15.749	3.725	-4.228	<0.000
Loan Growth	0.008	0.0046	1.630	0.104
Bank Size	4.002	0.9275	4.315	<0.000
Ln Reg. Capital	-3.839	0.8679	-4.422	<0.000
CRAR	0.469	0.996	4.716	<0.000
Gross NPA Ratio	-0.130	0.0262	-4.969	<0.000
Reverse Repo	0.392	0.1974	1.988	0.049
Liquid Asset/TD	-2.471	1.3790	-1.792	0.074
GDP Growth	-0.001	0.0379	-0.027	0.979
Interbank Rate	0.012	0.0265	0.449	0.653
t ₂₀₀₈₋₁₀	-0.204	0.1185	-1.718	0.087
t ₂₀₁₁₋₁₄	-0.130	0.1330	-0.973	0.331
t ₂₀₁₅₋₁₆	0.163	0.1822	0.895	0.372
Sargan over-identification test - Null hypothesis: all instruments are valid LM = 25.142 with p-value = P(Chi-Square(1) > 25.142) = 5.326e007			Hausman test - Null hypothesis: OLS estimates are consistent. Chi-square(2) = 214.179 with p-value = 3.10126e-047	
Weak instrument test - Cragg-Donald minimum Eigen value: 4.8307			Adjusted R²: 0.3919 F(11,339): 13.793 P-value(F): 7.05e-22	

(Table 9: Empirical Results for interactive effect of CRAR & Liquidity on Profitability)

justified the economics of scale of big size bank as asset size is positively related to CRAR. Bigger banks can have more maneuvering power to earn more revenue to improve their CRAR through diversified lendings. Further, the positive relation between leverage and CRAR calls for efficient use of networth in creating assets which would, in turn, improve the CRAR. The positive relationship between profitability and CRAR prevails upon management to adopt prudent risk practices to control loan risk which otherwise, negatively affect the CRAR. The positive relationship between liquidity and CRAR recommend banks' management to leverage capital in creating more long-term assets, which could provide more profit so as to enhance the Tier-I capital. Though capital to absorb risk, but more capital prevails upon banks to create more illiquid loans which may increase fragility of banking system. The article has found liquidity and CRAR positively related and liquidity and profitability inversely related. From this finding, it can be inferred that banks can be more liquid with less profit, but less risky with more liquidity. Banks should be adequately liquid to protect the interest of depositors, disburse loans, and protect its own solvency.

The article has significantly contributed to the existing literature. We estimate the determinants of liquidity using Arellno-Bond dynamic panel data method for a sample of 35 publicly traded banks in an emerging economy like India. We have found liquidity, regulatory capital along with a set control variable which include central bank policy instruments influence the liquidity dynamic in case of Indian Banking sector. The panel nature of our dataset allows us to examine the impact of the institutional and regulatory environment on systemic liquidity of banks, which are of particular interest to policy makers. The article fills the gap in the literature of banks' liquidity and provides new empirical evidence on the interactive effect of liquidity, profitability, and regulatory capital. We further establish the relationship among these aforesaid variables and capture their interrelationship using the 2SLS system dynamic through instrumental variables regression method. Our model includes control variables, common to all the three estimated measures and a set of instruments, specific to each relation, which is a methodological contribution of this article. Through empirical analysis, the article brings new insights on various determinants of banks'

liquidity in case of an emerging market economics like India. It was hypothesized earlier that big size banks generally create more loans in the economy and hence they are illiquid in nature. However, our study has found that big banks with their strength of diversified assets and branches can mobilize funds easily and hence size contributes positively to liquidity. We have also found that creation of assets through leveraging of network contributes positively to liquidity.

The article contradicts the financial fragility hypothesis (Diamond & Rajan, 2000, 2001) and thereby concludes that increased capital does not impede liquidity creation. Our findings also challenge the empirical studies (Bordeleau & Graham, 2010; Kosmidou et al., 2005; Lartey et al., 2013) and conclude that profitability is negatively related to liquidity and CRAR and adequately capitalized banks can only disburse riskier loans to make more profit.

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Author details

Sudipa Roy
 E-mail: sudipa.roy@gmail.com¹
 Arun Kr Misra¹
 E-mail: arunmisra@vgsom.iitkgp.ac.in
 Purna Chandra Padhan
 E-mail: pcpadhan@xlri.ac.in²
 E-mail: pcpadhan@xlri.ac.in
 Molla Ramizur Rahman¹
 E-mail: ramizurscience@yahoo.com

¹ Vinod Gupta School of Management, Indian Institute of Technology Kharagpur, Kharagpur, West Bengal 721302, India..

² XLRI, Xavier School of Management, Jamshedpur, Jharkhand 831001, India..

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