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FUNDING COST AND BANK LIQUIDITY CREATION: EVIDENCE FROM THE U.S.

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ABSTRACT

Recent academic research shows that banks with a high amount of deposits are inclined toward creating more liquidity and taking more risk. However, little is known about the puzzle of liquidity creation and how it is influenced by the cost of funding. This article aims to study the impact of the cost of funding on liquidity creation in the U.S. banking industry. Using comprehensive quarterly data for the period 2001 to 2019, we find that the cost of funding negatively relates to the bank's ability to create liquidity and the bank creates less liquidity and takes less risk when the cost of funding is high. Moreover, we show that large and public banks are more responsive to depositors' behaviour, arising from changes in the cost of deposits. Our results are robust to alternative econometric approaches including addressing the endogeneity concerns, the measure of funding cost and liquidity creation, bank size and different crisis periods.

Keywords: Funding cost, Liquidity creation, Bank risk, Deposits, U.S. banking industry

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INTRODUCTION

Over the last few decades, the U.S. banking sector has gone through massive regulatory changes, such as the deregulation started in the 1970s and then the Gramm-Leach Bliley Financial Services Modernisation Act of 1999, which had largely detached many restrictions, allowing banks to operate in a full range of financial services. Subsequently, banks actively engaged in high-yield toxic activities, including derivatives backed by wantonly cheap mortgages, resulting in liquidity crunch which was the major cause of Global Financial Crises (GFC) 2007–2009. Moreover, the widely accepted notion that the banks are the safe haven for investors during episodes of market deterioration was negated by the recent financial crises (Acharya & Mora, 2015).

The financial intermediation theory advocates that banks provide financial services on both sides of their balance sheet. They receive deposits on the liability side and transform them into illiquid loans to borrowers on the asset side, i.e., bank amalgamated deposit-taking with loan commitment (Kashyap et al., 2002). The aforementioned activities require banks to hold enough liquidity that could meet depositor's demand as well as to provide loans to borrowers which can only be possible if the demand deposits and loan commitment are not correlated (Acharya & Mora, 2015). This fundamental function of banks to create liquidity makes them vulnerable to default as it makes it less liquid through the channel of providing liquidity to external business entities (Berger & Bouwman, 2017; Acharya & Naqvi, 2012). Consequently, the bank faces losses (i) from default on loans and (ii) the losses linked with the discounted sale of illiquid assets to meet its obligations on demand deposits. Diamond and Dybvig (1983) argue that aggregate excessive demand for liquidity leads to "bank run" by the depositors as observed during recent financial crises.

There are numerous studies evaluating the dynamics of liquidity risk and its relationship with different bank-specific factors (for example, see Acharya & Mora, 2015; Zheng et al., 2019; DeYoung & Jang, 2016). However, little is known about how liquidity creation is influenced by funding costs. Therefore, the main aim of this article is to investigate the impact of the cost of funding on liquidity creation. More specifically, we drive our motivation for this study from the seminal work of Acharya and Naqvi (2012) who presented the theoretical framework of liquidity management and the risk-taking behaviour of banks.

When banks augment their liquidity creation, they concurrently enhance the interest income, thereby increasing the surplus allocated to the bank's shareholders. This, in turn, elevates the overall value of the bank (Berger & Bouwman, 2009). Conversely, when a bank possesses ample liquid assets, it mitigates the risks it encounters and curtails the financing expenses it incurs. This subsequently bolsters the bank's profitability and diminishes its vulnerability to insolvency (Sahyouni & Wang, 2019; Tran et al., 2016).

Deposits serve as the primary means of liquidity for banks, and their capacity to generate liquidity is influenced by the cost associated with these deposits. When macroeconomic risks are high, banks tend to attract more deposits, which boosts their liquidity. However, an excess of liquidity in the form of deposits may lead banks to ease their lending standards, potentially extending loans to borrowers with lower creditworthiness. Furthermore, the manager's compensation is proportionate to his performance in terms of loan issued which might arise the agency problem. In order to increase his private gains, the manager will take excessive risk. The actions of the managers, if he has acted over aggressively, can only be audited ex-post, especially when the liquidity shortfall arising from his actions is large enough to put the bank at stake (Acharya & Naqvi, 2012; Khan et al., 2017).

Excessive risk-taking behaviour of banks induces all stakeholders involved in monitoring and disciplining banks' operations to protect their rights. For a given increase in risk, the resulting cost of market discipline is likely to be larger. This is more intuitive when the share of uninsured deposits is larger than the insured. Banks tend to take less risk when they have more uninsured deposits (Gropp & Vesala, 2004). Depositors reprimand the bank with excessive risk by asking their funds back or higher yields on deposits which will limit bank's ability to create liquidity. Acharya and Mora (2015) find that the cost of deposits for banks increased during financial crises.

Previous literature on liquidity creation mainly focused on its relation with financial crises (Chatterjee, 2018; Berger & Bouwman, 2017), capital requirement (Zheng et al., 2019; Tran et al., 2016), liquidity creation through merger and acquisition (Baltas et al., 2017), bank risk-taking behaviour (Khan et al., 2017; Acharya & Naqvi, 2012; Andreou et al., 2016), bank liquidation through debt and equity-based channels (Acharya & Thakor, 2016), liquidity creation and deposit insurance (Fungáčová et al., 2017) and how banks manage their liquidity (DeYoung & Jang, 2016).

To begin with financial crises, Chatterjee (2018) considered liquidity creation an important recession forecaster. He investigates the relationship of liquidity creation with the recession in the U.S. banking industry for the period 1984–2010. He finds that the on-balance sheet liquidity of the bank reduces about four quarters before the recession, while the larger bank's balance sheet reflects more information to predict a recession. Similarly, Berger and Bouwman

(2017) empirically document that high liquidity creation of the bank transmits the information to predict the crises, particularly through off-balance sheet channels while the monetary role of banks tends to be weaker or insignificant during financial crises.

In the wake of financial crises, the implementation of the Basel III and Dodd-Frank Act of 2010 has renewed the debate of capital management and bank's liquidity creation. The stringent capital rules will make it hard for banks to raise funds at a lower cost, thus reducing the liquidity requirement. Notwithstanding this argument, Admati et al. (2013) argued that highly capitalised banks take less risk, which reduces moral hazard and exhibits less distortion in the lending decision. In this regard, Zheng et al. (2019) reported the relationship of bank liquidity creation with bank insolvency to be conditional on the level of bank capital. They argued that a bank increases its solvency with an increased level of capital, which also enhances its ability to create liquidity. Further, banks attract deposits at a lower cost and loan them at a higher rate when banks have higher capital ratios (Ashraf, 2018). However, Tran et al. (2016) argued that the aforementioned relation differs depending on the capital measure, bank size and sample period. They reported that only small banks to have a positive relationship of capital and liquidity creation. The introduction of deposit insurance also moderates this relationship, especially in banks with higher household deposit ratios, weakening the capital impact on liquidity creation (Fungáčová et al., 2017).

As noted above, liquidity creation, through the fire sale of illiquid assets to meet depositor liquidity demand, increase the default probability of banks (Diamond & Dybvig, 1983). However, this default probability can be partly diminished through mergers and acquisitions (M&As). According to Carletti et al. (2007), M&As change the bank behaviour by creating an "internal money market" where banks exchange reserves internally. Recently, Baltas et al. (2017) presented the "cost-efficiency-liquidity-creation" (CELCH) hypothesis and found that M&As enhance liquidity creation and create additional sources of credit channels in the economy. In contrast, several studies reported the increases of market power of banks through M&As, which resulted in a decline in short-term deposit rates (Dinger, 2015; Craig & Dinger, 2009; Focarelli & Panetta, 2003; Prager & Hannan, 1998). This reduction in deposit rates reduces the customer-base of the bank and negatively influences its liquidity creation ability; alternatively, increases the liquidity risk for the banks.

Recently, Khan et al. (2017) and Dahir et al. (2018) analysed the relationship of funding liquidity risk and bank risk-taking behaviour in the U.S. and BRICS (Brazil, Russia, India, China and South Africa) banking industry for the period of 1986–2014 and 2006–2016, respectively. Both studies find that banks with lower funding liquidity risk (proxied by deposits to total assets) take more risk and are less stable. In developing countries, banks generally hold higher liquidity buffers due to limited access to capital and money markets and the less diversified nature of the financial products, which diminish their ability to liquidity creation. For example, banks in South Asian countries take less risk when they have more liquidity (Rokhim & Min, 2018).

This article aims to offer a comprehensive assessment of the cost of funding and its relationship with bank liquidity creation in the U.S. banking industry for the period of 2000:Q1 to 2017:Q4. We measure the cost of funding as the natural log of cost of domestic and for liquidity creation, we use the "catfat" measure of bank liquidity creation, proposed by (Berger & Bouwman, 2009).

To briefly present the results, we find that the cost of funding has a statistically significant negative relation with bank liquidity creation. Due to the high cost of deposits, banks will eventually have a lower stock of interest-bearing deposits, which increases bank funding liquidity risk and restricts banks to create less liquidity. Our results are robust to the alternative econometric approaches, the measure of funding cost and liquidity creation, bank size and ownership structure, and different crisis periods. Particularly, our results reveal that large and public banks are more responsive in terms of liquidity creation towards changes in the cost of deposits. Furthermore, during the turmoil period, banks are less responsive to changes in funding costs. We apply the 2SLS and propensity score matching to address endogeneity and find the same results.

Our study contributes to the current literature in several ways. Firstly, although funding cost is an important determinant of bank risk-taking behaviour, a systematic understanding of the aforementioned relationship still lacks in the literature. Previous studies have tested this relationship and found a positive relationship between funding liquidity risk and bank risk-taking (Khan et al., 2017; Dahir et al., 2018). Nevertheless, these studies proxied the amount of deposits to measure funding liquidity. We argue that the bank's decision to behave aggressively and create more liquidity depends on the cost of liquidity they receive in the form of deposits. We fill this gap by assessing the impact of funding costs on bank liquidity creation.

Secondly, our results complement the previous literature on bank funding cost and liquidity creation (Dahir et al., 2018; Rokhim & Min, 2018; Khan et al., 2017; Acharya & Naqvi, 2012) and highlight that high cost of deposit limit the bank to take higher risk and create more liquidity. Thirdly, this study also adds to the literature on the role of bank size and ownership in determining the funding cost and risk behaviour (Tran et al., 2019; Samet et al., 2018; Laeven et al., 2016; Barry et al., 2011).

DATA AND METHODOLOGY

Data

We use the publically available data from the period of 2001 to 2019 from the Federal Reserve, which provides quarterly call reports of the U.S. commercial banks. Since the quality of data is a major concern in empirical analysis, we put great effort into ensuring the reliability of our sample. We remove all bank quarters with missing or incomplete information on the part of accounting data to be used in the study. As the primary aim of this study is to assess the impact of the funding cost on liquidity creation, we also remove the observations with missing or negative values of deposits and loans. The final dataset contains 9,264 banks with 281,622 bank-quarters observations.

Measurement of Variables

Measurement of bank liquidity creation and funding cost

To estimate the liquidity creation, we use "catfat" – the preferred proxy variable to measure liquidity creation; proposed by Berger and Bouwman (2009) and widely used by the earlier literature (Berger & Bouwman, 2017; Chatterjee, 2018; Fungáčová et al., 2017; Khan et al., 2017). Following Berger and Bowman (2009; 2017), we categorised bank on and off-balance sheet items as a liquid, semi-liquid and illiquid and finally assigned the weights as in Equation (1).

$$\begin{aligned} LC = {} & [0.5 \times \textit{illiquid assets} + 0.5 \times \textit{illiquid liabilities} + 0.5 \times \\ & \textit{illiquid guarantees}] + [0 \times \textit{Semi} - \textit{liquid assets} + 0.5 \times \\ & \textit{Semi} - \textit{liquid liabilities} + 0.5 \times \textit{Semi} - \textit{liquid guarantees}] \\ & - [0.5 \times \textit{liquid assets} + 0.5 \times \textit{illiquid liabilities} + 0.5 \times \\ & \textit{equity} + 0.5 \times \textit{liquid guarantees} + 0.5 \times \textit{liquid derivatives}] \end{aligned} \quad (1)$$

After measuring the LC, we then standardised it by the total assets. This "catfat" measure of LC determines the total dollar amount of liquidity created by a bank in the economy. Banks transform short-term availability of liquidity in the form of deposits from depositors into long-term availability of liquidity for borrowers in the form of loans (Diamond & Dybvig, 1983). Therefore, the high value of this variable represents the greater ability of bank liquidity creation but with higher liquidity risk due to maturity transformation mismatch (Imbierowicz & Rauch, 2014).

For the cost of funding (FC), we use the natural log of the cost of domestic deposits, which is measured as interest expenses paid on domestic deposits during a quarter divided by interest-bearing deposits during the last quarter (Levine et al., 2016; Gilje et al., 2016; Acharya & Mora, 2015). Table 1 describes all the variables used in this study.

Table 1
Description of variables

Variables	Definitions	Source
Dependent variables		
LC	Dollar amount of "catfat" liquidity creation normalised by gross total asset. The "catfat" measure classifies loans based on category and includes off-balance sheet activities.	Berger & Bowman (2009) Authors' calculation
LC (catnonfat)	Dollar amount of "catfat" liquidity creation normalised by the gross total asset. The "catfat" measure classifies loans based on category without off-balance sheet activities.	Berger & Bowman (2009) Authors' calculation
Deviation of LC	$LC_{i,t}$ – Average $LC_{i,t}$ of the industry	Authors' calculation
Independent variables		
Funding Cost (FC)	Natural logarithm of the cost of (domestic) deposits equals natural logarithm of interest expenses on domestic deposits divided by interest-bearing domestic deposits at the beginning of a period.	Authors' calculation
Control variables		
SIZE	The natural logarithm of total gross assets.	Authors' calculation
CAPITAL	Book value of equity over total gross assets.	Call reports
EARNINGS	Income before taxes, provisions recognised in income over total gross assets.	Call reports
GROWTH	Rate of change of total gross assets.	Call reports
NPL	Non-performing assets over the quarter, scaled by total loans at the beginning of the quarter.	Call reports
ZSCORE	A bank measure of financial risk calculated as [Avg. (ROA) + Avg. (Equity/GTA)]/Stdv. ROA; a larger value indicates lower overall bank risk. Means of ROA and Equity/GTA as well as the standard deviation of ROA are computed over the previous 12 quarters (t–11 to t).	Authors' calculation
EARNINGS VOLATILITY	Standard deviation of pre-managed earnings over the previous 12 quarters (t–11 to t).	Authors' calculation
NII	Non-interest incomes over the net operating incomes.	Call reports

Control variables

Following the previous literature on liquidity creation and funding cost (Rokhim & Min, 2018; Dahir et al., 2018; Khan et al., 2017; Andreou et al., 2016), we control for several factors that can possibly influence the overall results.

We use the natural logarithm of total assets (SIZE) to capture the impact of each bank's dimension. Larger banks might create more liquidity both on the asset (extending loans) and liability side (deposits) of the balance sheet side due to economies of scale or scope. We also consider the growth of total assets (GROWTH), profitability (EARNING) and volatility in profitability (EARNINGS VOLATILITY) to reflect the potential non-linear relationship between bank expansion and liquidity creation: a greater focus on growth could encompass more relaxed credit screening criteria and increase the liquidity creation of the bank. We incorporate the non-interest income (NII) since a bank with a concentration in non-traditional activities might reduce the bank's liquidity. We also include non-performing loans (NPL) that can negatively affect the liquidity management of the bank.

Similarly, we include equity to total asset ratio (CAPITAL) and bank stability (ZSCORE) variables. The Z-score is calculated as the sum of the ROA and the equity-to-asset ratio, divided by the standard deviation of the ROA. Higher values of the Z-score signal higher resilience and, therefore, more stability. Highly capitalised and stable banks tend to have more liquidity. On the one hand, such banks attract deposits at a lower cost (Ashraf, 2018) and may incentivise the bank to lend more and create more liquidity on the other hand (Donaldson et al., 2018).

Econometric Model

We run a series of multivariate regressions to investigate the impact of the cost of funding on bank liquidity creation with the following model:

$$\mathrm{Y}_{it} = \alpha_0 + \beta_1 FC_{it-1} + \beta_2 CV_{it-1} + \delta_i + \theta_t + \varepsilon_{it} \tag{2}$$

The $Y_{i,t}$ will take the value of dependent variables, which is liquidity creation (LC) while the cost of funding (FC) is the main explanatory variable. CV represents the vector of bank-specific control variables. All the bank-specific variables are winsorised at 1% at each tail to mitigate the possible effect of an outlier which can influence our results. To control for bank and time fixed effect, we include firm () and time () dummies in all regression models. is the error term. We use one-period lagged values of independent and bank-specific control variables to mitigate the issue of reverse causality. Lastly, we also cluster standard error at bank-level since LC might be correlated within bank overtime.

Descriptive Statistics

Table 2 presents the descriptive statistics of our winsorised sample of the U.S. commercial banks used for this study. Overall, the results show a minimal presence of outliers in the data except for ZSCORE with a standard deviation of 34.07. On average, the liquidity created by each bank is 21.1% of the total assets which is much higher as compared to the previous literature (Khan et al., 2017), this could be due to differences in the sample period of the study. The funding cost ranges from 0.1% to 4.6% with mean value of 2%. The bank in our sample is less dependent on non-traditional activities. The average size and capital of the bank are 11.85 and 11%, respectively, with an average earning of 1.4% and growing at a steady rate of 2%. The average ZSCORE over the sample period is 40.265, which implies the high stability of the U.S. banking industry. This is further evident from the NPL ratio which is on average to be 6%.

Table 2
Descriptive statistics

Variable	Obs.	Mean	S. D.	Min	Max
LC	281,622	0.211	0.191	–0.726	0.671
FC	281,622	0.020	0.009	0.001	0.046
SIZE	281,622	11.855	1.211	9.053	17.118
CAPITAL	281,622	0.110	0.050	0.054	0.731
EARNINGS	281,622	0.014	0.012	–0.033	0.082
GROWTH	281,622	0.020	0.055	–0.110	0.272
NPL	281,622	0.060	0.082	0	0.461
ZSCORE	281,622	40.265	34.070	1.459	234.303
EARNINGS VOLATILITY	281,622	0.007	0.010	0.001	0.067
NII	281,622	0.118	0.098	–0.035	0.926

Notes: This table presents the descriptive statistics of the main variables. The dependent variable is liquidity creation (LC) while the independent variable is the cost of funding (FC). Control variables are log of total assets (SIZE), equity to total assets (CAPITAL), profitability (EARNING), growth in total assets (GROWTH), non-performing loans (NPL), bank stability (ZSCORE) and EARNINGS VOLATILITY and non-interest income (NII).

Table 3 reports the correlation coefficient values of all the variables employed in this study. The correlation results show the absence of multi-collinearity in the data since all the variables of interest are not highly correlated.

Table 3
Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) LC	1.000									
(2) FC	0.030***	1.000								
(3) SIZE	0.408***	–0.153***	1.000							
(4) CAPITAL	–0.488***	–0.043***	–0.223***	1.000						
(5) EARNINGS	0.059***	0.047***	0.143***	0.221***	1.000					
(6) GROWTH	0.045***	0.091***	0.024***	0.051***	–0.030***	1.000				
(7) NPL	0.023***	–0.024***	0.022***	–0.050***	–0.174***	–0.149***	1.000			
(8) ZSCORE	-0.103***	0.037***	0.132***	0.080***	0.102***	–0.012***	–0.242***	1.000		
(9) EARNINGS VOLATILITY	–0.085***	0.010***	–0.109***	0.352***	–0.043***	0.037***	0.354***	–0.439***	1.000	
(10) NII	–0.109***	–0.234***	0.138***	0.387***	0.359***	–0.011***	0.011***	–0.066***	0.273***	1.000

Notes: This table provides the pairwise correlation among all the variables. The dependent variable is liquidity creation (LC) while the independent variable is the cost of funding (FC). Control variables are non-interest income (NII), log of total assets (SIZE), equity to total assets (CAPITAL), profitability (EARNING), growth in total assets (GROWTH), non-performing loans (NPL), bank stability (ZSCORE) and EARNINGS VOLATILITY. *** indicate statistical significance at 1%.

MAIN RESULTS AND DISCUSSION

Does The Cost of Funding Affect Liquidity Creation?

Table 4 reports the main results of our analysis. The results from our baseline model show the negative and statistically significant relationship between the cost of funding and bank liquidity creation which implies that banks, having a higher cost of funding, produce less liquidity. Since the cost of deposits is higher, banks will eventually have a lower stock of interest-bearing deposits. On one side, this phenomenon might increase funding liquidity risk for the bank, as deposits are the stable source of liquidity, and will also restrict the risk-taking behaviour of banks. Our results are in line with the previous literature and funding liquidity risk theories (Dahir et al., 2018; Khan et al., 2017; Acharya & Naqvi , 2012) which suggest that lower level of funding liquidity risk increases bank riskiness and sow the seed for the future crises.

Table 4

Funding cost and liquidity creation–Baseline analysis

	Baseline model	Lag of 4 periods	Exclude M&A sample	Exclude crisis period	Only 4th quarter	Balanced panel data	Fama-McBeth	Small	Medium	Large
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FC	–1.170***	–1.001***	–1.125***	–1.405***	–1.287***	–1.071***	–2.676***	–0.768**	–0.923***	–1.544***
	(0.170)	(0.171)	(0.164)	(0.180)	(0.202)	(0.186)	(0.628)	(0.346)	(0.166)	(0.261)
SIZE	0.011***	0.011***	0.008**	0.009**	0.010**	0.011**	0.048***	0.004	–0.025***	–0.009
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.003)	(0.010)	(0.005)	(0.006)
CAPITAL	–0.798***	–0.351***	–0.857***	–0.795***	–0.789***	–0.798***	–1.245***	–0.851***	–0.815***	–0.687***
	(0.030)	(0.030)	(0.037)	(0.036)	(0.037)	(0.075)	(0.075)	(0.044)	(0.048)	(0.091)
EARNINGS	0.938***	0.255***	0.980***	1.043***	1.075***	0.813***	2.135***	0.672***	1.002***	1.038***
	(0.073)	(0.072)	(0.070)	(0.083)	(0.087)	(0.076)	(0.289)	(0.129)	(0.076)	(0.126)
GROWTH	–0.040***	0.024***	–0.046***	–0.028***	–0.019**	–0.053***	0.222***	–0.054***	–0.039***	–0.048***
	(0.005)	(0.005)	(0.005)	(0.006)	(0.009)	(0.007)	(0.062)	(0.010)	(0.006)	(0.009)
NPL	–0.093***	–0.113***	–0.092***	–0.082***	–0.091***	–0.082***	–0.129***	–0.056***	–0.085***	–0.117***
	(0.007)	(0.008)	(0.007)	(0.009)	(0.008)	(0.011)	(0.041)	(0.010)	(0.009)	(0.016)
ZSCORE	–0.000***	–0.000**	–0.000***	–0.000***	–0.000***	–0.000**	–0.001***	–0.000**	–0.000**	–0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
EARNINGS VOLATILITY	–0.206**	–0.195*	–0.228***	–0.134	–0.128	–0.085	1.438***	-0.256	–0.290**	–0.567***
	(0.088)	(0.099)	(0.087)	(0.102)	(0.096)	(0.141)	(0.196)	(0.164)	(0.117)	(0.156)
NII	–0.011	0.027***	–0.015	–0.013	–0.016	0.000	0.019	-0.021	–0.030***	0.000
	(0.010)	(0.010)	(0.010)	(0.010)	(0.011)	(0.013)	(0.022)	(0.021)	(0.011)	(0.017)
Constant	0.140***	0.109***	0.172***	0.169***	0.139***	0.102*	-0.200***	0.206**	0.542***	0.463***
	(0.044)	(0.042)	(0.043)	(0.046)	(0.049)	(0.058)	(0.042)	(0.103)	(0.057)	(0.072)
Obs.	281,622	274,706	277,085	222,863	69,673	155,772	281,622	79,375	118,226	84,021
Adj. R^2	0.216	0.126	0.206	0.210	0.194	0.185	0.299	0.219	0.167	0.218
BFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
QFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents the impact of funding cost on the liquidity creation of banks. The dependent variable is liquidity creation (LC) while the independent variable is the cost of funding (FC). Control variables are non-interest income (NII), log of total assets (SIZE), equity to total assets (CAPITAL), profitability (EARNING), growth in total assets (GROWTH), non-performing loans (NPL), bank stability (ZSCORE) and EARNINGS VOLATILITY. Model (1) present the Baseline model. Model (2) employed the lag of 4 periods. Model (3) and (4) exclude banks involved in M&As activities and crises period, respectively. Model (5) uses only 4th quarter of the sample period while model (6) incorporates fully balanced data. Model (7) presents the results of Fama-McBeth regression. Lastly, model (8), (9) and (10) present the results of small, medium and large banks. Robust standard errors in parentheses; *** indicate statistical significance at 1%, ** at 5% and * at 10%, respectively.

Following the literature of Haq et al. (2019) and Berger et al. (2016), we re-run our baseline model by incorporating the lag of 4 quarters (Model 2), excluding banks involved in merger and acquisition (M&As) activities (Model 3) and financial crisis period (2007:Q3 to 2009:Q2) (Model 4). M&As reduces the bank default probability and create an internal money market to raise funds during the episodes of liquidity shortage (Berger & Bouwman, 2009; Carletti et al., 2007). Similarly, during the financial crisis 2007/2008, banks went through a considerable level of structural breaks which significantly changed their risk profile toward liquidity creation (Adhikari & Agrawal, 2016). Additionally, considering the banks as a safe haven, investors tend to keep their investments with banks in the form of deposits (Gatev & Strahan, 2006). Similarly, as reported in the Models (2), (3) and (4), the direction of the relationship remains the same; however, the magnitude of the coefficients slightly changes, suggesting that our baseline result are not driven by the financial crises and M&A activities.

Liu et al. (1997) argue that managers have more incentives to monitor and control in the fourth quarter than in the other quarters of the fiscal year before the start of the audit. To confirm that results are not driven by such practices of managers, we run the regression in the Model (5) with only fourth-quarter data and find similar results, i.e., the statistically significant negative relationship of cost of funding and liquidity creation. Further, we also run the analysis with fully balanced data in Model (6) and the alternative econometric approach of Fama–MacBeth (Fama & MacBeth, 1973) in Model (7) to control the issue of panel data (such as missing values) and find the same results.

Literature expansively discussed the impact of size of the bank in terms of deposit-taking and liquidity creation. The ex-ante belief of "Too big to fail" has incentivised banks to take the excessive risk, which led to recent financial crises. The ex-post expectation of government bailout to rescue big banks has reduced the incentives for depositors, creditors and other stakeholders to monitor and control the banking operations, which might increase the systemic risk and financial instability. Acharya and Thakor (2016) argue that banks, in the absence of deposit insurance, face greater market discipline which enhances the quality of the bank's loan portfolio and liquidity creation ability. Similarly, Laeven et al. (2016) documented that systemic risk increases with the size of the bank. To control and classify the bank size, following (Berger et al., 2017), we split our sample as small (assets under USD1 billion) (model 8), medium (Asset between USD1 billion and USD5 billion) (model 9) and large banks (assets more than USD5 billion) (Model 10).

Overall, our results remained in the same direction with differences in the magnitude of coefficients. It is important to note that large banks are more responsive towards depositor's behaviour resulting from changes in deposit rates. For example, 1% increase (decrease) in deposit rates will reduce (increase) the liquidity creation by 1.544 in large banks. A high deposit rate will force these banks to raise liquidity from other cheaper sources or create less liquidity. Jacewitz and Pogach (2018) show that market demand lower risk premium from larger banks and receives a discount of 35 bps in raising funds as compared to small banks.

As far as the control variables are concerned, highly capitalised banks tend to create less liquidity and are reluctant to take more risk. We find a statistically significant impact of CAPITAL on bank liquidity creation across all specifications. Profitability (EARNINGS) also shows a positive trend and high liquidity creation for banks. Non-performing loans reduce the liquidity creation of the bank, especially on the asset side of the balance sheet. The core function of the bank is to receive deposits and extend loans. However, banks create less liquidity when they are more focused on non-traditional activities (f.i. fee and commissions) and the coefficient of non-interest income (NII) confirms this pattern.

Quantile Regression

In this section, we run Equation (2) with a quantile regression approach for two reasons to confirm if the earlier results hold across different quartiles of liquidity creation. First, the traditional Ordinary least square approach (OLS), used in the above section, ignores the heterogeneity in the sample and captures the only average effect of the cost of deposits with respect to liquidity creation. Secondly, OLS provides the best unbiased linear estimator when the error term independently, identically and normally distributed. Albeit, these assumptions might not hold when the average distribution of the dependent variable, i.e, liquidity creation, is affected by extreme values. To overcome these issues, prior literature suggests using the quantile regression approach (Tran et al., 2019; Chaabouni et al., 2018).

Table 5 reports the results of the quantile regression approach. Indeed, the results are uniform and hold across all quartiles of liquidity creation, indicating that the higher cost of deposits will reduce the bank's liquidity creation; however, this relationship is more pronounced in the upper quartile of liquidity creation.

Table 5
Quantile regression

Variables	Q25	Q50	Q75
	(1)	(2)	(3)
FC	–1.010***	–1.221***	–2.070***
	(0.075)	(0.065)	(0.068)
SIZE	0.051***	0.059***	0.061***
	(0.000)	(0.000)	(0.000)
CAPITAL	–1.810***	–1.366***	–0.932***
	(0.014)	(0.013)	(0.014)

(*Continued on next page*)

Table 5 (*Continued*)

Variables	Q25	Q50	Q75
EARNINGS	1.639***	2.007***	2.466***
	(0.046)	(0.039)	(0.041)
GROWTH	0.273***	0.309***	0.280***
	(0.009)	(0.007)	(0.007)
NPL	–0.004	–0.044***	–0.076***
	(0.006)	(0.005)	(0.005)
ZSCORE	–0.001***	–0.001***	–0.001***
	(0.000)	(0.000)	(0.000)
EARNINGS VOLATILITY	1.556***	2.036***	2.514***
	(0.067)	(0.049)	(0.055)
NII	–0.027***	–0.054***	–0.056***
	(0.005)	(0.004)	(0.005)
Constant	–0.318***	–0.354***	–0.292***
	(0.006)	(0.006)	(0.006)
Observations	281,622	281,622	281,622

Notes: This table presents the effect of funding cost on liquidity creation of banks using Quantile regression approach. The dependent variable is liquidity creation (LC) while the independent variable is the cost of funding (FC). Control variables are Non-interest income (NII), log of total assets (SIZE), equity to total assets (CAPITAL), profitability (EARNING), growth in total assets (GROWTH), non-performing loans (NPL), bank stability (ZSCORE) and EARNINGS VOLATILITY. Robust standard errors in parentheses. *** indicate statistical significance at 1%, ** at 5% and * at 10%, respectively.

ROBUSTNESS

To further strengthen and validate our results, we incorporate a series of robustness checks in this section, apply alternative measures of funding cost and liquidity creation, examine the effect of crises and lastly address endogeneity concerns.

Alternative Measure of Liquidity Creation and Funding Cost

We employed three alternative measures of liquidity creation and two alternative measures of funding cost.

Firstly, we consider the "catnonfat" measure of liquidity creation to confirm if our results hold across different balance sheet structures of the bank, i.e., on and off-balance sheet. The difference between "catfat" and "cat nonfat" is that the latter does not include the off-balance sheet items in the measurement. Secondly, we incorporate "matfat" measure of liquidity creation which considers loan maturities rather loan categories to estimate liquidity creation. Lastly, we also consider the "matnotfat" variable of liquidity creation which also considers loan maturities but ignores off-balance sheet activities (Berger & Bouwman, 2009). We also re-run our baseline model of Equation (2) in Table 6 to confirm that our results are not driven by a single source of cost of funding. More specifically, following Levine et al. (2016), we measured the total cost of all liabilities in Model (4) by dividing the total interest expense of each quarter by interest-bearing liabilities at the beginning of the quarter. We also incorporate the cost of subordinated debt as an alternative measure of funding cost. Results are reported in Table 6 and remain unchanged.

Table 6
Alternative measure of liquidity creation

Variable	catnonfat	matfat	matnonfat	Total interest expense	Cost of subordinated debts
	(1)	(2)	(3)	(4)	(5)
FC	–1.041*** (0.114)	–1.816*** (0.162)	–1.803*** (0.130)	–1.140*** (0.155)	–0.005*** (0.001)
SIZE	0.020*** (0.003)	–0.006* (0.004)	–0.001 (0.003)	0.010*** (0.004)	–0.027* (0.014)
CAPITAL	–0.896*** (0.020)	–0.918*** (0.028)	–1.042*** (0.024)	–0.827*** (0.030)	–0.244 (0.208)
EARNINGS	0.678*** (0.046)	0.689*** (0.069)	0.477*** (0.045)	0.947*** (0.073)	0.725*** (0.235)
GROWTH	–0.067*** (0.004)	–0.049*** (0.005)	–0.072*** (0.005)	–0.016*** (0.006)	–0.026 (0.021)
NPL	–0.025*** (0.006)	–0.117*** (0.007)	–0.053*** (0.006)	–0.092*** (0.007)	–0.100*** (0.031)
ZSCORE	–0.000*** (0.000)	–0.000** (0.000)	–0.000** (0.000)	–0.000*** (0.000)	–0.000 (0.000)
EARNINGS VOLATILITY	–0.041 (0.070)	–0.114 (0.083)	0.018 (0.069)	–0.212** (0.088)	–0.338 (0.345)
NII	–0.025*** (0.007)	0.009 (0.009)	–0.008 (0.007)	–0.012 (0.010)	0.033 (0.040)
Constant	–0.003 (0.034)	0.408*** (0.043)	0.306*** (0.034)	0.144*** (0.044)	0.692*** (0.182)
Obs.	299,805	281,622	299,805	281,658	6,757
Adj. R^2	0.288	0.187	0.257	0.216	0.152
BFE	Yes	Yes	Yes	Yes	Yes
QFE	Yes	Yes	Yes	Yes	Yes

Notes: This table presents the effect of funding cost on the liquidity creation of banks using the OLS approach. The dependent variables are catnontfat, matfat and matnonfat measure of liquidity creation (LC) while the independent variable is the cost of funding (FC) based on total interest expenses and cost of subordinated debts. Control variables are non-interest income (NII), log of total assets (SIZE), equity to total assets (CAPITAL), profitability (EARNING), growth in total assets (GROWTH), non-performing loans (NPL), bank stability (ZSCORE) and EARNINGS VOLATILITY. Robust standard errors in parentheses. *** indicate statistical significance at 1%, ** at 5% and * at 10%, respectively.

Funding Cost and Bank Liquidity Creation: The Effects of The Crisis

In this section, we analyse how banks respond to changes in funding cost during different time periods. Banks are more prone to default during the turmoil period, which ultimately leads depositors to maintain greater discipline over banks. However, government intervention might offset the greater discipline on the part of depositors. Moreover, Cornett et al. (2011) argue that the financial crisis dwindled liquidity in the market. They divide banks into two categories:

1. Banks, having deposits and equity capital finance as the core source of funding, continue to lend more as compared to other banks.
2. Banks, having more illiquid assets, reduce lending and created less liquidity.

Our study starts from 2000:Q1, then includes the last crisis from 2007:Q3-2009:Q2 following Acharya and Mora (2015). W re-run our baseline model by including the crisis dummy and its interaction with FC (FC*Crisis).

Table 7 shows a similar pattern. However, during the crisis period, banks are less responsive to changes in the funding cost. This is more intuitive for banks with illiquid assets. To overcome the liquidity shortage, they will accept more deposits at high cost and lend less (Cornett et al., 2011).

Table 7
The effects of the crisis

Variable	(1)
FC	–1.272*** (0.185)
FC*CRISIS	0.257** (0.112)
CRISIS	0.058*** (0.005)
SIZE	0.011*** (0.004)
CAPITAL	–0.798*** (0.030)
EARNINGS	0.944*** (0.073)
GROWTH	–0.040*** (0.005)
NPL	–0.093*** (0.007)
ZSCORE	–0.000*** (0.000)
EARNINGS VOLATILITY	–0.202** (0.088)
NII	–0.012 (0.010)
Constant	0.144*** (0.044)
Obs.	281,622

(*Continued on next page*)

Table 7 (*Continued*)

Variable	(1)
Adj. R^2	0.216
BFE	Yes
QFE	Yes

Notes: This table presents the effect of funding cost on the liquidity creation of banks during the crisis period by using the OLS approach. The dependent variable is liquidity creation (LC) while the independent variable is the cost of funding (FC). Control variables are non-interest income (NII), log of total assets (SIZE), equity to total assets (CAPITAL), profitability (EARNING), growth in total assets (GROWTH), non-performing loans (NPL), bank stability (ZSCORE) and EARNINGS VOLATILITY. Robust standard errors in parentheses. *** indicate statistical significance at 1%, ** at 5% and * at 10%, respectively.

Endogeneity Concerns

To further strengthen our baseline results, we also address the endogeneity issues to gain a robust understanding of the impact of funding costs on bank liquidity creation. However, the fundamental question is; does liquidity creation by the banks solely driven by funding cost or other certain factors lead banks to create more liquidity?

To address endogeneity concerns, we follow the previous literature (Tran, 2020; Haq et al., 2019) and employed Two-Stage Least Square (2SLS) and the propensity score matching (PSM). The results are shown in Table 8.

For the 2SLS, we use the average of deposit costs of all other banks (except bank i) in each quarter as the IV following (Laeven & Levine, 2007). We report the first-stage and the second-stage in Models (1)–(2) of Table 8. The Cragg–Donald weak identification test statistic shows that our IV is relevant. In Model (1), the coefficient on our IV is positively and significantly associated with the odds of paying higher costs. This confirms the relevance of our instrumental variable. The result reports from the second-stage (Model (2)) comfirms our main findings. The coefficient on FC from the 2SLS estimation is larger than the OLS estimation (Model (1) Table 4), supporting our concern about the reverse causality and hence with the need to use an IV approach to identify the impact of funding costs to the creation of liquidity. The OLS estimation might yield coefficient estimates of the effects of FC on liquidity creation that are biased toward zero, whereas the 2SLS estimation yields the more accurate (hence larger) impact of FC on liquidity creation.

We next use the propensity score matching developed by Rosenbaum and Rubin (1983) and extended by Heckman et al. (1997). We follow Chen et al. (2016) and rank all banks in each quarter based on their deposit cost into

10 groups (deciles). The dummy variable DUM_FC is set to unity if a bank belongs to the top group (i.e., the group that belongs from 8th deciles) (treated group), and zero if it is in the bottom group (i.e., the group under 4th deciles) (untreated group). We measure the propensity of undergoing treatment (i.e., the probability of paying high cost) by using a logit model for both treated and untreated samples. We match each treated bank with one untreated bank, which shares similar characteristics as reflected in their propensity scores. We use one-to-one matching without replacement, requiring each treated bank to be used exactly once in Model (3). We use one-to-one matching with replacement in Model (4). In Models (5)–(6), we match each treated bank (i.e., banks that pay the highest funding costs) with two and three other banks sharing the closest propensity scores, respectively. The results remain unchanged.

Table 8
Endogeneity concerns

Variable	IV 1st-stage	IV 2nd-stage	PSM (N = 1) without replacement	PSM (N = 1) with replacement	PSM (N = 2)	PSM (N = 3)
	(1)	(2)	(3)	(4)	(5)	(6)
FC		–1.492***	–1.335***	–1.448**	–1.254**	–1.389***
		(0.202)	(0.356)	(0.584)	(0.530)	(0.538)
SIZE	0.003***	0.012***	0.009	0.003	0.004	0.005
	(0.000)	(0.001)	(0.007)	(0.011)	(0.008)	(0.008)
CAPITAL	–0.006***	–0.800***	–0.803***	–0.766***	–0.768***	–0.768***
	(0.000)	(0.005)	(0.053)	(0.103)	(0.070)	(0.067)
EARNINGS	–0.017***	0.931***	0.900***	0.871***	0.839***	0.849***
	(0.001)	(0.018)	(0.140)	(0.248)	(0.207)	(0.189)
GROWTH	–0.007***	–0.042***	–0.054***	–0.042**	–0.051***	–0.057***
	(0.000)	(0.003)	(0.010)	(0.018)	(0.013)	(0.012)
NPL	–0.000***	–0.093***	–0.067***	–0.077***	–0.072***	–0.075***
	(0.000)	(0.002)	(0.012)	(0.020)	(0.017)	(0.015)
ZSCORE	0.000***	–0.000***	–0.000**	–0.000***	–0.000***	–0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
EARNINGS VOLATILITY	0.012***	–0.202***	–0.300*	–0.593*	–0.559**	–0.506**
	(0.001)	(0.022)	(0.162)	(0.303)	(0.223)	(0.224)
NII	–0.004***	–0.013***	–0.006	–0.001	–0.012	–0.024
	(0.000)	(0.003)	(0.018)	(0.028)	(0.021)	(0.020)
FC_MEAN	0.625***					
	(0.006)					

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Table 8 (*Continued*)

Variable	IV 1st-stage	IV 2nd-stage	PSM ($N = 1$) without replacement	PSM ($N = 1$) with replacement	PSM ($N = 2$)	PSM ($N = 3$)
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	–0.019***	0.138***	0.175**	0.237*	0.227**	0.212**
	(0.000)	(0.007)	(0.079)	(0.125)	(0.093)	(0.092)
Obs.	281,478	281,478	63,258	23,872	36,555	46,164
Adj. R^2	0.833	0.216	0.201	0.180	0.184	0.185
BFE		Yes	Yes	Yes	Yes	Yes
QFE		Yes	Yes	Yes	Yes	Yes
Cragg-Donald Wald F-Stat	11552.52***					
Anderson-Rubin Wald test	54.54***					

Notes: This table presents the effect of funding cost on the liquidity creation of banks by using 2SLS and the Propensity score matching approach. The dependent variable is liquidity creation (LC) while the independent variable is the cost of funding (FC). Control variables are non-interest income (NII), log of total assets (SIZE), equity to total assets (CAPITAL), profitability (EARNING), growth in total assets (GROWTH), Non-performing loans (NPL), bank stability (ZSCORE) and EARNINGS VOLATILITY. Robust standard errors in parentheses. *** indicate statistical significance at 1%, ** at 5% and * at 10%, respectively.

CONCLUSION

Acharya and Naqvi (2012) proposed a theory that proxies the deposits as the major source of funding liquidity. When the deposits are high, managers take risks aggressively and create both on- and off-balance liquidity and plant the seed for the next crises. Recent literature has examined the relationship between funding liquidity risk and bank risk-taking behaviour (Khan et al., 2017; Dahir et al., 2018). However, to the best of our knowledge, no study has yet analysed the impact of the cost of funding on liquidity creation and bank risk-taking. This article attempts to fill this gap by investigating the issue, using a comprehensive high-quality dataset in the U.S. banking industry from 2000:Q1 to 2019:Q4.

We provide evidence of the negative relationship between the cost of funding and bank liquidity creation. Banks with higher costs of funding attract more deposits, which shield the bank from instantaneous liquidity shortfall and extend the bank with more caution to lend aggressively and create more liquidity. We use alternative econometric methodology, measures of the cost of funding and bank liquidity. Regardless of any approach and measure, our results remain unchanged.

Furthermore, we also investigate if the bank size and crisis period play any role in the relationship between funding cost and liquidity creation. Our results show that large banks are more responsive towards variation in the cost of funding and create less liquidity when the deposit rates are high. Consistent with previous literature, we also show that the bank creates less liquidity during the turmoil period, invest in low-yield marketable securities-maintained liquidity buffers to overcome any liquidity shortfall.

This study is also subject to some limitations and provides further future research direction. Although, based on the Federal Reserve policy rate and volume of deposits, the bank internally decides the deposit rate be offered to the depositors. However, a valid question that arises is how both a bank and its depositors will respond when the Federal Reserve adjusts its policy rate, which is not addressed in this study. For instance, when the Federal Reserve raises its policy rate, borrowers may find it more challenging to fulfill their financial obligations promptly, potentially leading to an escalation in the risk of default for the bank. In such a situation, the bank may opt to prioritise investing in treasury bills over conventional lending practices.

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