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Arindam Bandyopadhyay
Mayuri Saxena

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NATIONAL INSTITUTE OF BANK MANAGEMENT
Pune, Maharashtra, 411048
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ABSTRACT

This paper investigates if there exists any inter-linkage between credit risk and liquidity risk and examines key contributing factors to determine both the risks for the scheduled commercial banks in India. We have used a panel data of total 43 public and private commercial banks in India during the period 2010-2019 to assess the linkage between two major risk sources in the light of implementation of Basel 3 norms by Reserve Bank of India in 2015. Our results indicates that before Basel 3 norms during 2010-14, non-performing assets leads to significant reduction in liquid assets, thus reducing liquidity both for 90 days as well 365 days horizon. Hence, credit risk was significantly impacting liquidity risk position of Indian banks. However, neither capital, nor macroeconomic indicators have any significant impact on liquidity risk. In the post Basel 3 era (2015-19), effect of credit risk over liquidity risk (up to one year) has been insignificant. However, we observe that capital and macroeconomic factors have significant influence on liquidity risk. Higher is the capital position of banks, better is their liquidity situations. Our empirical results reveal that Basel 3 norms implementation by RBI has strengthened the liquidity situation of Indian banks

Key words: Credit Risk, Liquidity Risk, Bank Performance

JEL Classification Number: G20, G30, L14

Arindam Bandyopadhyay ***(Corresponding Author)***
National Institute of Bank Management, India
E-mail: arindam@nibmindia.org

Mayuri Saxena
Accenture, INDIA
E-mail: mayurisaxena041294@gmail.com

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A Comparison of the Pre & Post Basel 3 Conditions

1. Introduction

Banks are very useful entity in the financial intermediary process in the economic system. Key role banks play in the economy is the maturity transformation. Banking is accepting deposits and transforming them into long term assets. In return for providing this service they make profit by charging more for a loan than then offer to pay on deposits. Banks assume various risks, i.e. create chances of incurring future losses, in the process of allocating their deposits and other borrowings to loans and investments. Liquidity risk arises due to maturity transformation since banks borrower short and lend long to generate profit. Credit risk is inherent because banks are lending to counterparties to generate assets and therefore exposed to default risk. When market fluctuations are regulated or predictable, these risks and potential losses are small. But, with globalization, innovation and competition, portfolios of Indian banks have become much more complex. In such an environment, only some risks are explicit while most others are hidden. Large losses from these latent risks are bunched during episodes like the global financial crisis. This is why Basel III advanced approaches (BCBS 2010) insists on detailed measurement of all possible risks, their correlations in normal markets and shifts in such correlations during stress situations.

Liquidity risk and credit risk are considered as the two important sources of banking risk. The global financial crisis has shown once again how challenging credit risk management and asset-liability management can be under banking competition. Fewer attempts by banks to reduce long term, liquid assets or short term volatile liabilities culminated in the global financial crisis. The recent NBFCs crisis in India was also triggered by such problems. As banks fund their long-term assets with short-term liabilities, to increase net interest margins, they are exposed to liquidity risk. The possibility of sudden withdrawal of short-term deposits and other borrowings threatened the solvency of even reputed banks.

Credit risk arises due to uncertainty in a borrower's ability or willingness to meet its contractual obligations. Credit risk results in increase in the ratio of gross non-performing assets in banks. Liquidity risk arises when banks are unable to meet its commitments on time due to unexpected cash outflow or unable to sell assets or investment loses its liquidity. All these may result in customer deposit runoff, fall in market value of the securities, increase in funding costs and fall in borrowing capabilities in banks. Hence, liquidity risk is defined as the risk of being unable to meet the obligation of depositors or to fund increases in assets due to shortage of liquid assets in the financial entity. Liquidity Risk Management ensures that there is enough cash or near cash assets to repay maturing liabilities on time. Credit Risk Management ascertains that, despite some defaults and delayed payment, the overall quality of maturing assets is good enough to pay down liabilities as scheduled. A bank might expect the cash inflows from different assets to arrive in full and on time. The problem arises when some of its assets make delayed or partial payments and then bank can run into a funding deficit. Additionally, since banks accept deposits from savers and lend those funds to borrowers, a bank's asset and liability structures are closely connected, especially in terms of borrower's default

and deposit outflows. Thus the question arises, whether liquidity risk and credit risk are closely related in banking business? This paper is an attempt to address this issue empirically.

The existing literature in this contour provides two alternate views on the linkage between credit risk and liquidity risk. Theoretical works of Bryant (1980) and Diamond and Dybvig (1983) suggest that liquidity and credit risk are positively related in banks. This was supported by empirical studies by Cai and Zhang (2017). More specifically, an increase in loan defaults can increase liquidity risk by leading to decrease in cash flows and erosion in valuation of assets. Further, due to delay in repayments or loan defaults, the bank may run into a funding deficit whereby the depositors, Cash Credit/Overdrafts and other off balance sheet commitment cannot be paid on demand. These will ultimately lead to liquidity risk. A well-capitalized bank is deemed creditworthy and is not expected to face sudden whidrawal by depositors and other lenders. Therefore, the bank should fix its liquidity risk exposure (i.e. limits on potential cash outflows) with respect to its available cash capital. A bank with higher level of cash capital can quickly convert stand-by liquidity sources into cash. The other version of studies suggests there is no relationship between liquidity risk and credit risk as such (Imberierowicz and Rauch in 2014 and Ghemini, Chaibi and Mohamed Ali in 2017). Given the inconsistent viewpoints presented in the literature, the inter-relationship between Liquidity risk and credit risk remains an interesting research question to investigate for emerging market economy like India.

Banking sector in India is undergoing a rapid transformation today. It is trying to balance the challenges of managing capital and asset quality with the demands for expanding outreach and access. Increasing non performing assets and decreasing profitability is a major concern for Indian banks. Further, banks need to comply with the Basel 3 norms (BCBS 2008 & 2013) that was implemented by Reserve Bank of India from January 2015. It majorly emphasizes on liquidity coverage ratio (LCR), Net Stable Funding ratio (NSFR) and leverage ratio and thereby giving more reliance over quality capital and stable liquidity positions. With this backdrop, this paper investigate if there exists any inter-linkage between credit risk and liquidity risk and examines their impact on the performance of the scheduled commercial banks in India. This paper is an attempt to empirically find out the key determinants of credit risk and liquidity risk in the balance sheet of commercial banks in India and understand the interaction between these two key risks in banking.

The rest of the paper is organized as follows. Section 2 provides an overview of the literature reviewed relating to relationship between credit risk and liquidity risk that we have studied. It also presents the objectives and discusses the testable hypotheses. Section 3 presents the data source, methodology and variables. Section 4 presents the analysis and discussion of results. Section 5 concludes the paper.

2. Literature Review

Following the financial intermediation theorem, Bryant (1980), Diamond and Dybvig (1983) argue that a bank's asset and liability structures are closely associated in terms of borrower default risks and fund withdrawals. More specifically, borrower defaults can prompt decrease in cash flow and depreciation in loan assets and thereby increase liquidity risk (Dermine, 1986).This relationship has implications for bank stability (Acharya and Viswanathan, 2011). While solvency of banks through strong

capital requirements is necessary for stability of the banking sector, they are not sufficient by themselves in the absence of a strong liquidity base. This was proved beyond doubt in the early stage of the credit crisis in which many banks, despite adequate capital levels, still experienced difficulties because they did not manage their liquidity risk in a prudent manner. Several bank failures during global financial crisis also highlight the importance of investigating the relationship between credit and liquidity risk. During post global financial crisis, revised Basel III regulations has highlighted the importance of liquidity risk as an important pillar 2 risks that the banks need to examine.

Hetrich (2015) finds a negative relationship between the Credit Defaults Swap (CDS) bid-ask spread and market liquidity in the stock market. Their study observes that an increase in illiquidity and therefore liquidity risk is associated with higher bid ask spreads (represents heightened credit risk). Cai and Zhang (2017) in their study of Ukrainian banks for the period from Q1 2009 to Q4 2015 document credit risk as having a positive relationship with liquidity risk. Moreover, this positive relationship is more prominent amongst foreign and large banks. Their empirical findings suggest banks with high level of non-performing loans might not meet depositors' withdrawal demands, which could lower cash flow and trigger depreciations in loan assets, and consequently increase liquidity risk.

There are other version of findings where authors provide negative or no evidence regarding the relationship between liquidity and credit risk (e.g. Imberiowicz and Rauch (2014); Ghenimi, Chaibi and Omri (2017)). In particular, different studies have used different proxies for liquidity and credit risk and have obtained different relationships between two risks, either positive or negative.

Imberierowicz and Rauch (2014) and Ghenimi, Chaibi and Omri (2017) did not find any significant impact of credit risk over liquidity risk in US banks and MENA region respectively. Imberierowicz and Rauch (2014) empirically shed light on the relationship between credit risk and liquidity risk and highlighted the importance of management of joint risk to increase bank stability. However, their study mainly focuses on US commercial banks and examined the impact of credit risk and liquidity risk on bank profitability.

Our paper emphasizes on finding the key determinants of credit risk and liquidity risks in commercial banks and study their inter relationships in the pre Basel 3 and post Basel 3 regime in emerging market economy like India. They key findings of our panel data analysis will contribute to the existing literature on inter connection between the credit risk and liquidity risk at micro level.

3. Data, Variables & Summary Statistics

Banks in database are solely India-based Scheduled Commercial banks. For all bank balance sheet, profit & loss account, and off-balance sheet items, we have used yearly audited data publicly obtainable through RBI database, Prowess IQ, Ace equity and Annual reports of respective banks. All banks (both public and private sector) are analyzed on standalone basis over a period from 2010 to 2019 which covers pre Basel 3 era and post Basel 3 era. Our data set consists of total 41 banks along with their financial and non-financial factors in pre Basel 3 period. Out of 41 banks, 21 are public sector banks and remaining 20 are their private sector counterparts. Some new banks like Bandhan bank and IDFC bank was opened in 2015 so they are included in post Basel era. This gives us total 43 banks during post Basel 3 period. Some merger exercises were conducted in

India with public sector banks. Like merger of Bank of Baroda, Vijaya Bank and Dena bank. These banks were treated as separate entities till 2018. However from 2019 these banks were considered merged with Bank of Baroda. Some additional information has been extracted from Basel3 disclosures of banks like High Quality liquid assets, leverage ratio and Core Tier1 capital. Basel 3 guidelines about liquidity norms were also studied to analyze the impact of new norms like Liquidity Coverage ratio, Net Stable Funding ratio and Leverage ratio over Liquidity risk proxy variables. Maturity pattern of assets and Liabilities of each bank has been obtained from its respective annual report to segregate short term advances (having maturity <1 year), short term deposits (having maturity <1 year) and short term investments (having maturity <1 year).

3.1. Proxy variables for capturing liquidity risk and credit risk in banks

In this study, mainly two proxies are used to reflect liquidity risk and one proxy is used to measure credit risk. Liquidity risk is basically funding liquidity risk which reflects banks' ability to deal with unexpected liquid demand. Table 1 presents the description of the variables used in the analysis.

The first liquidity risk variable (LIQRISK1) is calculated by dividing total liquid assets by total assets of banks where liquid assets mean cash and bank balances with RBI, Balances with other banks at call and short notice and Investments up to period of 90 days (including Held for trading and available for sale portfolio). This first measure usually denotes short term liquidity and has been taken from the standard definition prescribed by Reserve bank of India for defining liquid assets.

The second liquidity risk variable (LIQRISK2) is calculated by dividing total current assets by current liabilities. Current assets of banks are calculated by adding Investments up to 1 year, Advances up to 1 year, cash balances with RBI and Cash and bank balances with other banks. Similarly Current liabilities considers deposits up to 1 year. These variables are in line with empirical work of Willams (2007) in predicting the effect of liquidity risk on net interest margins of Australian Banks.

The credit risk variable is purely a ratio of Net non-performing assets (NNPA) to Total advances. A higher ratio implies higher credit risk due to borrower defaults. By dividing net NPA from total advances, the ratio has been standardized and it has the ability to capture credit risk for a bank for a particular year. Empirical studies by Mpofu and Nikolaidou (2018); Tehulu and Olana (2014) in assessing the determinants of credit risk in the banking system in Sub-Saharan Africa have considered similar variable. Study by Kannan, Narain and Ghosh (2001) have also considered this factor as a proxy to capture credit risk in banks while assessing its impact on net interest margins.

3.2 Descriptive Statistics

As reported in table 2 in between 2010-14, efficiency ratio (EFR) which is measured in terms of cost to income ratio remains on an average 0.487 which can be inferred as good as banks are efficient in saving cost in comparison of generating income. When it comes to own funds, banks are keeping equity only 6.98% of total assets (CAPR) which is quite low in pre Basel 3 era. The Deposits to assets ratio (DAR) and Loans to asset ratio (LAR) on average indicate good mobilization of funds by most of the banks. Liquid assets in proportion to total assets (LIQRISK1) are however on an average 11% only which is a matter of concern in terms of liquidity risk position of Indian Banks. The

average net interest margin (NIM) revolves around 2.5% with a lower standard deviation 0.06%. In 2010-2014 banks are using deposits for giving more credit and less investments which is indicated by credit deposit as well as investment deposit ratio. Current ratio (LIQRISK1) is also less than 1 indicating banks have more current liabilities than current assets.

In the table 3 it is prominently visible that the current ratio (LIQRISK1) as well as liquid asset (LIQRISK2) positions have been improved after the Basel 3 implementation. However, NPA ratio has increased (reflected by credit risk proxy, CREDRISK). Moreover efficiency (EFR) has been decreased by increase in cost to income ratio. Capital ratio (CAPR) has been improved. Funding Volatility risk (FVRISK) has been increased in 2015-19 because of more Volatile liabilities. Size, NIM, deposits assets ratio and Loan assets ratio are almost same.

4. Empirical Methodology

Panel data structure has been fully utilized in the study that combines time series and cross section data. The pooled data models assumes the fact that differences across units can be captured in differences in constant term (termed as fixed effects models) or alternately, individual specific constant terms are randomly distributed across cross sectional units (random effect models). In our study, 41 banks are used in pre Basel era and 43 banks are used in post Basel era (2015-19), adding Bandhan and IDFC bank. Multicollinearity can be an important issue in multivariate regression models. To test multicollinearity, variance inflation factor test (VIF) has been done on both Pre-Basel (2010-2014) and Post Basel (2015-19) panel data. Variables having value greater than 10 has been dropped to avoid multicollinearity problem (results can be produced on request).

We have performed multivariate analysis using a set of panel regression framework. Since we are dealing with a balanced panel data set, the ordinary least square estimates may give us biased estimates where unobserved bank specific effects are correlated with the observed explanatory variables.

A large portion of panel data empirical applications (Greene 2007, Reyna, 2007) involve one of the following assumptions about the individual effects: 1) Random effects model: individual effect is uncorrelated with regressors or 2) Fixed effects model: individual effect is correlated with regression factors.

Equation of panel fixed effect model is expressed as:

$$LIQRISK_{it} = \beta_0 + \beta_1 CREDRISK_{it} + \beta_2 CAPR_{it} + \beta_3 LAR_{it} + \beta_4 BSIZE_{it} + \beta_5 NIM_{it} + \beta_6 IDR_{it} + \beta_7 CDR_{it} + \beta_8 CASHDEPOR_{it} + \beta_9 FVRISK_{it} + \beta_{10} DAR_{it} + \beta_{11} GDPGR_{it} + \beta_{12} NIFTBNK_{it} + \beta_{13} NIFTREAL_{it} + \beta_{14} GSEC_{it} + \beta_{15} EFR_{it} + \alpha_i + e_{it}$$

Equation 1

Where $LIQRISK_{it}$ is the dependent variable (it is represented by either Liquid assets/ Total Assets or Current assets/Current liabilities); β_0 is the intercept; α_i represents all stable characteristics of banks; X_{it} represents the vector of independent variables mentioned above; e_{it} is the error term.

When using fixed effect panel model, we assume that something within the individual may impact or bias the predictor or outcome variables and we need to control for this. This is the rationale behind the assumption of the correlation between entity's

error term and predictor variables. Fixed effect specification removes the effect of those time-invariant characteristics so we can assess the net effect of the predictors on the outcome variable.

It is important to note that Fixed Effect model controls for all time-invariant differences between individuals, so the estimated coefficients of the fixed-effects models cannot be biased because of omitted time-invariant characteristics.

Alternatively, the panel random effect model is specified as:

$$LIQRISK_{it} = \beta_0 + \beta_1 CREDRISK_{it} + \beta_2 CAPR_{it} + \beta_3 LAR_{it} + \beta_4 BSIZE_{it} + \beta_5 NIM_{it} + \beta_6 IDR_{it} + \beta_7 CDR_{it} + \beta_8 CASHDEPOR_{it} + \beta_9 FVRISK_{it} + \beta_{10} DAR_{it} + \beta_{11} GDPGR_{it} + \beta_{12} NIFTBNK_{it} + \beta_{13} NIFTREAL_{it} + \beta_{14} GSEC_{it} + \beta_{15} EFR_{it} + \alpha_i + \mu_{it} + \varepsilon_{it}$$

Equation 2

Where, Liquidity risk (LIQRISK) captured by two indicators LIQRISK1 and LIQRISK2; ε_{it} is within entity error; μ_{it} represents between entity errors. Random effect (RE) specification assumes that there are unique, time constant attributes of individuals that are not correlated with the individual regressors.

To decide between the choices of fixed or random effects, Hausman (1978) specification test has been used where the null hypothesis is preferred model is random effect model vs. the alternative the fixed effects. It basically tests whether the unique errors are correlated with regressors, the null hypothesis is they are not. The Hausman test statistic is asymptotically distributed as Chi-Square with *k* degrees of freedom under the null hypothesis that the random effect estimator is correct. This implies that the random effect model has been correctly specified and α_i is uncorrelated with the regressor X_{it}. In such a case the coefficient estimated by fixed effect estimator and same coefficient that are also estimated by random effect should not statistically differ (i.e. null hypothesis). The significance of the Chi-Square statistic of the Hausman test enables us to make a choice between Fixed Effect and Random Effect Models. If the p value reported in the Hausman Chi-Square test is less than 5%, we reject the null hypothesis and hence fixed effect model is more appropriate than random effect estimator. If the *p* value is higher than the 5%, we select random effect specification.

Breusch-Pagan Lagrange multiplier (LM) test was also performed to choose between random effect model and simple pooled robust regression model. The null Hypothesis is that variances across entities is zero. That is no significant differences across units (i.e. no panel effects). A lower chi-square or higher p-value (>0.05) would fail to reject the null (no panel effect) and conclude that the random effect is not appropriate.

To take a final decision on the specification of panel model structure, we first go by Hausman test and then check LM test to decide the suitability of Fixed Effect or Random Effect or simple regression model. The presence of Heteroscedasticity in the error structure has been removed by using "robust" standard errors in Panel data regressions.

5. Empirical Results and Findings.

This section presents our multivariate models in capturing the relationship between credit risk and liquidity risk during Pre & Post Basel 3 regimes.

5.1. Results for Pre Basel 3 norms period 2010-14

5.1a. When dependent variable is: LIQRISK1 (liquid assets/Total assets)

Results in table 4 indicates that when credit risk (i.e. NPA) increases Liquid assets decreases therefore liquidity risk increases. Here, when more loans are disbursed, liquidity gets eroded from the system thus leading to more liquidity risk. When more investments are done, less liquid assets are kept with the banks leading to more liquidity risk. Here, in investments, since it is pre Basel norms, no stringent norms were there to invest in High quality liquid assets. These investments can be of long term in nature, promising high yield. Effective mobilization of deposit to credit decreases liquidity risk adding to more liquid assets. If credit deposit ratio is low, it means bank may not be earning as much as they could be. Funding Volatility risk implies presence of more volatile liabilities, which leads to fall in liquid assets and leading to more liquidity risk.

5.1b. When dependent variable is LIQRISK2 (current assets/current liabilities)

Results in above table 5 also indicates presence of statistically significant association between credit risk and liquidity risk. When the level of non-performing asset increases, current assets falls leading to more liquidity risk. Similarly when investment deposit ratio falls, current assets increases, thus liquidity risk decreases.

Our empirical results of the period 2010-2014 indicates a significant statistical relationship between NPAs and liquidity. That period was considered as good time in Indian banking scenario where credit growth was high. As more and more credit is disbursed, More NPA occurred leading to reduction in cash flows, Net interest margin and liquidity. Reserves fall because of more provisioning requirements. Thus, increasing NPAs leads to fall in liquid assets as well as current assets and thus creating and increasing funding liquidity risk.

Loans to assets ratio indicates the percentage of loan disbursed out of total assets. If such ratio increases, it means less assets are invested in liquid assets because they yield low returns (SLR) or no returns (CRR). However, Loans are illiquid yet high yield assets. It is obvious that to sustain in competing market when your NPAs are increasing and NIM is falling, to maximize spread, banks will disburse loans which are of long tenure and thus creating liquidity pressure.

Investment deposit ratio states the investments made out of total deposit. Since the NPAs rise, banks are more prone to invest in riskier corporate securities which are less liquid thus decreasing liquidity and increasing liquidity risk. Credit deposit ratio indicates effective mobilization of deposit funds. For this period, mean credit deposit ratio was 0.75, which means out of 1 Rs. of deposit 0.75 was lent as credit, rest 0.25 was still available for Reserves and investment. Moreover high credit deposit ratio indicates effectiveness of returns. Thus, mobilizing funds effectively, reduces asset liability mismatch reducing the liquidity pressure.

When more and more Net interest margin is available, more money is available to keep as cash flows and reserves thus reducing liquidity risk and in this era larger size banks kept more liquid assets in comparison to smaller size banks. Funding volatility risk leads to liquidity drain which is measured by volatile liabilities to total assets. The point to be noted is that neither capital nor macro-economic factors were significant in this era.

5.2. Results for Post Basel 3 norms period 2015-19

5.2a. When dependent variable is LIQRISK1 (liquid assets/Total assets)

As observed from above table 6 macro-economic variables are all significant. NIFTY realty has been dropped because of collinearity. All the macroeconomic variables have negative coefficients, indicating whenever there is economic downturn less investment is done in NIFTY bank, GSec returns falls and GDP falls, therefore more liquid assets are kept thus reducing liquidity risk. The factor NPA is still significant for liquid assets which signifies that credit risk has strong influence on liquidity risk. Similarly, more deposits (DAR) leads to additional liquid assets therefore reducing liquidity risk. More loans (LAR) reduces liquidity. Funding volatility risk (FVRISK) is still has significant influence on liquidity risk position of banks.

5.2b. When dependent variable is LIQRISK2 (Current assets/current liabilities)

Capital is one of the most important feature of Basel Norms which come out as significant factor for liquidity. More the capital more will be liquidity. Macro- economic variables are significant but most important Credit risk is not significant indicating the effectiveness of Basel Norms. Increase in Investment deposit ratio will increase liquidity indicating banks are more investing in liquid assets.

During the post Basel 3 period, apart from Loans to assets ratio, deposit assets ratio and credit deposit ratio, the major change which is observed is investment deposit ratio. Banks invested more in liquid assets because of Liquidity coverage ratio and leverage ratio norms and thus increase in investment deposit ratio leads to increase in liquidity. Apart from it Capital came out as significant factor for liquidity having horizon up to one year. GDP, NIFTY BANK and NIFTY REALTY have negative and statistically significant relationship with liquidity, indicating portfolio substitution effect. When returns on other portfolios increases, banks invest less in liquid assets, so portfolio substitution occurs. When GDP increases, credit boom occurs, leading to increase in Loan asset ratio and decrease in investment in liquid assets.

NPA was significant for liquidity up to 90 days but it is not significant for a horizon of one year, indicating Basel norms somewhat have nullified the effect of NPAs over funding liquidity.

For multicollinearity check for all our regression models, we have performed variance inflation (VIF) test which confirms that our estimates do not suffer from multicollinearity issue.

6. Concluding Discussions

The empirical results presented in this paper have several interesting implications. For period 2010-2014, Credit risk has positive influence on liquidity risk either for shorter horizon up to (90 days depicted by liquid assets) or longer horizon (for one year depicted by current assets). In both the cases, an increase in NPA leads to reduction in liquid assets as well as current ratio of the banks. Thus, it is quite evident that during this period, higher credit risk has led to rise in liquidity risk situation for Indian banks. However, neither capital ratio nor macroeconomic variables had any significant influence on liquidity risk. Factors like loans to assets ratio, investment deposit ratio, credit deposit ratio have significant impact over liquidity during pre-Basel

3 period. Moreover, volatile liabilities indicated by funding volatility risk has prominent significant impact over bank liquidity.

However, when we consider the post Basel 3 period (2015-19), we find other factors becomes more important. Macro-economic variables such as GDP, NIFTY bank returns and G-sec returns are statistically significant effect on liquidity position of banks. Capital ratio is significant for liquidity horizon up to one year (Current ratio. Investment deposit ratio and cash deposit ratio are also significant.

One major finding of this paper is that after the implementation of Basel 3 reforms in India, credit risk has significant impact on short term liquidity horizon only (up to 90 days), but it is insignificant for liquidity up to one year (Current ratio) implying when NPA increases liquid assets will fall, but it will not affect current assets. Capital also becomes significant. Another major implication is reliance over bank specific factors have been reduced, now the Indian banking Liquidity risk and credit risk conditions depends more on economy. Earlier condition of liquidity depends more on bank specific factors and were in hands of banks. Now after the implementation with stringent norms, it is more of macro- economic in nature. Thus, it can be inferred that Basel 3 norms implementation by RBI has strengthened the liquidity situation. However there is still scope of improvement which may be overcome through effective implementation of net stable fund ratio. Our empirical results confirm that Basel III has contributed significantly in improving resilience to stress in liquidity and capital position of banks in India.

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Table 1:- Description of Variables used in the study and hypotheses.

Variables	*Full form and definition*	*Argumentation/Logic for Selection of variable*
LIQRISK1	Liquidity risk ratio1=Liquid Assets/Total Assets	Lower the ratio, greater is the liquidity risk
LIQRISK2	Liquidity risk ratio2=Current Assets/Current Liabilities	Lower the ratio, greater is the liquidity risk
CREDRISK	Credit risk = Net NPA/ Total Advances	Higher the NPA i.e. Credit risk, Higher the liquidity risk
CAPR	Capital ratio = (Net worth)/(Total assets)	Higher the capital, higher will be liquidity, thus lower liquidity risk.
DAR	Deposit Ratio = Total deposits/Total Assets	Deposits have influence over liquidity risk
LAR	Loan assets ratio = Total advances/Total assets	Advances have influence over liquidity risk
BSIZE	Size of banks is represented by amount of total assets. It is estimated by natural log of total assets: ln(total assets)	Size of banks determines the effectiveness of smaller and larger banks and their ability to manage liquidity risk.
NIM	Net interest Margin= (Interest Income-Interest Expense)/ (Average Earning Assets).	Higher the Net interest margin, lower will be liquidity risk.
IDR	Investment Deposit Ratio: Total Investments/ Total Deposits	Investment deposit ratio has significant impact on Liquidity risk depending on the type of portfolio.
CDR	Credit Deposit ratio = Total Advances/ Total deposits	Credit deposit ratio determines fund mobility and thus significantly influence liquidity risk.
CASHDEPOR	Cash deposit ratio = Cash and bank balances with RBI and other banks at short notice/ Total deposits.	Higher the cash deposit ratio, lower will be liquidity risk.
FVRISK	Funding Volatility risk Indicator = (Volatile liabilities- liquid assets)/(Total assets – liquid assets)	Lower the Funding volatility risk, lower the liquidity risk
GDPGR	Annual GDP growth rate	GDP determines growth of economy and hence significantly affect liquidity risk.
NIFTBNK	Nifty bank Index Returns	More the NIFTY bank returns, less will be investments in liquid assets, more liquidity risk.
NIFTREAL	Nifty realty Index returns	More the NIFTY realty returns, less investments in liquid assets, thus more liquidity risk.
GSEC	91 days government securities return	Higher the returns on G-SEC, lower the liquidity risk.
EFR	Efficiency ratio = Total cost/total income	Lower the efficiency ratio, Lower will be liquidity risk.

Table 2: Descriptive statistics of each variable in the model for pre Basel era i.e. 2010-2014.

SL#	*Variables*	*25th percentile*	*Median*	*75th percentile*	*Mean*	*Standard deviation*
1.	EFR	0.41255	0.45585	0.51575	0.48715	0.1278518
2.	LIQRISK2	0.684266	0.9116541	1.104624	0.9560732	0.3664498
3.	CREDRISK	0.0057225	0.013052	0.0226141	4.22813	32.62586
4.	LIQRISK1	0.0757593	0.1048267	0.1474551	0.1183077	0.0552134
5.	CAPR	0.0537624	0.0602729	0.0763789	0.0698417	0.0299532
6.	DAR	0.779676	0.8536708	0.8744479	0.8114703	0.1054651
7.	LAR	0.5798746	0.6127682	0.638694	0.6006569	0.0621852
8.	BSIZE	10.5304	11.53283	12.34496	11.37528	1.322967
9.	NIM	0.02205	0.025	0.0291	0.0259613	0.006158
10.	IDR	0.3	0.33	0.38	0.3704902	0.1543196
11.	CDR	0.7032	0.7458	0.7874	0.7511074	0.0864452
12.	CASHDEPOR	0.05	0.06	0.07	0.0620588	0.0162698
13.	FVRISK	0.0647982	0.1374222	0.1969999	0.1266381	0.1177746
14.	GDP Growth Rate (GDP)	0.0546	0.0639	0.0741	0.06592	0.0123328
15.	NIFTY Real	-0.001182	-0.000951	-0.000306	-0.0001134	0.0016587
16.	NIFTY Bank	0.00044	0.0005	0.0009	0.000942	0.001373
17.	GSEC	-0.000789	0.00437	0.01089	0.0053116	0.0091971

Table 3: Descriptive statistics of each variable in the model for post Basel era i.e. 2015-2019.

SL#	*Variables*	*25^{th} percentile*	*Median*	*75^{th} percentile*	*Mean*	*Standard deviation*
1.	EFR	0.4544	0.5067	0.5082	0.533266	0.1351
2.	LIQRISK2	0.7738275	1.032467	1.372025	1.17665	0.7507695
3.	CREDRISK	0.017	0.041	0.074	5.95	44.79
4.	LIQRISK1	0.085	0.125	0.1794	0.145	0.091
5.	CAPR	0.055	0.064	0.087	0.077	0.062
6.	DAR	0.765	0.853	0.8775	0.8093	0.112
7.	LAR	0.5677143	0.610459	0.644591	0.5963566	0.068703
8.	BSIZE	11.03178	12.08747	12.69534	11.82291	1.678341
9.	NIM	0.021	0.024	0.03015	0.0265447	0.0088648
10.	IDR	0.28	0.31	0.35	0.3456009	0.25851
11.	CDR	0.6839	0.7434	0.8286	0.77559	0.35610
12.	CASHDEPOR	0.05	0.05	0.06	0.26	0.0567308
13.	FVRISKIN	0.065077	0.16205	0.217825	0.13789	0.16391
14.	GDP Growth Rate (GDP)	0.0699	0.0758	0.08085	0.07537	0.005669
15.	NIFTY Real	0.000578	0.001287	0.001287	0.000603	0.001056
16.	NIFTY Bank	0.0005	0.0009	0.0012	0.0007	0.000731
17.	GSEC	-0.0092	-0.0046	-0.0044	-0.0048	0.005576

Table 4: Relationship of liquidity risk (LIQRISK1=liquid assets/Total assets) with Credit Risk and other independent variables, Pre Basel III Era (2010-14)

Variables	*Coefficients*	*z-value*	*P > |z|*
Credit Risk (CREDRISK)	-0.0086944***	-3.44	0.001
Capital ratio (CAPR)	-0.0104719	-0.12	0.907
Loan to assets ratio (LAR)	-0.8767997***	-6.44	0.000
Size (BSIZE)	0.0081431**	2.06	0.040
Net Interest Margin (NIM)	1.592439**	2.00	0.045
Investment deposit ratio (IDR)	-0.4060004***	-6.06	0.000
Credit Deposit Ratio (CDR)	0.0024683***	3.02	0.003
Cash Deposit ratio (CASHDEPOR)	-0.1243146	-0.64	0.521
Funding Volatility Risk (FVRISK)	-.3160116***	-3.13	0.002
Annual GDP Growth (GDPGR)	-0.2816864	-0.70	0.483
NIFTY BANK returns (NIFTBNK)	5.486566	1.61	0.108
NIFTY REALTY returns (NIFTREAL)	-0.9698541	-0.31	0.757
G-SEC Returns (GSEC)	0.1016443	0.44	0.659
Cost to Income ratio (EFR)	0.0403878	1.58	0.114
Intercept	0.5135067	5.53	0.000
No. of Observations			193
R^2			0.6656
Wald chi^2 (d.f.)			270.00 (15)
P-value			0.00
Hausman Chi2 (d.f)			20.62 (13)
P-value			0.10
Final Model			Random effects model
Note: *** denotes significance at 1 percent of better; ** denotes significance at 1-5 percent.			

Table 4: Relationship of liquidity risk (LIQRISK1=liquid assets/Total assets) with Credit Risk and other independent variables, Pre Basel III Era (2010-14)

Variables	*Coefficients*	*z-value*	*P > |z|*
Credit Risk (CREDRISK)	-0.0086944***	-3.44	0.001
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Loan to assets ratio (LAR)	-0.8767997***	-6.44	0.000
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G-SEC Returns (GSEC)	0.1016443	0.44	0.659
Cost to Income ratio (EFR)	0.0403878	1.58	0.114
Intercept	0.5135067	5.53	0.000
No. of Observations			193
R^2			0.6656
Wald chi^2 (d.f.)			270.00 (15)
P-value			0.00
Hausman Chi2 (d.f)			20.62 (13)
P-value			0.10
Final Model			Random effects model
Note: *** denotes significance at 1 percent of better; ** denotes significance at 1-5 percent.			

Table 5: Relationship of liquidity risk (LIQRISK2=current assets/current liabilities) with other independent variables, Pre Basel III Era (2010-14)

Variables	*Coefficients*	*z-value*	*P > |z|*
Credit Risk (CREDRISK)	-0.0952245***	-3.99	0.000
Capital ratio (CAPR)	2.466817	1.04	0.299
Loan to assets ratio (LAR)	-2.084481	-1.60	0.110
Size (BSIZE)	0.0033301	0.06	0.952
Net Interest Margin (NIM)	-2.34955	-0.19	0.846
Investment deposit ratio (IDR)	-1.331453*	-1.79	0.073
Credit Deposit Ratio (CDR)	0.011814	1.54	0.123
Cash Deposit ratio (CASHDEPOR)	-2.54815	-1.56	0.118
Funding Volatility Risk (FVRISK)	-0.8075719	-1.64	0.102
Annual GDP Growth (GDPGR)	1.509415	0.37	0.709
NIFTY BANK returns (NIFTBNK)	28.31896	0.82	0.411
NIFTY REALTY returns (NIFTREAL)	-15.21203	-0.51	0.613
G-SEC Returns (GSEC)	-2.100702	-0.78	0.436
Cost to Income ratio (EFR)	0.4037156	0.77	0.441
Intercept	1.508025	1.31	0.190
No. of Observations			163
R^2			0.2173
Wald chi^2 (d.f.)			29.14 (15)
P-value			0.0154
Hausman Chi2 (d.f)			15.63 (12)
P-value			0.2086
Final Model			Random effects model
Note: *** denotes significance at 1 percent of better; ** denotes significance at 1-5 percent.			

Table 6: Relationship of liquidity risk (LIQRISK1=liquid assets/total assets) with other independent variables, Post Basel III Era (2015-2019)

Variables	Coefficients	t-value	P > |t|
Credit Risk (CREDRISK)	-0.0009699***	-3.94	0.000
Capital ratio (CAPR)	0.2706218	1.05	0.299
Loan to assets ratio (LAR)	-0.1753155**	-2.41	0.021
Size (BSIZE)	-0.020022	-1.26	0.214
Deposit assets ratio (DAR)	0.2517***	3.07	0.004
Net Interest Margin (NIM)	-0.7948432	-1.51	0.139
Investment deposit ratio (IDR)	0.0136836	0.70	0.488
Cash Deposit ratio (CASHDEPOR)	0.13857	1.65	0.106
Funding Volatility Risk (FVRISK)	-0.6161973***	-8.29	0.000
Annual GDP Growth (GDPGR)	-4.454376***	-6.15	0.000
NIFTY BANK returns (NIFTBNK)	-13.5493***	-4.72	0.000
G-SEC Returns (GSEC)	-1.098055***	-2.87	0.007
Cost to Income ratio (EFR)	-0.0400678	-1.49	0.144
Intercept	0.7130804***	3.46	0.001
No. of Observations			162
R^2			0.4592
F (df1,df2)			85.00 (13,41)
Prob>F			0.00
Hausman Chi2 (d.f.)			49.41 (10)
P-value			0.00
Final Model			Fixed effects model
Note: ***, **, and * denote significance at the 1%, 5% and 10% level respectively.			

Table 7: Relationship of liquidity risk (LIQRISK2=current assets/current liabilities) with other independent variables, Post Basel 3 Era (2015-2019).

Variables	*Coefficients*	*t-value*	*P > |z|*
Credit Risk (CREDRISK)	-0.004203	-1.28	0.208
Capital ratio (CAPR)	8.770092**	2.31	0.026
Size (BSIZE)	-0.2214598	-1.04	0.306
Net Interest Margin (NIM)	-3.228017	-0.30	0.764
Investment deposit ratio (IDR)	2.359855***	16.36	0.000
Cash Deposit ratio (CASHDEPOR)	2.381928*	1.78	0.083
Funding Volatility Risk (FVRISK)	-1.430761***	-2.38	0.022
Annual GDP Growth (GDPGR)	-21.69994***	-3.13	0.003
NIFTY BANK returns (NIFTBNK)	-66.04545*	-1.93	0.060
G-SEC Returns (GSEC)	-5.013857	-0.94	0.354
Cost to Income ratio (EFR)	-0.2757844	-0.71	0.483
Intercept	4.244958	1.73	0.086
No. of Observations			151
R^2			0.5444
F (df1,df2)			47.86 (11,100)
Prob>F			0.00
Hausman Chi2 (d.f.)			25.40 (9)
Final Model			Fixed effects model
Note: ***, **, and * denote significance at the 1%, 5% and 10% level respectively.			