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A. Gorodilov, V. Sokolov[1]

Bank capital and liquidity creation: Evidence from the Russian experience

In this paper we examine the relationship between regulatory bank capital and liquidity creation. We test the "financial fragility-crowding out hypothesis" and the "risk absorption hypothesis" on the sample of 885 Russian banks over the 2010–2019 period. Inspired by Berger and Bouwman's (2009) approach, we develop a liquidity creation measure that simultaneously considers the category and maturity of secondary accounts. After conducting several robustness checks, we report that bank capital is negatively related to liquidity creation which supports the "financial fragility-crowding out hypothesis". We also show that this relationship is independent of the bank size and the economic cycle. Our findings suggest that the Central Bank of Russia faces a trade-off between financial stability and liquidity creation by the banking system, as tougher regulatory capital requirements decrease banks' abilities to finance the real sector of the economy.

Keywords: liquidity creation; total capital ratio; the Russian banking system; Basel III.
JEL classification: G21; G28.

1. Introduction

The 2008–2009 global financial crisis revealed the mechanism of how the inability of financial institutions to quickly solve liquidity provision problems can lead to aggregate macroeconomic instability. To ensure the health of the financial system the Basel Committee on Banking Supervision released a new regulatory framework known as Basel III. The new accord requires banks to substantially increase capital ratios compared to the Basel II standards and build up countercyclical capital buffers. While increasing the solvency of banks, this new regulation has an ambiguous effect on an important function of the banking system — liquidity creation.

One strand of theoretical literature predicts that when liquid short-term liabilities are replaced by illiquid long-term capital the bank lending and investment activities in the economy will decline (Diamond, Rajan, 2000, 2001; Gorton, Winton, 2017). This is known as the "financial fragility-crowding out hypothesis".

Another theory predicts that higher capital ratios increase the risk-bearing capacity of banks and induce them to lend more, in other words, create more liquidity on their asset side. The more liquidity is created, the greater is the likelihood that some loans would be non-performing, the more capital is needed to accept associated expenses caused by increased provisions for non-performing

[1] **Gorodilov, Aleksei** — HSE University, Moscow; agorodilov@hse.ru.
Sokolov, Vladimir — HSE University, Moscow; vsokolov@hse.ru.

loans (Diamond, Dybvig, 1983; Allen, Santomero, 1997; Allen, Gale, 2004; Bhattacharya, Thakor, 1993; Repullo, 2004; Von Thadden, 2004; Coval, Thakor, 2005). This mechanism is known as the "risk absorption hypothesis".

The main goal of this study is to investigate empirically the association between banks' capital and liquidity creation in the Russian banking system and test predictions of two competing theoretical hypotheses: the "financial fragility-crowding out hypothesis" and the "risk absorption hypothesis".

The second contribution of this paper is methodological. Because the existing liquidity ratios such as liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR) cannot provide answers to the questions of what amount of liquidity banks create and what types of banks create the most and the least liquidity in the economy Berger and Bouwman (2009) have developed an algorithm for constructing the liquidity creation measures. Our contribution to the liquidity creation methodology is the improved liquidity creation measure that simultaneously considers the category and *maturity* of loans and other secondary accounts using the unique highly detailed information from the balance sheet data available in Russia[2].

Due to the availability of this balance sheet's data, we can augment Berger and Bouwman's algorithm of calculating the banks' liquidity creation measures and create an additional so-called *catmat nonfat* liquidity creation measure which relies on the *category* and *maturity* classifications and excludes off-balance sheet data which is traditionally not significant for the Russian banks according to Fungáčová, Weill (2012) and Fungáčová et al. (2017).

Related literature. In the aftermath of the global financial crisis regulation of banks' capital and liquidity has received much attention. The seminal paper by Berger and Bouwman (2009) developed a method for measuring bank liquidity creation which sparked a vibrant empirical literature investigating banks' contribution to liquidity creation or destruction. Following the original work of Berger and Bouwman (2009), the literature has been particularly concerned with the role of capital adequacy requirements of banks in the liquidity creation process. The extensive literature that studies liquidity creation for different countries finds overwhelming evidence in favor of a negative relationship between capital ratios and liquidity creation due to the financial fragility effect. We overview the most influential of these studies below.

Distinguin et al. (2013) analyze the association between bank capital and liquidity for the U. S. and European publicly traded commercial banks over the 2000–2006 period. To solve the endogeneity problem, they simultaneously estimate the system of the regulatory capital and the liquidity equations using the generalized method of moments (GMM). Following Berger and Bouwman (2009) in the calculation of liquidity creation measure, they have found a negative and statistically significant effect of Tier 1 regulatory capital ratio on liquidity creation.

The association between bank capital structure and liquidity creation was examined by Lei and Song (2013) on a sample of 135 banks operating in China over the 1988–2009 period. Lei and Song (2013) find evidence in favor of the "financial fragility-crowding out hypothesis" for domestic banks. Moreover, they have found the presence of the "risk absorption" effect for foreign banks that decreases the "financial fragility-crowding out" effect.

Fungáčová, Weill (2012) and Fungáčová et al. (2017) use a rich dataset consisting of 38000 Russian bank-quarter observations over the 1999–2009 period. Fungáčová et al. (2017) apply a difference-in-difference approach to assess how the introduction of the deposit insurance scheme influences the association between bank capital and liquidity creation. They have found a significant

[2] We use detailed data on secondary accounts reported by banks in the 101 form.

negative relationship between capital ratio and liquidity creation for a subsample of banks with a higher share of household deposits in their balance sheet. The introduction of the deposit insurance scheme enables this group of banks to absorb greater risk which reduces the impact of capital on liquidity creation for these banks.

Horváth et al. (2014) analyze the sample of 31 Czech banks over the 2000–2010 period (monthly data) to examine the association between bank capital and liquidity creation. Authors have found a significantly negative bi-causal relationship between liquidity creation and bank capital for Czech banks.

Fu et al. (2016) investigate the association between liquidity creation and bank capital on a sample of 3274 bank-year observations (606 banks) from 14 Asia-Pacific countries over the 2005–2012 period. To address the potential endogeneity problem, they use a simultaneous equations model with a GMM estimator. They have found a significantly negative bi-causal association between liquidity creation and capital for Asia-Pacific banks supporting the "financial fragility-crowding out hypothesis".

Ghosh (2016) estimates the interrelationships among credit risk, capital, and liquidity using the financial statements' data of 103 banks (1065 bank-year observations) operating in one of the six countries comprising the Gulf Cooperation Council (GCC) market over the 1996–2012 period. The author employs two measures of illiquidity: the inverse of Berger and Bouwman's (2009) liquidity creation indicator and the NSFR. Referring to the theory that suggests the joint determination of bank capital, liquidity, and credit risk, Ghosh (2016) simultaneously estimates the three-equation model using the three-stage least squares (3SLS) estimator with bank-specific, industry-specific, and macroeconomic variables. The author's main result is that there is a statistically significant and positive association between the inverse of Berger and Bouwman's (2009) liquidity creation indicator and bank capital which is in line with the "financial fragility-crowding out hypothesis".

Casu et al. (2019) evaluate the relationship between capital and the inverse of the NSFR and Berger and Bouwman's (2009) liquidity creation measures on the sample of 7275 bank-year observations (1367 banks) operating in 17 Eurozone countries over the 1999–2013 period. They use the same approach as Distinguin et al. (2013) and Fu et al. (2016) and have found a significantly negative bi-causal association between bank capital and liquidity creation which is in line with the "financial fragility-crowding out hypothesis".

Le (2019) employs a sample of 25 Vietnamese commercial banks (198 bank-year observations) over the 2007–2015 period. The author uses a 3SLS estimator to simultaneously estimate regressions and states that a 3SLS estimator is more efficient than 2SLS estimator due to the increase in "strength of the interrelations among the error terms" (Belsley, 1988, p. 1). Le (2019) demonstrates a negative bi-causal relationship between bank capital and liquidity creation confirming the "financial fragility-crowding out hypothesis".

There are a few country studies that find a positive relationship between bank capital and liquidity creation. For example, Al-Khouri (2012) empirically examines the effect of bank capital on liquidity creation for yearly data of 43 commercial banks operating in one of the six countries comprising the Gulf Cooperation Council (GCC) market over the 1998–2008 period. The main result of the study is a positive and statistically significant relationship between capital and liquidity creation which is in line with the "risk-absorption hypothesis".

Tran et al. (2016) examine the interrelationships between bank capital, liquidity creation, and bank profitability on a sample of 507715 U.S. bank-quarter observations over the period 1996–2013. The authors have found a positive bidirectional relationship between liquidity creation and regulatory capital for small banks, and that this relationship stays the same primarily during non-crisis periods. Another important result is that bank capital positively influences liquidity creation if the bank is adequately capitalized, and the opposing relation for an undercapitalized bank[3].

Our paper contributes to this literature by augmenting the original Berger and Bouwman's (2009) algorithm and constructing a liquidity creation measure that simultaneously considers the category and maturity of balance sheet secondary accounts. We find a negative and statistically significant effect of the total regulatory capital ratio on the augmented measure of liquidity creation which provides additional evidence in favor of the "financial fragility-crowding out hypothesis".

While two classical theories "financial fragility-crowding out hypothesis" and "risk absorption hypothesis" predict the opposite relationship between banks' capital and liquidity creation, more recent theories suggest a more nuanced relationship. A dynamic general equilibrium model by Begenau (2020) asks a question: What is the optimal capital requirement for banks? She finds parameterizations of the model, under which the higher level of capital requirement mitigates bank risk-taking without substantially reducing useful bank services, such as the credit supply and liquidity provision. This theoretical work lays the ground for reconciling the opposite empirical results on the relationship between capital and liquidity creation that are found by researchers for different countries and subsamples.

The rest of the paper is structured as follows. Section 2 provides a detailed description of the algorithm for calculating the new liquidity creation measure. Sections 3 and 4 describe the data and empirical methodology. Sections 5 and 6 contain an interpretation of the empirical results and robustness checks. The policy implications are discussed in the conclusion.

2. New liquidity creation measure

2.1. Original Berger and Bouwman's algorithm

The original Berger and Bouwman's (2009) algorithm for constructing liquidity creation measures consists of three steps.

1) The assignment of liquidity classes liquid, semi-liquid, and illiquid to all balance sheet classes relying on the ease, cost, and time for banks to obtain liquid funds.

2) The assignment of weights based on liquidity creation theory to all balance sheet classes. This theory suggests that the maximum amount of liquidity is created when \$1 of liquid liabilities (for example, short-term deposits) is used to finance \$1 of illiquid assets (for example, long-term loans). In this case, a weight of 0.5 is assigned, and the liquidity creation is equal to:

$$0.5 \cdot \$1 + 0.5 \cdot \$1 = \$1. \tag{1}$$

Conversely, the maximum liquidity is destroyed when \$1 of illiquid liabilities (for example, deferred tax liability) is used to finance \$ 1 of liquid assets (for example, cash). A weight of –0.5 is assigned, and the liquidity creation is equal to:

$$-0.5 \cdot \$1 + (-0.5) \cdot \$1 = -\$1. \tag{2}$$

[3] A bank is considered undercapitalized if its Tier 1 capital ratio is less than the minimal Tier 1 regulatory threshold of 4% plus one standard deviation of its own Tier 1 capital ratio, and it is considered adequately capitalized otherwise.

3) The application of formulas for deriving liquidity creation measures, such as *cat nonfat*, *cat fat*, *mat nonfat*, or *mat fat*, adopts the terminology introduced by Berger and Bouwman (2009). Below we present the calculation formula exclusively for *cat nonfat*, where “cat” denotes the classification of assets by category and “nonfat” denotes the exclusion of off-balance sheet accounts from the computation of liquidity creation.

$$\begin{aligned} cat\,nonfat = {} & 0.5 \cdot illiquid\ assets + 0 \cdot semiliquid\ assets - 0.5 \cdot liquid\ assets - \\ & - 0.5 \cdot illiquid\ liabilities + 0 \cdot semiliquid\ liabilities + \\ & + 0.5 \cdot liquid\ liabilities - 0.5 \cdot capital. \end{aligned} \tag{3}$$

2.2. Augmented algorithm

Our contribution to the liquidity creation theory is the improved liquidity creation measure that simultaneously considers the category and maturity of loans and other secondary accounts using highly detailed information from balance sheet data. This unique source contains the opening balance, turnovers, the closing balance, and maturity for secondary accounts of all banks at a certain date and is available on the website of the Central Bank of Russia (CBR).

Due to the availability of more detailed balance sheet data, we have modified Berger and Bouwman’s (2009) algorithm for constructing liquidity creation measures. This allows us to calculate the *catmat nonfat* liquidity creation measure which relies on the category and maturity classifications. We make the following steps to obtain the new liquidity creation measure.

1) We assign 34 balance sheet classes (for example net loans, cash, securities) to a total of 11139 secondary accounts from the Form 101 following the publicly available instructions provided by the CBR No. 2332-U dated 12.11.2009, No. 4212-U dated 24.11.2016, No. 4927-U dated 08.10.2018 (Instructions…, 2009, 2016, 2018). Despite the evolution of the CBR instructions over time, the overall impact on the construction of the balance sheet was insignificant.

2) We assign a positive sign to closing balances of active secondary accounts and a negative sign to closing balances of passive secondary accounts included in the balance sheet’s classes of assets, and otherwise for accounts included in the balance sheet’s classes of liabilities and equity. This is important for step 5 to not overestimate liquidity created on a balance sheet’s class.

3) We assign liquidity classes (liquid, semi-liquid, illiquid) to all 11139 secondary accounts relying on the ease, cost, and time for banks to obtain liquid funds. This assessment considers the descriptions of maturity available in the Form 101 as well as the categories of secondary accounts. Our contribution lies in the simultaneous utilization of both maturity and category for all secondary accounts.

4) We assign liquidity weights based on liquidity creation theory to all secondary accounts[4].

5) We summarize the product of liquidity weight and closing balance for each *k* secondary accounts across *i* balance sheet’s classes:

$$Balance\ sheet's\ class_i = \sum_{k=1}^{S} Liquidity\ weight_{ki} \cdot Closing\ balance_{ki}. \tag{4}$$

[4] Refer to Appendix for liquidity weights.

6) We apply the following formula to the amount of liquidity created on the asset side (*LqdA*), the amount of liquidity created on liability side (*LqdL*), and the amount of liquidity created on equity side (*LqdE*) for each bank

$$X = \sum_i Balance\,sheet's\,class_i, \tag{5}$$

where X — *LqdA* for balance sheet's classes $i = 1,\ldots,13$, *LqdL* for $i = 15,\ldots,22$ or *LqdE* for $i = 24,\ldots,35$ for liquidity created on asset, liability, or equity side correspondingly of each bank. All balance sheet's classes are listed in Appendix.

Finally, we obtain the total amount of liquidity created (*LqdALE*) without off-balance sheet liquidity:

$$catmat\ nonfat = LqdALE = LqdA + LqdL + LqdE. \tag{6}$$

2.3. Example comparing the original and augmented algorithms

Consider the simplified bank balance sheet with different categories and maturities of assets and liabilities shown in Table 1.

Table 1. Bank balance sheet example

Bank balance sheet					
Class (-*Account*)	A/P	Value	Class (-*Account*)	A/P	Value
Cash	A	100	Equity		200
			- *capital*	P	*220*
			- *treasury shares*	A	*–20*
Loans		900	Total equity		200
- *1 month consumer loans*	A	*350*	Deposits		800
- *5 years car loans*	A	*650*	- *4 months*	P	*500*
- *provisions*	P	*–100*	- *2 years*	P	*300*
Total assets		1000	Total liabilities		800

Note. A — active secondary accounts, P — passive secondary accounts.
Text in italic is secondary accounts names.

The liquidity creation measure proposed by Berger and Bouwman (2009), known as the *cat nonfat* (3), solely considers the category of loans and does not simultaneously incorporate the elements of maturity and category. Consequently, their preferred liquidity creation measure would produce the following value:

$$\begin{aligned} cat\,nonfat &= Cash \cdot (-0.5) + Loans \cdot 0.5 + 4\,months\,Deposits \cdot 0.5 + \\ &+ 2\,years\,Deposits \cdot (-0.5) + Equity \cdot (-0.5) = 100 \cdot (-0.5) + \\ &+ 900 \cdot 0.5 + 500 \cdot 0.5 + 300 \cdot (-0.5) + 200 \cdot (-0.5) = 400. \end{aligned} \tag{7}$$

Our new *catmat nonfat* (6) measure simultaneously takes into account maturity and category of loans and yields more conservative value for the liquidity creation by this hypothetical bank. Moreover, we use secondary accounts data for the calculation of liquidity creation

$$\begin{aligned} catmat\,nonfat &= LqdALE = Cash\cdot(-0.5) + 1\,month\,Loans\cdot(-0.5) + 5\,years\,Loans\cdot 0.5 - \\ &- Provisions\cdot 0.5 + Capital\cdot(-0.5) - Treasury\,shares\cdot(-0.5) + 4\,months\,Deposits\cdot 0.5 + \\ &+ 2\,years\,Deposits\cdot(-0.5) = 100\cdot(-0.5) + 350\cdot(-0.5) + 650\cdot 0.5 - 100\cdot 0.5 + \\ &+ 220\cdot(-0.5) - 20\cdot(-0.5) + 500\cdot 0.5 + 300\cdot(-0.5) = 50. \end{aligned} \tag{8}$$

This artificial example illustrates the fact that our new preferred measure of liquidity creation is always more conservative compared to the traditional measure of Berger and Bouwman (2009).

In this empirical work, we will apply our preferred formula to construct the *catmat nonfat* (6) liquidity measure for each Russian bank throughout the sample. Furthermore, in Section 6, we will examine the robustness by employing the *cat nonfat* (3) liquidity creation measure.

3. Data and summary statistics

Our sample consists of the quarterly panel data of Russian banks over the 2010–2019 period. The highly detailed data on secondary accounts of balance sheets, primary data on profit and loss (P&L) statements, and the data on mandatory ratios were obtained from the CBR website. We also use Bloomberg to get the full history of M&A and the National Financial Association (NFA) website to get Moscow Prime Offered Rate (MosPrime) over the sample period.

The sample initially contains 1217 financial institutions, but subsequently, we delete non-bank credit organizations and those banks that do not disclose secondary accounts' data. We also delete banks with only 1 bank-quarter observation because it prevents us from performing panel data models. The final sample consists of 885 banks (20785 bank-quarter observations).

We additionally segment the sample into two subsamples based on the classification of a bank as a systematically important financial institution (SIFI) in accordance with the Instruction of the Bank of Russia No. 3737-U dated 22.07.2015 (Instruction…, 2015). This division aims to investigate whether "too-big-to-fail" banks experience the opposite effect of bank capital on liquidity creation compared to medium and small-sized banks.

Our main variable of interest is the total regulatory capital ratio which before 01.01.2014 was calculated as H1, and after this date, it was calculated as H1.0 in accordance with the new CBR instructions implementing the Basel III regulations in Russia.

Following previous studies, we divide the set of control variables into three groups: bank-specific, industry, and macroeconomic variables. Table 2 defines each control variable for the empirical analysis and includes data sources and summary statistics. To calculate bank-specific variables we construct balance sheets and P&L statements for each bank and quarter using secondary accounts of balance sheets, the primary data on P&L statements, and the publicly available instructions of the CBR (No. 2332-U dated 12.11.2009, No. 4212-U dated 24.11.2016, No. 4927-U dated 08.10.2018). These instructions contain guidance for constructing balance sheets and P&L statements from secondary accounts. As a result, we get balance sheets and P&L statements for each

Table 2. Variable definitions, summary statistics, and data sources

Notation	Definition	Mean	St. dev.	Min	Median	Max
	Main variables					
nLqdALE	Liquidity creation measure divided by total assets	–0.081	0.182	–1.330	–0.068	0.787
nLqdAL	Liquidity creation measure on both asset and liability sides divided by total assets	0.026	0.171	–0.957	0.032	0.762
nLqdA	Liquidity creation measure on asset side divided by total assets	0.050	0.184	–1.024	0.068	0.483
nLqdL	Liquidity creation measure on liability side divided by total assets	–0.023	0.169	–0.639	–0.032	0.485
nLqdE	Liquidity creation measure on equity side divided by total assets	–0.107	0.080	–0.498	–0.080	0.292
TCR	Total capital ratio (similar to Tier 1 ratio). Before 01.01.2014 it is calculated as H1. After 01.01.2014 it is calculated as H1.0[5] (CBR data)	0.260	0.214	0.000	0.184	5.310
	Bank-specific variables					
lnAssets	Log of total assets	15.65	1.83	11.70	15.34	24.08
ROA	Return on assets	0.012	0.082	–1.270	0.009	2.965
NPLGL	Non-performing loans divided by gross loans	0.055	0.129	0.000	0.031	8.748
ROASD	The standard deviation of ROA over last 8 quarters	0.039	0.082	0.000	0.019	3.673
lnZscore	Log of [1 + (ROA + Total equity / Total Assets) / ROASD]	2.359	0.992	–4.779	2.333	6.964
Big	1 if the bank meets the requirements to be a systematically important financial institution (SIFI) as defined in the Instruction of the Bank of Russia No. 3737-U dated 22.07.2015, 0 otherwise	0.019	0.138	0.000	0.000	1.000
M&A	1 if the bank participated in M&A on both sides (18 unique banks-acquirer, 23 unique banks- target) during this quarter, 0 otherwise. (Bloomberg)	0.003	0.058	0.000	0.000	1.000
Sanctions	1 if the bank is on the sanctions list of the Office of Foreign Assets Control (OFAC)[6], 0 otherwise. (OFAC data)	0.019	0.135	0.000	0.000	1.000
Foreign	1 if the bank is in the CBR list of operating credit institutions with a 100% share of non-residents in the paid capital of a credit institution, 0 otherwise[7]. (CBR data)	0.065	0.247	0.000	0.000	1.000
leadDefault	1 if the bank will lose the banking license next quarter, 0 otherwise. (CBR data)	0.021	0.145	0.000	0.000	1.000
	Industry variable					
HHI	Herfindahl–Hirschman index — the sum of squared shares of the bank's deposits (funds) of individuals, including individual entrepreneurs, to total deposits in the banking system	0.217	0.013	0.192	0.215	0.245
	Macroeconomic variables					
grGDP	Growth rate of real gross domestic product (GDP) of Russian Federation. (OECD)	0.351	0.655	–1.019	0.341	2.264
MosprimeON	Moscow Prime Offered Rate Overnight. (NFA data)	0.081	0.028	0.036	0.074	0.160

[5] The operational risk multiplier was raised from 10.0 to 12.5 on 01.02.2014, resulting in a 0.2% decrease in the total capital ratio. In October and November 2014, the CBR introduced new risk components, leading to an increase in the denominator of H1.0. Additionally, in December 2014, the CBR implemented measures to stabilize the financial sector. The overall impact of these regulatory changes and measures on H1.0 was estimated to be +1.5% as of 01.01.2015. However, according to the CBR Report on the Development of the Banking Sector and Banking Supervision in 2014, new regulatory requirements without the December measures were expected to have a dampening effect on H1.0.

[6] https://sanctionssearch.ofac.treas.gov/.

[7] Our main results are robust to re-classification of foreign banks according to Vernikov (2023).

bank-quarter observation and perform several tests to make sure that the data is aggregated correctly. Firstly, the difference between total assets and the sum of total liabilities and total capital should be equal to 0, and this is true for every bank-quarter observation. Finally, we randomly choose several bank-quarter observations and compare balance sheets and P&L statements with those available at the CBR website officially reported financial statements. We do not observe any substantial differences.

ROA provides information on a bank's profitability and shows how much net income a bank earns during a certain period in relation to the average of total assets at the beginning and the end of this period. Bank size and dummy Big are used to control implicit benefits from being "too-big-to-fail" and easier access to the interbank market than small banks have.

NPL to gross loans, the standard deviation of *ROA*, and *lnZscore* are proxies of the bank's risk. A higher *lnZscore* indicates a bank's financial stability while higher values of the first two risk proxies mean a less stable bank's position.

We control for the bank's *M&A* history because, after the transaction completion, an acquirer gets new clients and increases deposits and loans on the balance sheet. Dummy *Sanctions* is used to control the restrictions set on certain Russian banks in the international financial market.

We introduce dummy Foreign because there are mixed results related to the influence of bank ownership. On the one hand, institutes differ from country to country, and foreign banks could not adapt to local business culture or could face tough competition from domestic banks. On the other hand, foreign banks have expertise and technologies that could allow them to cope with an information asymmetry and successfully compete with domestic banks.

In 2013 the CBR started the financial recovery of the Russian banking system by revoking banking licenses from "faulty" banks. These banks withdraw funds using fictitious loans to their related parties just before losing licenses. In the balance sheet, it looks like a bank creates liquidity by converting liquid into illiquid assets, although a bank is not going to function as a bank anymore. Another mechanism is that depositors know about the bank's problems and withdraw funds in advance. This destroys liquidity before the CBR revokes the banking license. For this reason, we introduce dummy *leadDefault* which is used to control such effects.

The industry variable is *HHI* measured as the sum of squared shares of the bank's deposits (funds) of individuals, including individual entrepreneurs, to total deposits of individuals in the banking system. Several theories offer two perspectives on the impact of competition on liquidity creation. On the one hand, competition can force banks to lower their risk appetites, and this results in a decrease in liquidity creation since this process is risky. On the other hand, competition can induce banks to improve efficiency and transparency which has a positive effect on monitoring efforts. As a result, these banks can lend more, and hence, create more liquidity.

The macroeconomic variables are the real growth rate of the Russian GDP (*grGDP*) and the MosPrime overnight rate (*MosprimeON*). These are common measures of macroeconomic conditions in which banks operate.

Table 3 contains summary statistics for big and small banks. It can be seen that small banks exhibit a mean *TCR* of 0.262, which is twice the value observed for big banks. This observation leads us to posit that smaller banks may be intentionally maintaining a higher level of capitalization to avoid any concerns regarding their capital adequacy raised by the CBR. The higher level of illiquid capital explains the negative value of liquidity creation measures for small banks over the period.

Table 3. Summary statistics for big and small banks, the 2010–2019 period

	Big banks ($N = 401$)		Small banks ($N = 20384$)		Difference	
	Mean	Median	Mean	Median	Mean	Median
nLqdALE	0.116	0.138	–0.085	–0.072	0.201***	0.210
nLqdAL	0.167	0.199	0.024	0.029	0.143***	0.170
nLqdA	0.186	0.214	0.047	0.066	0.139***	0.148
nLqdL	–0.018	–0.019	–0.024	–0.032	0.006	0.014
nLqdE	–0.051	–0.049	–0.108	–0.081	0.057***	0.032
TCR	0.135	0.130	0.262	0.187	–0.127***	–0.057
lnAssets	21.37	21.10	15.54	15.30	5.83***	5.81
ROA	0.012	0.010	0.012	0.009	0.000	0.001
NPLGL	0.057	0.036	0.055	0.031	0.002	0.005
ROASD	0.017	0.010	0.040	0.019	–0.023***	–0.009
lnZscore	2.52	2.46	2.36	2.33	0.17***	0.13
M&A	0.057	0.000	0.002	0.000	0.055***	0.000
Sanctions	0.224	0.000	0.015	0.000	0.209***	0.000
Foreign	0.150	0.000	0.064	0.000	0.086***	0.000
leadDefault	0.005	0.000	0.022	0.000	–0.017***	0.000

Note. *** — significance at the 1% level.

Big and small banks have almost equal mean values of *ROA* and the share of *NPL* in gross loans. From the risks side, big banks look more stable: *lnZscore* is slightly higher, and the standard deviation of *ROA* (*ROASD*) is twice as low as for small banks. Big banks are more often involved in M&A activity and have higher chances of being on the OFAC sanction list. The share of foreign-owned banks is significantly higher among big banks rather than small banks. Small banks are more exposed to license withdrawals or liquidation compared to big ones.

We also calculated Pearson correlations between all variables, and most of them are weak but statistically significant. Moderate correlations are observed between bank size and total capital ratio (–0.45), bank size and dummy *Big* (0.44), *MosprimeON* and *HHI* (–0.60), *MosprimeON* and *grGDP* (–0.61), and *HHI* and *grGDP* (0.64). Liquidity creation *nLqdALE* negatively and significantly correlates with the total capital ratio at 1% level (–0.41).

We plot the average dynamics of our preferred liquidity measure and liquidity creation based on Berger and Bouwman's (2009) algorithm for small and big banks subsamples in Figure 1. The solid line plots the *catmat nonfat* measure based on the augmented algorithm, and the dashed line plots the original *cat nonfat* measure due to Berger and Bouwman (2009). It provides valuable insight into aggregate liquidity creation in the Russian banking system. Only big systemically important banks that control 70–90 percent of banking services in Russia create liquidity. This is consistent with Fungáčová and Weill (2012) who rank Russian banks by size and find that the largest banks are the key liquidity creators. Figure 1 shows that small banks on average destroy liquidity. This is because our new *catmat nonfat* (6) liquidity measure is always on average more conservative compared to traditional Berger and Bouwman's (2009) *cat nonfat* (3) measure. It is explained by the construction of the latter which only accounts for a category of loans (mainly illiquid). The battery of regression results in the following sections underpin the financial fragility hypothesis for small banks: higher capital ratios lead to higher liquidity destruction.

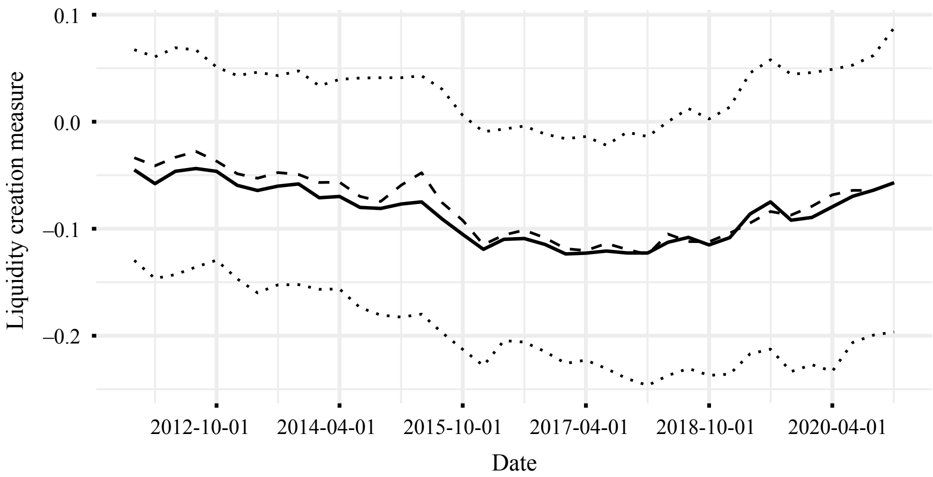

Fig. 1. Dynamics of average liquidity creation measures for small (876) and big (24) banks over the 2010–2019 period

Figure 2 demonstrates the binned scatter plot for the whole dataset of 885 Russian banks over the 2010–2019 period by quarters. The preferred liquidity creation measure is on the *y*-axis and the total capital ratio is on the *x*-axis. The direction suggests a negative relationship between these two variables.

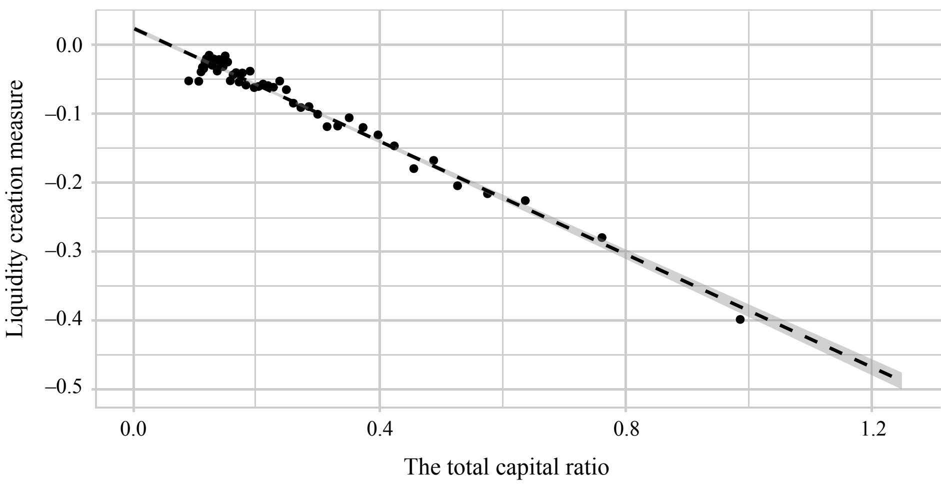

Fig. 2. The binned (n = 50) scatter plot between preferred liquidity creation measure and the total capital ratio, the 2010–2019 period

4. Empirical strategy

4.1. Hypothesis formulation

The modern theory of financial intermediation proposes two main roles for banks. When banks issue riskless deposits to finance risky loans, they perform a risk transformation role (Diamond, 1984). When banks fund relatively illiquid assets with relatively liquid liabilities, they create liquidity (Bryant, 1980; Diamond, Dybvig, 1983).

The risk transformation role of banks has already been well-studied by researchers. This cannot be said about the role of banks as liquidity creators which was insufficiently explored before the 2008–2009 global financial crisis.

Two opposite theories explain the influence of bank capital on liquidity creation. The first set of theories known as the "financial fragility-crowding out hypothesis" consists of two mechanisms.

The authors of the first mechanism are Diamond and Rajan (2000, 2001). They created the "financial fragility structure" effect which can be shown in the following process. The bank takes depositors' funds and uses them to finance investment projects. The agency problem comes into play because the bank knows borrowers' profitability levels while depositors do not. The bank might require a premium from its depositors. If they refuse to pay this premium, the bank can threaten them by reducing monitoring of borrowers and decreasing loan-collecting efforts. Depositors are prudent about that outcome and do not put their funds in the bank. Thus, the bank must deserve depositors' trust by implementing a fragile financial structure. If the bank decreases loan-collecting efforts or reduces monitoring of borrowers, depositors can run on the bank leaving it without liquid funds. A fragile financial structure induces the bank to collect more deposits and lend more funds because of this potential behavior of depositors. Higher capital increases the bargaining power of the bank which reduces the incentives to make necessary efforts in favor of depositors. Hence, higher capital decreases liquidity creation.

The second mechanism was suggested by Gorton and Winton (2017) who come to the same result through the "crowding-out of deposits" effect. They show that an overall increase in required bank capital forces investors to decrease depositors' funds in favor of bank capital. Thus, higher capital decreases liquidity creation since deposits are liquid and bank capital is illiquid.

Another set of theories is known as the "risk absorption hypothesis" and it also consists of two mechanisms. The first mechanism (Diamond, Dybvig, 1983; Allen, Santomero, 1997; Allen, Gale, 2004) works as follows. Banks are obliged to make provisions for NPL. The more liquidity is created, the greater the likelihood that some loans would be NPL, and the more capital is needed to accept associated expenses caused by increased provisions.

The second mechanism claims that too high a capital ratio increases the risk-bearing capacity and induces banks to lend more, in other words, create more liquidity on the asset side (Bhattacharya, Thakor, 1993; Repullo, 2004; Von Thadden, 2004; Coval, Thakor, 2005). In this case, an increase of equity by 1 unit allows a bank to lend more by nearly 10 units to remain within the regulatory requirements.

Based on the theories on the relationship between bank capital and liquidity creation, we posit the following main hypotheses.

Hypothesis 1. Bank capital has a significantly negative impact on the liquidity creation of the Russian banks which is in line with the "financial fragility-crowding out hypothesis".

Hypothesis 2. Bank capital has a significantly positive impact on the liquidity creation of the Russian banks which supports the "risk absorption hypothesis".

Although the seminal work of Berger and Bouwman (2009) proposes different effects of bank capital on liquidity creation depending on bank size, most recent studies (Casu et al., 2019; Le, 2019) have not found evidence of that.

Based on these empirical studies on the relationship between bank capital and liquidity creation, we posit the following auxiliary hypotheses.

Hypothesis 3. Bank size does not influence the sign of the relationship between bank capital and liquidity creation.

Lei and Song (2013), Horváth et al. (2014), Fu et al. (2016), etc. use the samples in their studies that cover the 2008–2009 global financial crisis. They have not found a statistically significant effect of the downturn periods on the relationship between bank capital and liquidity creation.

Hypothesis 4. The 2014–2015 financial crisis in Russia did not affect the sign of the relationship between bank capital and liquidity creation.

To test the above-mentioned hypotheses, we implement several empirical specifications that are further described.

4.2. Empirical specification

Our baseline specification employs the two-way fixed effects model with OLS estimator, as in (Berger, Bouwman, 2009; Lei, Song, 2013) and White (1980) standard errors,

$$nLqdALE_{i,t} = c + \beta_1 TCR_{i,t} + \sum_k \gamma_k CV_{i,t}^k + \upsilon_i + \tau_t + \varepsilon_{i,t}, \tag{9}$$

where *nLqdALE* is the preferred *catmat nonfat* (6) liquidity creation measure normalized by total assets of i^{th} bank at time *t*, *TCR* is the total capital ratio, *CV* is the vector k^{th} of control variables, $\varepsilon_{i,t}$ — the residual. Normalization of a liquidity creation measure by total assets of a bank is necessary to make meaningful comparisons across different banks. Further, we will also take pre-determined lagged values of all control variables to alleviate the endogeneity concerns due to simultaneity. υ_i denotes bank fixed effects that absorb unobserved time-invariant characteristics across banks. τ_t is time-fixed effects that absorb time-specific unobserved macro shocks and subsume average differences in liquidity creation across years due to these shocks. The two-way fixed effects model allows control for omitted variables bias that may not be captured by the set of observable time-varying control variables.

The theoretical models suggest the key determinants of liquidity creation and banks' capital. Ghosh (2016) and Le (2019) who study this relationship for India and Vietnam respectively suggest that the key variables of interest could be jointly determined and employ the simultaneous equations' model with 3SLS-GMM estimator:

$$\begin{cases} nLqdALE_{i,t} = c_1 + \beta_1 TCR_{i,t} + \sum_k \gamma_k CV_{i,t-1}^k + \varepsilon_{i,t}, \\ TCR_{i,t} = c_2 + \alpha_1 nLqdALE_{i,t} + \sum_k \alpha_k CV_{i,t-1}^k + \theta_{i,t}. \end{cases} \tag{10}$$

The simultaneous equations' framework allows alleviating the possible simultaneity bias due to joint determination of *nLqdALE* and *TCR*. Although there are a lot of estimation methods that can be applied to estimate simultaneous equations, we choose 3SLS-GMM estimator because it allows to account for heteroskedasticity of standard errors and different right-hand side variables in both equations.

Moreover, Belsley (1988) finds that the 3SLS estimator is more efficient than 2SLS estimator due to the increase in strength of the interrelations among the disturbances. Nevertheless, we perform Hausman test for misspecification to answer the question of whether the 3SLS-GMM estimator is consistent and asymptotically efficient.

Finally, we employ the dynamic panel data model with the two-step Arellano–Bond GMM estimator and Windmeijer's (2005) corrected standard errors (as in (Horváth et al., 2014; Tran et al., 2016)):

$$nLqdALE_{i,t} = \sum_{l} \alpha_l nLqdALE_{i,t-l} + \beta_1 TCR_{i,t} + \sum_{k} \gamma_k CV^k_{i,t-1} + \upsilon_i + \varepsilon_{i,t}\,. \tag{11}$$

Arellano, Bond (1991) and Blundell, Bond (1998) point out that the dynamic panel data model with the two-step Arellano–Bond GMM estimator outperforms traditional estimators due to:

a) it corrects potential endogeneity, heteroskedasticity, and autocorrelation problems in the panel data; and
b) this method uses lagged dependent variable and the set of exogenous variables as instruments to eliminate a simultaneity bias.

The efficiency of the two-step Arellano–Bond GMM estimator of Arellano, Bover (1995) and Blundell, Bond (2000) is higher than the difference GMM of Arellano, Bond (1991) because both regressions are used not only in difference but also in level. The potential downward bias of the two-step Arellano–Bond GMM estimator is corrected by applying Windmeijer's (2005) robust standard errors.

To address the potential endogeneity problem and examine the robustness of our findings we use several techniques: divide the liquidity creation measure into the measures created on asset and both asset and liability sides, use the *cat nonfat* (3) liquidity creation measure, divide the sample on the subsamples of before, during and after the 2014–2015 financial crisis in Russia, use one year lagged independent variables, and divide the sample into the subsamples of defaulted and survived banks.

5. Results

5.1. Baseline results

First, we report the empirical results of the two-way fixed effects model with OLS estimator and White (1980) standard errors (FE), the simultaneous equations' model with 3SLS-GMM estimator (SE), and the dynamic panel data model with the two-step Arellano–Bond GMM estimator and Windmeijer's (2005) corrected standard errors (DPD) for the relationship between the total capital ratio and liquidity creation in Table 4. The dependent variable is preferred measure of liquidity creation *catmat nonfat*. The sample period is 2010–2019. The Hausman test for FE is used to choose between FE and RE estimators. The Hausman test for SE is used to choose between 2SLS and 3SLS estimators. The Arellano–Bond (AB) test for zero correlation is based on the null hypothesis of second-order autocorrelation in the first differenced errors.

Table 4. Total regulatory capital ratio and liquidity creation

	Model		
	FE	SE	DPD
TCR	–0.346***	–1.066***	–0.238***
	(0.030)	(0.101)	(0.039)
nLqdALE (–1Q)	—	—	0.605***
	—	—	(0.028)
lnAssets	0.038***	–0.024***	0.022**
	(0.010)	(0.005)	(0.010)
ROA	–0.022	–0.062**	–0.046***
	(0.014)	(0.019)	(0.014)
NPLGL	0.014	–0.001	–0.005
	(0.041)	(0.014)	(0.013)
ROASD	–0.059	0.321***	–0.000
	(0.038)	(0.052)	(0.021)
lnZscore	0.005*	0.052***	0.002
	(0.003)	(0.005)	(0.002)
MA	–0.004	0.072**	–0.003
	(0.017)	(0.027)	(0.007)
Sanctions	0.031	0.166***	0.029*
	(0.025)	(0.016)	(0.016)
Foreign	0.022	0.125***	–0.016
	(0.044)	(0.014)	(0.023)
leadDefault	–0.017**	–0.072***	–0.009
	(0.008)	(0.011)	(0.006)
HHI	—	1.959***	0.153
	—	(0.377)	(0.107)
grGDP	—	–0.008*	0.001
	—	(0.003)	(0.001)
MosprimeON	—	0.123	0.032
	—	(0.142)	(0.053)
Time effects	Yes	No	No
Individual effects	Yes	No	Yes
Observations	20785	20785	18649
F-test (p-value)	0.000	—	—
Hausman test (p-value)	0.000	1.000	—
AB test (2) (p-value)	—	—	0.758

Note. *, **, and *** denote significance at the 10, 5, and 1% levels, respectively.
Standard errors are given in parenthesis.

To statistically estimate FE model's significance, we apply the *F*-test and conclude that the alternative hypothesis is not rejected meaning that FE model is statistically significant. The Hausman test for FE model is used to choose between FE and RE estimators. *P*-value calculated using this test is almost zero, thus, we cannot reject the alternative hypothesis that FE estimator is consistent at 1% level of significance.

We report only the first equation for SE model to save space. Detailed results can be provided upon request. The Hausman test for the SE model is used to choose between 2SLS and 3SLS estimators. Under the null hypothesis of the test, both 2SLS and 3SLS estimators are consistent, but the 3SLS estimator is asymptotically efficient. Since the *p*-value calculated using this test is approximately equal to one, we cannot reject the null hypothesis concluding that 2SLS and 3SLS estimators are consistent, but only the 3SLS estimator is asymptotically efficient at a 1% level of significance.

We introduce 1 quarter lag of the dependent variable in the DPD model because we do not find any seasonal patterns in Figure 1 where the average normalized liquidity creation measure is presented for big and small banks. If there were seasonality, we had to choose another lag or deseasonalize the liquidity creation measure.

The Arellano–Bond (AB) test for first- and second-order autocorrelation is based on the null hypothesis of zero autocorrelation in the first differenced errors at orders 1 and 2. We apply this test and conclude that we reject zero autocorrelation at order 1 and cannot reject zero autocorrelation at order 2. This presents evidence that the Arellano–Bond model assumptions are satisfied.

As a result, all models show a statistically significant and negative association between the total capital ratio and liquidity creation. An increase of 1% in the total capital ratio corresponds to a decrease in liquidity creation by 0.24–1.07% which is in line with the "financial fragility-crowding out hypothesis".

Bank size is measured as the log of total assets positively and significantly influences liquidity creation at 1 and 5% levels correspondingly for FE and DPD models. SE model shows a negative relationship between bank size and liquidity creation at a 1% level of significance.

SE and DPD models provide a negative and statistically significant relationship between profitability and liquidity creation at 5 and 1% levels correspondingly. This can be explained in two ways: an increase in total assets reduces *ROA* and at the same time can enhance liquidity creation, and an increase in net income leads to higher retained earnings which are part of illiquid equity, hence, lower liquidity creation.

The share of *NPL* in gross loans, the standard deviation of *ROA* and *lnZscore* are used in the models to control bank risk since a primary reason why banks hold capital is to absorb risk. An increase in *NPLGL* and *ROASD* leads to an increase in bank risk while an increase in *lnZscore* indicates higher stability of a bank. We do not interpret any relationships between these variables and liquidity creation since they help to isolate the effect of the total capital ratio on liquidity creation from the role of the total capital ratio in supporting the risk transformation function of banks.

SE and DPD models provide positive and statistically significant estimates of sanctions on liquidity creation at 1 and 10% levels correspondingly. The OFAC sanctions list contains not only banks but commercial companies from Russia. In order to finance capital expenditures and working capital, these companies apply for a loan from the bank. The bank can refuse to provide financing to these companies because it fears getting on the sanctions list, and these companies apply for a loan to the bank that has already been sanctioned by the OFAC. Hence, the sanctioned bank can increase its liquidity creation at the expense of non-sanctioned banks.

Foreign ownership has a positive and statistically significant effect on liquidity creation at a 1% level suggesting that foreign banks have the expertise and technology to successfully compete with domestic banks for clients.

Default next quarter dummy negatively affects liquidity creation which is in line with the view that depositors know about the bank's problems and withdraw funds in advance. As a result, liquidity is being destroyed before the CBR revokes the banking license.

The involvement of a bank in mergers and acquisitions positively affects liquidity creation at a 5% level of significance. An acquirer gains new clients by increasing deposits and loans on the balance sheet, while a target can refocus business lines and gain higher interest margins from riskier loans.

Higher market competition measured as *HHI* has a positive and significant effect on liquidity creation. This finding suggests that banks operating in competitive market conditions tend to enhance their efficiency and transparency. As a result, they increase lending activities while simultaneously managing and mitigating risks effectively.

The real growth rate of the Russian GDP negatively affects liquidity creation at a 10% level. Economic growth frequently results in higher inflation rates, prompting central banks to implement interest rate hikes. These higher interest rates can have an adverse effect on loan demand, making borrowing more expensive for businesses and consumers alike. Consequently, reduced loan demand can lead to a decrease in liquidity creation by banks.

The estimated coefficients on the MosPrime overnight rate are insignificant suggesting that a proxy for the interest rate in the economy does not significantly influence liquidity creation.

5.2. "Too-big-to-fail" banks versus medium and small banks

Berger and Bouwman (2009) report a positive relationship between bank capital and liquidity creation for big banks and a negative relationship for small banks. We have obtained controversial results for the entire sample. In order to examine the link between bank capital and liquidity creation with respect to bank size, we conducted regressions on subsamples, differentiating banks based on whether they are SIFI (Table 5). In the Tables 5 and 6 the dependent variable is preferred measure of liquidity creation *catmat nonfat*, and the sample period is 2010–2019. All of the control variables from the models' specifications are included in these regressions, but their estimates are not shown.

We include only bank-specific control variables and use only FE and DPD models due to an insufficient number of observations in the subsample of only big banks. As a result, the effect of the total capital ratio on liquidity creation is negative and statistically significant for both big and small banks at a 1% level while employing the FE model. DPD model shows that the relationship is insignificant for big banks and negative and significant at a 1% level for small banks.

We also construct the interaction term as the product of the total capital ratio and dummy variable Big and run FE and DPD models with the interaction term (Table 6). Although this helps to increase the number of observations in each regression, the interaction term is insignificant while the total capital ratio still negatively affects liquidity creation.

Table 5. The effect of banks size on the relationship between total capital ratio and liquidity creation

	Model			
	"Too-big-too-fail"		Medium and small banks	
	FE	DPD	FE	DPD
TCR	–1.570***	–0.595	–0.310***	–0.237***
	(0.549)	(1.144)	(0.028)	(0.038)
nLqdALE(*–1Q*)	—	0.610**	—	0.604***
	—	(0.241)	—	(0.028)
All control variables	Yes	Yes	Yes	Yes
Time effects	Yes	No	Yes	No
Individual effects	Yes	Yes	Yes	Yes
Observations	401	366	20384	18283

Note. **, and *** denote significance at the 5 and 1% levels, respectively.
Standard errors are given in parentheses.

Table 6. Interaction of banks size with total capital ratio and liquidity creation

	Model	
	FE	DPD
TCR	–0.346***	–0.239***
	(0.030)	(0.039)
TCR Big	–0.018	–0.133
	(0.178)	(0.082)
All control variables	Yes	Yes
Time effects	Yes	No
Individual effects	Yes	Yes
Observations	20785	18649

Note. *** denote significance at the 1% level. Standard errors are given in parenthesis.

This is not an unexpected result because most recent studies (Casu et al., 2019; Le, 2019) have not found evidence of opposite effects of bank capital on liquidity creation for different bank sizes. Thus, we confirm the hypothesis 3 that bank size does not influence the sign of the relationship between bank capital and liquidity creation.

5.3. Liquidity creation and banking crisis

We are also interested in how the relationship between the total capital ratio and liquidity creation behaves in different time periods: before, during, and after the 2014–2015[8] financial crisis in Russia (Table 7). The beginning of the 2014–2015 financial crisis in Russia coincided with

[8] The period after the 2014–2015 financial crisis is from January 2016 to December 2019.

the introduction of Basel III which requires to maintain tougher capital standards compared to Basel II. However, both shocks do not have any effect on the sign of the association between the total capital ratio and liquidity creation that remains negative and statistically significant at the 1% level. This holds even after the crisis ended in 2016 which supports the "financial fragility-crowding out hypothesis".

Table 7. The subsample results depending on the 2014–2015 financial crisis

	Period / Model								
	Before the 2014–2015 crisis			During the 2014–2015 crisis			After the 2014–2015 crisis		
	FE	SE	DPD	FE	SE	DPD	FE	SE	DPD
TCR	–0.222***	–0.873***	–0.372***	–0.315***	0.786	–0.189***	–0.292***	–1.113***	–0.202***
	(0.034)	(0.131)	(0.122)	(0.035)	(0.631)	(0.064)	(0.029)	(0.145)	(0.038)
nLqdALE(–1*Q*)	—	—	0.616***	—	—	0.249**	—	—	0.644***
	—	—	(0.050)	—	—	(0.117)	—	—	(0.058)
All control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	No	No	Yes	No	No	Yes	No	No
Individual effects	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Observations	8888	8888	7823	4726	4726	2506	7171	7171	5864

Note. Dependent variable — measure of liquidity creation *catmat nonfat*. **, and *** denote significance at the 5 and 1% levels, respectively. Standard errors are given in parenthesis.

These results suggest no influence on the sign of the relationship between bank capital and liquidity creation during the 2014–2015 financial crisis in Russia are confirmed, and the hypothesis 4 is verified.

6. Robustness checks

6.1. Exclusion of equity from the liquidity creation measure

To check the robustness of the results obtained in the previous chapter we analyze how the total capital ratio influences the liquidity created: a) only on the asset, and b) both on the asset and liability sides (Table 8). The sample period is 2010–2019. Only bank-specific variables are included in these regressions, but their estimates are not shown. This helps us to understand how components of our preferred liquidity creation measure respond to the change in the total capital ratio. Also excluding equity from the liquidity creation measure (*nLqdAL*) removes a potential endogeneity concern since the total capital ratio is calculated using the regulated capital.

Estimation results of the FE model (Table 8) suggest that an increase in 1% of the total capital ratio corresponds to a decrease in 0.27% of the liquidity created on the asset side, and 0.24% of the liquidity created on both asset and liability sides. This means that the implementation of more stringent capital requirements results in a lower ability of banks to generate liquidity, essentially limiting lending to the real sector of the economy.

Table 8. The regression results for the different measures of liquidity creation

	Dependent variable	
	nLqdA	*nLqdAL*
TCR	–0.270***	–0.241***
	(0.028)	(0.024)
Time effects	Yes	Yes
Individual effects	Yes	Yes
Observations	20785	20785

Note. *** denote significance at the 1% level. Standard errors are given in parentheses.

6.2. Original Berger and Bouwman's (2009) liquidity measure

In our second robustness check, we test how the total capital ratio affects the *cat nonfat* (3) measure calculated based on the original Berger and Bouwman's (2009) algorithm (Table 9). In the Table 9 the dependent variable is the measure of liquidity creation *cat nonfat*, the sample period is 2010–2019. All of the control variables from the models' specifications are included in these regressions, but their estimates are not shown. The estimated results confirm that the relationship remains negative while employing the original Berger and Bouwman's (2009) liquidity creation measure.

The effect of the total capital ratio on the coefficient on *cat nonfat* (3) remains negative and statistically significant at 1% level for the FE and DPD models and at the 10% level for the SE model.

Table 9. The regression results for the different measures of liquidity creation

	Model		
	FE	SE	DPD
TCR	–0.333***	–0.203*	–0.279***
	(0.035)	(0.082)	(0.049)
All control variables	Yes	Yes	Yes
Time effects	Yes	No	No
Individual effects	Yes	No	Yes
Observations	20785	20785	18649

Note. * and *** denote significance at the 10 and 1% levels, respectively.
Standard errors are given in parentheses.

We also conduct robustness checks using one-year lagged independent variables and subsamples of survived and defaulted banks and the relationship between liquidity creation and the total capital ratio remains negative which is in line with our previous findings. These results can be provided upon request.

7. Conclusion

This study examines the relationship between bank capital and liquidity creation in Russia. The Central Bank of Russia introduced a new regulatory framework known as the Basel III at the beginning of 2014 which substantially increases total capital ratios compared to the Basel II standards. Considering mixed results reported in the previous studies on the samples of U.S., UK, Brazilian, Chinese, Indian, South African, European, Asia-Pacific, and the GCC banks there was an open question: what is the effect of bank capital on liquidity creation in the Russian banking system.

Inspired by Berger and Bouwman (2009) approach to the liquidity creation measure calculation, we improve it by simultaneously considering the category and maturity of loans and other secondary accounts. For this purpose, we use highly detailed information from the balance sheet that is publicly available at the Central Bank of Russia website on a monthly basis.

We employ the two-way fixed effects model with the OLS estimator and White's (1980) standard errors, the simultaneous equations' model with the 3SLS-GMM estimator, and the dynamic panel data model with the two-step Arellano–Bond GMM estimator and Windmeijer's (2005) corrected standard errors. To address the potential endogeneity problem, we divide the liquidity creation measure into the measures of liquidity created on asset and both asset and liability sides, using the *cat nonfat* (3) liquidity creation measure constructed from the original Berger and Bouwman's (2009) algorithm, divide the sample into the subsamples of before, during and after the 2014–2015 financial crisis in Russia, use one year lagged independent variables, and divide the sample into the subsamples of defaulted and survived banks.

Using the sample of Russian banks over the 2010–2019 period (885 banks, 20785 bank-quarter observations) we find a negative and statistically significant effect of the total regulatory capital ratio on the liquidity creation which is in line with the "financial fragility-crowding out hypothesis". This result holds for big and small banks, for crisis and non-crisis periods, and for defaulted and survived banks. We also show that an increase in the total capital ratio destroys asset-side liquidity.

Our findings have major policy implications. They suggest that the Central Bank of Russia faces a trade-off between financial stability and liquidity creation, as tougher capital requirements decrease banks' ability to finance the real sector of the economy. Consequently, the regulator must consider this effect while making its decisions on the capital requirements of banks.

References

Al-Khouri R. (2012). Bank characteristics and liquidity transformation: The case of GCC banks. *International Journal of Economics and Finance*, 4 (12), 114–120. DOI: 10.5539/ijef.v4n12p114.

Allen F., Gale D. (2004). Financial intermediaries and markets. *Econometrica*, 72 (4), 1023–1061. DOI: 10.1111/j.1468-0262.2004.00525.x.

Allen F., Santomero A. M. (1997). The theory of financial intermediation. *Journal of Banking and Finance*, 21 (11–12), 1461–1485. DOI: 10.1016/S0378-4266(97)00032-0.

Arellano M., Bond S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies*, 58 (2), 277–297. DOI: 10.2307/2297968.

Arellano M., Bover O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68 (1), 29–51. DOI: 10.1016/0304-4076(94)01642-D.

Begenau J. (2020). Capital requirements, risk choice, and liquidity provision in a business-cycle model. *Journal of Financial Economics*, 136 (2), 355–378. DOI: 10.1016/j.jfineco.2019.10.004.

Belsley D. A. (1988). Two- or three-stage least squares? *Computer Science in Economics and Management*, 1, 21–30. DOI: 10.1007/BF00435200.

Berger A. N., Bouwman C. (2009). Bank liquidity creation. *The Review of Financial Studies*, 22 (9), 3779–3837. DOI: 10.1093/rfs/hhn104.

Bhattacharya S., Thakor A. (1993). Contemporary banking theory. *Journal of Financial Intermediation*, 3 (1), 2–50. DOI: 10.1006/jfin.1993.1001.

Blundell R., Bond S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, 87 (1), 115–143. DOI: 10.1016/S0304-4076(98)00009-8.

Blundell R., Bond S. (2000). GMM estimation with persistent panel data: An application to production functions. *Econometric Reviews*, 19 (3), 321–340. DOI: 10.1080/07474930008800475.

Bryant J. (1980). A model of reserves, bank runs, and deposit insurance. *Journal of Banking and Finance*, 4, 335–344. DOI: 10.1016/0378-4266(80)90012-6.

Casu B., Di Pietro F., Trujillo-Ponce A. (2019). Liquidity creation and bank capital. *Journal of Financial Services Research*, 56 (3), 307–340. DOI: 10.1007/s10693-018-0304-y.

Coval J. D., Thakor A. (2005). Financial intermediation as a beliefs-bridge between optimists and pessimists. *Journal of Financial Economics*, 75 (3), 535–569. DOI: 10.1016/j.jfineco.2004.02.005.

Diamond D. W. (1984). Financial intermediation and delegated monitoring. *Review of Economic Studies*, 51 (3), 393–414. DOI: 10.2307/2297430.

Diamond D. W., Dybvig P. H. (1983). Bank runs, deposit insurance, and liquidity. *Journal of Political Economy*, 91 (3), 401–419.

Diamond D. W., Rajan R. G. (2000). A theory of bank capital. *Journal of Finance*, 55 (6), 2431–2465. DOI: 10.1111/0022-1082.00296.

Diamond D. W., Rajan R. G. (2001). Liquidity risk, liquidity creation, and financial fragility: A theory of banking. *Journal of Political Economy*, 109 (2), 287–327. DOI: 10.1086/319552.

Distinguin I., Roulet C., Tarazi A. (2013). Bank regulatory capital and liquidity: Evidence from US and European publicly traded banks. *Journal of Banking and Finance*, 37 (9), 3295–3317. DOI: 10.1016/j.jbankfin.2013.04.027.

Fu X. M., Lin Y. R., Molyneux P. (2016). Bank capital and liquidity creation in Asia Pacific. *Economic Inquiry*, 54 (2), 966–993. DOI: 10.1111/ecin.12308.

Fungáčová Z., Weill L. (2012). Bank liquidity creation in Russia. *Eurasian Geography and Economics*, 53 (2), 285–299. DOI: 10.2747/1539-7216.53.2.285.

Fungáčová Z., Weill L., Zhou M. (2017). Bank capital, liquidity creation and deposit insurance. *Journal of Financial Services Research*, 51 (1), 97–123. DOI: 10.1007/s10693-016-0240-7.

Gorton G., Winton A. (2017). Liquidity provision, bank capital, and the macroeconomy. *Journal of Money, Credit and Banking*, 49 (1), 5–37. DOI: 10.1111/jmcb.12367.

Ghosh S. (2016). Capital buffer, credit risk and liquidity behaviour: Evidence for GCC banks. *Comparative Economic Studies*, 58, 539–569. DOI: 10.1057/s41294-016-0005-1.

Horváth R., Seidler J., Weill L. (2014). Bank capital and liquidity creation: Granger-causality evidence. *Journal of Financial Research*, 45, 341–361. DOI: 10.1007/s10693-013-0164-4.

Instruction of the Bank of Russia No. 2332-U (2009). On the list, forms, and procedure for the preparation and submission of reporting forms by credit institutions to the Central Bank of the Russian Federation (in Russian). https://www.cbr.ru/Queries/XsltBlock/File/86180/-1/1166-1167.

Instruction of the Bank of Russia No. 3737-U (2015). On the methodology for determining systemically significant credit institutions (in Russian). https://www.cbr.ru/Queries/XsltBlock/File/86277/-1/1667.

Instruction of the Bank of Russia No. 4212-U (2016). On the list, forms, and procedure for the preparation and submission of reporting forms by credit institutions to the Central Bank of the Russian Federation (in Russian). https://www.cbr.ru/Queries/XsltBlock/File/86297/-1/1846-1847.

Instruction of the Bank of Russia No. 4927-U (2018). On the list, forms, and procedure for the preparation and submission of reporting forms by credit institutions to the Central Bank of the Russian Federation (in Russian). https://www.cbr.ru/Queries/XsltBlock/File/86302/-1/2059-2060.

Le T. (2019). The interrelationship between liquidity creation and bank capital in Vietnamese banking. *Managerial Finance*, 45 (2), 331–347. DOI: 10.1108/MF-09-2017-0337.

Lei A. C. H., Song Z. (2013). Liquidity creation and bank capital structure in China. *Global Finance Journal*, 24 (3), 188–202. DOI: 10.1016/j.gfj.2013.10.004.

Lindquist K. G. (2004). Banks' buffer capital: How important is risk. *Journal of International Money and Finance*, 23 (3), 493–513. DOI: 10.1016/j.jimonfin.2004.01.006.

Repullo R. (2004). Capital requirements, market power, and risk-taking in banking. *Journal of Financial Intermediation*, 13 (2), 156–182. DOI: 10.1016/j.jfi.2003.08.005.

Tran V. T., Lin C. T., Hoa N. (2016). Liquidity creation, regulatory capital, and bank profitability. *International Review of Financial Analysis*, 48, 98–109. DOI: 10.1016/j.irfa.2016.09.010.

Vernikov A. V. (2023). Russian bank data: Breaking down the sample of banks by ownership. DOI: 10.2139/ssrn.2600738.

Von Thadden E. L. (2004). Bank capital adequacy regulation under the New Basel Accord. *Journal of Financial Intermediation*, 13 (2), 90–95. DOI: 10.1016/j.jfi.2003.04.002.

White H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica*, 48 (4), 817–838. DOI: 10.2307/1912934.

Windmeijer F. (2005). A finite sample correction for the variance of linear efficient twostep GMM estimators. *Journal of Econometrics*, 126 (1), 25–51. DOI: 10.1016/j.jeconom.2004.02.005.

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Appendix

This table presents the generalized assignment of liquidity classes to the balance sheet's classes, which are constructed based on secondary accounts. The balance sheet's subclasses are denoted in italics.

<table>
<tr><th colspan="3">Assets</th></tr>
<tr><th>Liquid — M<181 days
(weight = –1/2)</th><th>Semi-liquid — 181 days ≤M<1 year
(weight = 0)</th><th>Illiquid — M≥1 year
(weight = 1/2)</th></tr>
<tr><td>1. Cash and cash equivalents
2. Funds in the Central Bank of the Russian Federation
3. Funds in credit institutions</td><td></td><td></td></tr>
<tr><td colspan="3">4. Financial assets at fair value through profit or loss:</td></tr>
<tr><td>*Sovereign debt obligations, including those guaranteed by them*</td><td>*Subsovereign and bank debt obligations, stocks*</td><td>*Reserves and derivatives*</td></tr>
<tr><td colspan="3">5. Net loans at amortized cost</td></tr>
<tr><td colspan="3">6. Net investments in financial assets at fair value through other comprehensive income:</td></tr>
<tr><td>*Exchange listed stocks purchased for investments*</td><td></td><td>*Non-exchange listed stocks and debt*</td></tr>
<tr><td colspan="3">7. Net investments in securities and other financial assets measured at amortized cost (except loans):</td></tr>
<tr><td>*Exchange listed debt purchased for investments*</td><td></td><td>*Overdue debt obligations*</td></tr>
<tr><td></td><td>9. Current income tax requirements</td><td>8. Investments in subsidiaries and affiliates
10. Deferred tax asset
11. Fixed assets, right-of-use assets and intangible assets
12. Long-term assets held for sale</td></tr>
<tr><td colspan="3">13. Other assets:</td></tr>
<tr><td>*Settlements on transactions with securities and interbank transactions*</td><td>*Accounts receivable*</td><td>*Deferred expenses*</td></tr>
</table>

<table>
<tr><th colspan="3">Liabilities and equity</th></tr>
<tr><th>Liquid — M<181 days
(weight = 1/2)</th><th>Semi-liquid — 181 days ≤M<1 year
(weight = 0)</th><th>Illiquid — M≥1 year
(weight = –1/2)</th></tr>
<tr><td colspan="3">15. Loans, deposits and other funds of the Central Bank of the Russian Federation</td></tr>
<tr><td colspan="3">16.1. Financial institutions' funds at amortized cost</td></tr>
<tr><td colspan="3">16.2. Customer funds at amortized cost held by non-financial institutions</td></tr>
<tr><td></td><td colspan="2">17. Financial liabilities at fair value through profit or loss</td></tr>
<tr><td colspan="3">18.1. Issued debt securities at fair value through profit or loss</td></tr>
<tr><td></td><td>18.2. Issued debt securities at amortized cost</td><td></td></tr>
<tr><td></td><td></td><td>20. Deferred tax liabilities</td></tr>
<tr><td colspan="3">21. Other liabilities:</td></tr>
<tr><td>*Settlements on transactions with securities and interbank transactions*</td><td>*Accounts payable*</td><td>*Deferred income*</td></tr>
<tr><td></td><td></td><td>22. Provisions for potential losses on contingent credit obligations, other potential losses, and transactions with residents of offshore zones
24–35. Equity</td></tr>
</table>