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Monetary Policy and Bank Liquidity Creation: Does Bank Size Matter?

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ABSTRACT

This paper investigates the effect of monetary policy on liquidity creation of commercial banks and if the effect is conditional on bank size. The paper uses a dataset covering 23 Vietnamese commercial banks during the period 2007–2017 collected from various sources including State Bank of Vietnam, International Monetary Fund, SNL Financial database (provided by SNL Company), Vietnam General Statistic Office and banks' annual reports. Different econometric techniques are employed to analyse the data. Obtained results indicate that a contractionary monetary policy could lead to a decrease in bank liquidity creation. This result is less pronounced with larger banks. In particular, among three monetary policy instruments employed in Vietnam, an increase in the base rate is significantly associated with a contraction in bank liquidity creation; open market operations may have a marginal impact while required reserve ratio is ineffective because of its unchanged value throughout the period of the study. This paper is among the first, providing an insight into each monetary policy instrument's role in influencing bank liquidity creation in the context of an emerging economy.

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1. Introduction

Monetary policy is conventionally the main instrument for a central bank to steer the economy in the desired direction. It plays an important role in the economic growth, inflation control, cost and availability of credit and keeping the balance of payment in equilibrium. Thus an understanding of monetary policy transmission is an important research question for both policymakers and academic community (Hussain & Bashir, 2019).

Various factors play a role in monetary policy transmission, which has implications for the real economy. The extent to which these policy actions can be transmitted into the desired changes will depend on the functioning of the banking system. In particular, it subjects to the ability to create liquidity of commercial banks. Research on the effectiveness of monetary transmission from the central bank to the banking system is relatively

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scant, and little is known about factors influencing this mechanism. Berger and Bouwman (2017) is a rare study in this direction, but its focus is on the US. The fact that banking systems in emerging countries are generally more diverse and lacking strong institutional and regulatory bodies could elicit different impacts on the monetary policy and bank liquidity creation nexus.

Our study is intended to contribute to this niche by conducting a critical assessment of how monetary policy affects bank liquidity creation and whether bank size matters in an emerging economy, Vietnam. We aim to obtain the data of all 46 commercial banks in Vietnam from various sources including State Bank of Vietnam, International Monetary Fund, SNL Financial database (provided by SNL Company) and banks' annual reports. Because of the missing data problem, the final dataset consists of 253 observations of 23 Vietnamese banks during the period 2007–2017. We use the fixed-effect (FE) and two-stage least square instrumental variable (2SLS IV) to analyse the data. We find that the contractionary monetary policy could lead to a decrease in bank liquidity creation. This result is less pronounced with larger banks. In particular, among three monetary policy instruments employed in Vietnam, an increase in the base rate is significantly associated with a contraction in bank liquidity creation; open market operations exert a negligible impact while required reserve ratio is ineffective because of its unchanged value over the period of study. The obtained results are robust to different estimation models and methods. These findings serve as an essential guide to policymakers and researchers on monetary policy and banking issues.

Our study contributes to the literature on monetary policy and bank liquidity creation nexus by providing a critical assessment of monetary policy's impact on bank liquidity creation in an emerging economy. Although some conceptual studies have suggested the possible impact of monetary policy on bank liquidity creation (e.g. Shin, 2005), empirical evidence is scant. While the work of Berger and Bouwman (2017) is so far identified as the unique empirical study in this direction, it is confined within the context of the US, a developed country. By contrast, we consider an emerging economy whose market structure is far different from that of a developed economy in several aspects. Moreover, as suggested by Meslier et al. (2014) and Wong and Deng (2016), these countries' banking sectors have experienced many liberalisation reforms and deregulation, especially after the recent global financial crisis. This changing environment makes the study on monetary policy's impact on bank liquidity creation in emerging countries interesting and increasing importance. Hussain and Bashir (2019) provide a useful finding into the role of various factors in the bank lending channel of monetary policy transmission in an emerging economy, China. However, they only focus on bank loan growth rather than bank liquidity creation. Another study, Le (2019), provides some fundamental background on bank liquidity creation in Vietnam. Still, this study investigates the interrelationship between bank capital and liquidity creation of the Vietnamese banking system rather than the effects of monetary policy on bank liquidity creation.

2. Literature Review and Theoretical Framework

2.1. Bank Liquidity Creation

According to Yeager and Seitz (1989), liquidity is a financial institution's ability to meet all financial demands. The Basel Committee on Banking Supervision (BCBS) defines bank

liquidity as the bank's capability to fund increases in assets and satisfy obligations at short notice with little acceptable losses (BCBS, 2009). To compute bank liquidity, many empirical studies (e.g. Bunda & Desquilbet, 2008; Distinguin et al., 2013) employ ratios calculated from accounting data such as a ratio of liquid assets to total assets. Nevertheless, using such liquidity ratios could be imprecise under certain circumstances such as the Southeast Bank of Miami case. Despite having liquid assets to total assets above 30%, that bank went bankrupt due to its inability to repay some liabilities claimed on-demand with its liquid assets (Distinguin et al., 2013).

To deal with such issues, Deep and Schaefer (2004) construct a liquidity transformation measure to proxy for liquidity creation. They define the liquidity transformation gap or 'LT gap' as the ratio of the difference between a bank's liquid liabilities and liquid assets to its total assets. In their work, they consider all assets and liabilities that mature within one-year liquid but exclude loan commitments and other off-balance sheet activities due to their contingent nature. The ratio yields values between $+1$ and -1, indicating the amount of maturity transformation a bank performs. It thereby captures 'classic' banking business activities in creating liquidity. At the gap value of $+1$, a bank turns all deposits into assets that are not liquid (assuming that a bank is funded solely through deposits). In this case, the bank is likely to perform 'perfect' maturity transformation, meaning that it will turn all deposits into an asset with greater maturity. A LT gap value of 0 indicates that a bank only creates liquid assets with its deposits and, therefore, does not perform any maturity transformation at all. The ratio is negative when a bank holds more liquid assets than deposits, signifying that it would tap additional funding sources to hold liquid assets. The bank will extract liquidity from the market and hence perform negative maturity transformation. This method shows: (1) the absolute amount of liquidity a bank creates for the economy and (2) the amount of maturity transformation the bank performs to create this liquidity. Two kinds of liquidity creation can be captured in this method. By transforming the maturities of deposits when turning them into loans, banks create additional cash for the economy. Depositors are offered readily available withdrawals for their accounts, and borrowers are offered contemporaneously long-term cash through loans.

Drawing on the use of liquidity transformation to measure liquidity creation, Berger and Bouwman (2009) develop a comprehensive set of indicators. To construct their liquidity creation measures, they classify all bank assets, liabilities, equity, and off-balance sheet activities as liquid, semiliquid, or illiquid. After assigning weights to the activities classified earlier, they construct four liquidity creation measures by combining the activities as classified and weighted previously in different ways. The measures classify all activities other than loans by product category (i.e. 'cat') and maturity (i.e. 'mat'). To assess how much liquidity banks create on the balance sheet versus off the balance sheet, they alternatively include off-balance-sheet activities (i.e. 'fat') or exclude them (i.e. 'nonfat'). The measures developed by Berger and Bouwman (2009) have been the most widely accepted and employed in bank liquidity research so far.

In this paper, we employ the liquidity creation measurements developed by Berger and Bouwman (2009) to proxy liquidity creation. More details about the calculation of liquidity creation of Vietnamese banks are discussed later.

A significant amount of empirical research has focused on determinants of bank liquidity creation of which bank characteristics such as bank capital and bank size have been

widely examined. However, research focusing on the effect of monetary policy on bank liquidity creation is limited. Berger and Bouwman (2017) is a rare study in this direction, but its focus is on the US. The fact that banking systems in emerging countries are generally more diverse and lacking strong institutional and regulatory bodies could elicit different impacts on the monetary policy and bank liquidity creation nexus. Hussain and Bashir (2019) provide a useful initial finding into the role of various factors in the bank lending channel of monetary policy transmission in an emerging economy, China. However, the authors only focus on use loan growth to proxy bank lending capacity. Loan growth is insufficient to reflect the ability of commercial banks to create liquidity for an economy. This is because bank liquidity creation is the bank's capability to fund increases in assets and satisfy obligations at short notice with little acceptable losses.

2.2. Monetary Policy Instruments

Monetary policy is a macroeconomic policy conducted by a central bank or other regulatory committees to adjust the size of the money supply into an economy. Monetary policy affects bank deposits, hence bank loan supply and consequently, bank liquidity creation. Some studies (Ehrmann et al., 2003; Kishan & Opiela, 2000) argue that tight monetary policy changes the return on deposits which alter householder's preference to hold it instead of depositing in banks. According to Hussain and Bashir (2019), some other authors (Cantero-Saiz, Sanfilippo-Azofra, Torre-Olmo, & LópezGutiérrez, 2014; Disyatat, 2004) propose somewhat different opinion on the link of bank deposits and bank lending after monetary policy contraction. Disyatat (2004) suggests that bank deposits may be irrelevant to reduce bank lending following monetary policy contraction if three elements (Fiat money, sufficiently capitalisation, and liberalised financial system) exist. Under such conditions, the bank can fulfil loan demand without reducing loan supply. In other words, Disyatat (2011) underscores the relationship between loan supply from bank deposits but appraise the role of the balance sheet, risk position and market funding premium that amplify bank lending channel of monetary policy transmission.

Along this line of arguments, monetary policy is assumed to regulate bank liquidity creation of the whole banking system. Existing monetary policy literature (i.e. Ashcraft, 2006; Bech & Keister, 2017; Distinguin et al., 2013; Hussain & Bashir, 2019; Keister, 2019; Peek & Rosengren, 1995) identifies three instruments that a central bank can use to implement its monetary policy. The instruments are the base interest rate, required reserve ratio and open market operations. In developed economies, central banks conventionally use interest rates as the main policy instrument. In contrast, in emerging markets, some non-interest rate instruments (e.g. reserve requirements) are often employed to serve as a complement, or even substitute, of interest rate-based monetary policy (Chen et al., 2017). For example, the State bank of Vietnam (SBV) has employed all three instruments to implement its monetary policies (SBV, 2020). Possible explanations why central banks in emerging economies such as SBV prefer to use both interest and non-interest base instrument are as follow. In emerging economies, monetary policy is often employed with multiple aims, such as curbing inflation, stabilising exchange rates and promoting economic growth while banks still constitute the dominant part of the financial system and serve as the major financing source in most emerging economies (Chen et al., 2017). Using all three instruments can help

enhance the implementation of multi-purpose monetary policy of emerging economy governments. In the following parts, we will examine how these three monetary instruments implemented by SBV affect liquidity creation by commercial banks in Vietnam.

2.2.1. The Base Rate

The base rate is the interest rate that the central bank charges for the loans it provides to commercial banks. It is also known as the base interest rate. It is the main monetary policy tool (Gertler & Karadi, 2013; Lucchetta, 2007). In emerging economies, the lack of diversified security products together with an under-developed corporate bonds market and a low freedom level of capital mobility makes the central bank's financing a critical source of banks' money supply. Hence, a change in the central bank's base rate is likely to cause a change in the lending and deposit rates applied by banks.

When the central bank sets a higher base rate, commercial banks will probably increase lending and deposit rates. Given that firms in emerging economies are mostly credit constrained, perhaps a change in banks' lending rate does not affect much the demand for a fund from businesses. They still need capital to expand their operation, serve orders from overseas markets, or meet increasing domestic demand. However, a change in banks' deposit rate likely leads to a change in savers' behaviours. When the deposit rate is high, savers will deposit more money in banks, which leads to higher financial liability that banks may have to pay in short notice. Hence, an increase in banks' deposit rate will likely lead to higher liability and decreases bank liquidity. In sum, an increase in base rate may result in a decrease in bank liquidity. In the same vein, Shin (2005) develops an analytical framework showing that raising interest rates can have the perverse effect of exacerbating the banking crisis, resulting from a decline in the commercial banking system's liquidity. Taken together, we expect that an increase in base rate may result in a decrease in bank liquidity.

2.2.2. Open Market Operations

A central bank gets involved in open market transactions to regulate the money supply in its economy through tendering (buying or selling) short-term government bonds. These tenders are not always implemented in regular auctions where commercial banks could bid at different rates. They are the so-called fixed rate tenders in which the central bank sets the interest rate, and commercial banks bid merely for the amount they want to get at that rate (Bindseil, 2005). Kashyap et al. (2002) suggest that the central bank's open market operations can affect the liquidity of the banking system. It is often argued that central banks in developing countries may increase their holding of long-term public/private securities or bonds, leading to a change in the amount of liquidity at commercial banks (Bech & Keister, 2017; Keister, 2019).

When the central bank buys bonds in the open market at an attractive rate, commercial banks are likely to sell bonds and hence have more cash available to lend. These practices lead to more lending to businesses and thus, more liquidity created by banks. When banks have more cash available, their demand for deposits decreases and leads to lower liability and higher liquidity, by contrast, when the central bank sells bonds in the open market at an attractive rate, banks will buy bonds and have less cash available to lend and, hence, there is less liquidity created by banks. These practices can also lead to more demand for deposits, resulted in higher liability and lowered liquidity. Therefore, it is reasonable to expect an increase in the net amount of bonds bought and sold by the central bank in the

open market may be positively correlated with a bank's cash availability or higher bank liquidity creation.

2.2.3. The Required Reserve Ratio

The required reserve ratio is the ratio of cash to total deposits which the central bank orders commercial banks to hold to settle financial obligations. It is a primary instrument that the central bank uses to manage commercial banks' liquidity. Reserves do not yield any return to banks. Holding required reserve reduces the number of funds available for investment and, hence, the expected returns and liquidity (Bashir, 2003). This situation is more likely to happen in emerging market economies where getting financed from the capital markets is often not easy because of their under-developed stage. Banks in emerging markets are expected to decrease lending when the central bank sets a higher required reserve ratio. In other words, we anticipate that an increase in the required reserve ratio in emerging market economies means that the bank has less cash to lend, leading to less earning from lending, and lower capability to settle its financial liabilities in a timely fashion.

2.3. The Role of Bank Size in the Link Between Monetary Policy and Bank Liquidity

Arguably, the monetary policy-liquidity creation nexus is likely to be dependent on bank size. This hypothesis can be explained by the effect of a loosening monetary policy on-balance sheet liquidity creation as follow. Under a loosening monetary policy, bank reserves are increased, leading to a growth of bank deposits and, consequently, greater funds available for making loans. It can also be the case that the high cost of funds generated from expensive sources like federal funds is now replaced by a lower cost of funds arisen from cheaper deposits, which ultimately increases loans. In this context, bank liquidity creation on-balance sheet has been increased through the lending channel which is consistent with the view suggested by some previous studies (i.e. Bernanke and Gertler, 1995 and Kashyap and Stein, 1997). It is worth noting that since small banks tend to have less access to capital markets and are mainly dependent on deposits, it is reasonable to expect that monetary policy is stronger for this type of bank size. Besides, since small banks are more likely to create liquidity on-balance sheet (Berger & Bouwman, 2009), we expect that the effect of monetary policy on off-balance sheet tends to be dominated by monetary policy on-balance sheet. In contrast, since large banks are more likely to create more liquidity on off-balance sheet, the positive effect on on-balance sheet may be dominated by the ambiguous effect of monetary policy on off-balance sheet. Hence, we expect that the impact of monetary policy on liquidity creation is stronger for banks with small size and weaker for large banks.

2.4. Research on Vietnamese Banking System

Research on Vietnam banking system is rather limited. Most of them (e.g. Leung, 2009; Tran et al., 2015) describe the Vietnamese banking system. Doan et al. (2018); Le (2019); Luu et al. (2019) are a few exceptions that examine drivers of bank efficiency, the interrelationship between liquidity creation and bank capital, and financial performance of commercial banks in the context of Vietnam respectively. However, none of them focuses on the impact of monetary policy on bank liquidity in Vietnam.

3. Research Context

Current Vietnam's banking industry comprises 46 banks of different sizes, ranging from relatively larger state-owned commercial banks to small privately held banks. Since the start of economic reform in the late 1980s, the industry has grown tremendously from a mono-banking system to an extended network of banks and financial institutions. Over the past 30 years, the Vietnamese government has initiated many banking reforms to improve the banking system's efficiency and competitiveness, especially via the privatisation of its state-owned banks. Many of these reforms have been motivated by the country's entry into international trade and investment agreements, such as the US-Vietnam Bilateral Trade Agreement in 2001, and its accession to the World Trade Organisation (WTO) in 2007. As the country gradually deregulates the sector to allow foreign banks' entry, there has been an increasing foreign banks presence. There is also some ongoing partial privatisation for some state-owned commercial banks to comply with the Basel capital accords' international capital standards. However, this process is relatively slow, and banks struggle to deal with a high level of non-performing loans (NPLs) and other structural problems (Tran et al., 2015).

Before 1990, the State Bank of Vietnam (SBV) functioned as both a central bank and a commercial bank. Currently, the SBV's role is narrowed down to that of a central bank focusing on the formulation of monetary policies, management of foreign exchange reserves, and licensing and supervision of credit institutions (a term that encompasses commercial banks). Meanwhile, financial intermediation functions such as funds mobilisation and allocation are shifted to commercial banks. The government implements its monetary policy through the operations of SBV. The SBV has employed both administrative and money market instruments to monitor the banking system. According to the State Bank of Vietnam Law of 2010, the SBV governor decides the use of tools to implement the national monetary policy, including base rates, required reserves, open market operations and other measures as stipulated by the government. The SBV provides short-term capital, or in other words, refinances financial institutions with loans secured by the mortgage of valuable papers; discount of valuable papers, and other refinancing forms. The SBV is active in open market operations which involve selling and buying government bonds. It also regulates the refinance rate and governs the ceilings for deposit and lending rates applied by financial institutions. The Communist Party has an exclusive role in governing the economy, especially in the banking and finance sector, making Vietnam an interesting emerging economy to study. As a result, this study's evidence could provide an improved understanding of the conduct of monetary policy instruments in controlling bank liquidity creation in an emerging market like Vietnam which has so far been under-researched.

4. Research Methodology

4.1. Data and Research Sample

To achieve our research aims, we collect data on all 46 Vietnamese commercial banks from the SNL Financial database in 2007–2017 for the most available and up-to-date data. SNL Financial, Inc. (SNL) is a company based in Charlottesville, Virginia, the USA that provides extensive industry-specific financial market data for many public and private companies worldwide. SNL's information is considered highly accurate (Carty and Weiss,

Table 1. Definitions and sources of main variables used in regression analysis.

Variable name	Description	Definition and construction	Data Source	Source of reference
Liquidity creation	FLC, NFLC	As described in Table 1	SNL Financial Database	Berger and Bouwman (2009)
Bank size	Bank size	Natural logarithm of total assets	SNL Financial Database	Horvath et al. (2016); Angeloni and Faia (2013)
Base rate	Base rate	The central bank's interest rate (%)	IMF	Distinguin et al., (2013); Chen et al. (2017)
Open market operations	OMO	The ratio of the net amount of bonds sold and bought by the central bank over total transactions (%)	State Bank of Vietnam	Chen et al. (2017)
Non-performing loans	NPL	The ratio of non-performing loans to total loans (%)	SNL Financial Database	Horvath et al. (2016)
Net interest margin	NI	The lending interest rate minus the deposit rate (%)	SNL Financial Database	Distinguin et al. (2013)
Market share	Mshare		SNL Financial Database	Distinguin et al. (2013)
Bank age	Age		SNL Financial Database	
GDP growth rate	GDP	GDP growth rate	General Statistic of Vietnam	
Unemployment	Unemp	Unemployment rate	General Statistic of Vietnam	
Trade balance	Trade	The gap between export minus import volume	General Statistic of Vietnam	
Inflation	Inf	The inflation rate	IMF	Horvath et al., 2016

2012). Based on SNL's company ID, we collect all the data from regulated depositories defined as commercial banks to create our initial database. However, our final dataset consists of 253 bank-year observations from 23 Vietnamese commercial banks over the 11 years due to the missing data problem.

Most of our variables relating to the banks are computed based on this SNL Financial database. These include variables capturing liquidity creation, bank size, net interest margin and non-performing loans. Data for the variable capturing *open market operations* were retrieved from the State Bank of Vietnam.[1] For other variables relating to Vietnam's macroeconomic data, we gather the data from the General Statistic Office of Vietnam and the International Monetary Fund. Table 1 summarises our variables and data sources.

4.2. Empirical Model

To investigate the effect of monetary policy on bank liquidity creation and the moderating effect of bank size on the impact of monetary policy on bank liquidity creation, we develop an empirical model in which monetary policy, bank size and the interaction variable that is the product of monetary policy variable and bank size are key predictors. The rationale for the inclusion of the interaction variables is based on Jaccard et al.'s (1990) work, which develops the use of an interaction variable to gauge the moderating effect of one independent variable on the impact of another independent variable on a dependent variable. We control various variables related to bank characteristics and macro-economic factors that potentially affect bank liquidity creation. Because our data spans through the global financial crisis year with massive financial market collapses in 2008 and 2009, we include crisis dummy variable to control for crisis effect. We also add a year dummy variable to control for year effect.

[1] The State Bank of Vietnam's website: https://www.sbv.gov.vn.

Note that we follow Aiken and West's (1991) procedure for testing the moderating effect of bank size. We use the mean centring approach suggested by Aiken and West (1991) to calculate the interaction variable to eliminate the possibility of multicollinearity. The interaction variable is calculated as below.

$$Banksize_{it}{*}MP_t = (MP_t - \text{mean score of } MP_t) * (Bank\ size_{it} - \text{mean score of } Bank\ size_{it})$$

Accordingly, we develop the following equation:

$$\begin{aligned} LC_{it} = {} & \alpha + \beta_1 MP_{t-1} + \beta_2\ Bank\ size_{it-1} + \beta_3\ Bank\ size_{it-1}{*}MP_{t-1} + \beta_4\ Bankcap_{it-1} \\ & + \beta_5\ Marketshare_{it-1} + \beta_6 NPL_{it-1} + \beta_7\ NIM_{it-1} \\ & + \beta_8\ Age_{it-1} + \beta_9 GDP_{t-1} + \beta_{10}\ Inflation_{t-1} + \beta_{11}\ Unemploy_{t-1} \\ & + \beta_{12}\ Year\ dummy\epsilon_i + \beta_{13}\ Crisis + \epsilon_{iit} \end{aligned} \quad (1)$$

In this formulation, LC_{it} denotes the liquidity creation of bank i at time t. Following Berger and Bouwman (2009)[2] and Le (2019),[3] We use two liquidity creation measures: non-fat liquidity creation (*NFLC*) for on-balance sheet activities and fat liquidity creation (*FLC*) for both on- and off-balance sheet activities. The construction of these measures is as follows. Firstly, all assets, liabilities, equity and OBS activities are classified as liquid, semi-liquid or illiquid by category. Secondly, these items are assigned weights according to the liquidity creation intuition. All else being equal, one dollar of liquidity is created by investing one dollar of liquid liabilities into one dollar of illiquid assets or illiquid OBS activities. Similarly, one dollar of liquidity is destroyed by transferring one dollar of illiquid liabilities or equity into one dollar of liquid assets or liquid OBS activities. Accordingly, if a bank creates more liquidity, it becomes more illiquid since transferring more liquid liabilities into illiquid assets. Following Berger and Bouwman (2009), we assign the weight of illiquid assets, liquid liabilities and illiquid OBS activities as 1/2, the weight of semi-liquid assets, semi-liquid liabilities and semi-liquid OBS as 0; and the weight of liquid assets, illiquid liabilities and liquid OBS activities as −1/2. Note that we classify consumer loans as illiquid assets since Vietnam's debt trading market has not developed due to the lack of a legal system, participants, and the implementation process. As such, consumers' loans in Vietnam are not collateralised by any organisation to sell for investors in the form of securities, making these loans illiquid.

Finally, liquidity creation is calculated according to the formulas below:

$$\begin{aligned} NFLC = {} & \frac{1}{2} * (\text{illiquid assets} + \text{liquid liabilities}) \\ & + 0 * (\text{semi} - \text{liquid assets} + \text{semi} - \text{liquid liabilities}) \\ & - \frac{1}{2} * (\text{liquid assets} + \text{illiquid liabilities} + \text{equity}) \end{aligned}$$

[2] Berger and Bouwman's (2009) LC measures have been the most comprehensive and widely employed in this literature so far.

[3] Le (2019), the only work studying bank liquidity creation in Vietnam, uses Berger and Bouwman's (2009) measures of LC to examine the causal effects between bank liquidity creation and bank capital.

Table 2. Liquidity classification and construction of two liquidity creation measures.

Assets		
Illiquid assets (weight = 1/2)	Semi-ilquid assets (weight = 0)	Liquid assets (weight = −1/2)
Corporate and commercial loans		Cash and due from other credit institutions
Other loans		Trading securities
Fixed assets		Derivatives
Other assets		Investment securities
Consumer/retail loans		At-equity investments in associates
		Other securities
Liabilities plus equity		
Liquid liabilities (weight = 1/2)	Semi-ilquid liabilities (weight = 0)	Illiquid liabilities plus equity (weight = −1/2)
Customer deposits-current	Customer deposits term	Senior debt maturing after 1 year
Customer deposits-saving'	Term deposits from banks	Subordinated borrowing
Demand deposit from banks and other credit institutions	Other deposits	Other funding
Derivatives	Short-term borrowing from banks	Other liabilities
Discounts and rediscounts of valuable papersa	Certificates of deposit	Total equity
OBS activities		
Illiquid OBS activities (weight = 1/2)	Semi-ilquid OBS activities (weight = 0)	Liquid OBS activities (weight = −1/2)
Acceptances and documentary credits reported OBS	Guarantees	
Committed credit lines		
Other contingent liabilities		

Sources: Le (2019). Note: The Vietnamese commercial banks ensure to buy back these items within 91 days so they are categorised as liquid liabilities.

$$\begin{aligned} FLC = {} & \frac{1}{2}*(\text{illiquid assets} + \text{liquid liabilities} + \text{illiquid OBS activities}) \\ & + 0*(\text{semi} - \text{liquid assets} + \text{semi} - \text{liquid liabilities} \\ & + \text{semi} - \text{liquid OBS activities}) \\ & - \frac{1}{2}*(\text{liquid assets} + \text{illiquid liabilities} + \text{equity} + \text{liquid OBS activities}) \end{aligned}$$

The details of calculations for NFLC and FLC can be founded in Table 2.

MP_{t-1} denotes a monetary policy instrument employed in year t-1. Specifically, monetary policy instruments include three different sets of indicators: base rate, open market operations, and required reserve ratio. The base rate ($Baserate_{t-1}$) is calculated following the common practice in the literature (e.g. Bech and Keister, 2017 and Keister, 2019). As per Bech and Keister (2017) and Keister (2019), the open market operations variable (OMO_{t-1}) is calculated as the ratio of the net amount of bonds bought and sold by the central bank over total transactions. In this research, due to the time invariance of required reserve ratio in our sample data (this ratio is kept stable over the study period), this required reserve ratio does not show it validity in an empirical analysis of the panel data. Therefore, we ignore this variable in our regression and focus on the other two.

$Bank\ size_{it-1}$ is the size of bank i in year t-1. Bank size is widely measured in term of total asset. Larger banks may generate a higher level of liquidity than their small counterparts (Le, 2019), perhaps due to the advantages of economies of scale or the 'too big to fail' belief

(Berger et al., 2016). Besides, the superior financial capability and the greater access in finance resources also help banks expand their competitiveness (Fecht et al., 2011). In this research, we calculated bank measured by the natural logarithm of total bank assets.

$Bank\ size_{it-1} * MP_{t-1}$ is an interaction term capturing the importance of bank size in affecting the monetary policy's effect on liquidity creation.

$Bankcap_{it-1}$ is the bank capital structure of bank i in year t-1. A capital structure that contains a substantial amount of equity can reduce the bank's vulnerability to market freezes; it reduces the risk of contagion to other financial institutions; it reduces the subsidy provided by deposit insurance; and, shareholders are less likely to be bailed out by government than debt holders. Hence, bank capital structure is likely to affect bank liquidity and is widely used as a control variable within the literature on bank liquidity due to its potential effect. According to the extant literature (e.g. Angeloni & Faia, 2013; Gale, 2010), bank capital structure is widely measured by the share of total equity to total assets.

Due to the potential effects of bank characteristics on bank liquidity, we include non-performing loans (NPL_{it-1}), net interest margin (NIM_{it-1}), market share $(Mshare_{it-1})$, and age (Age_{it-1}) as control variables in the estimation model.

Moreover, a bank's ability to create liquidity would be affected by the change of macroeconomic conditions and/or external shock (e.g. recent global financial crisis). We add GDP growth rate (GDP_{t-1}), unemployment $(Unem_{t-1})$ and inflation rate (Inf_{t-1}), year dummy and crisis dummy as control variables in the model to control potential effects of the macroeconomic conditions. We use log to normalise the values of the variables. α is a constant, ϵ_i is an error term.

4.3. Estimation Methods

For the longitude (panel) data as our dataset, the econometric literature (e.g. Wooldridge, 2013) suggests the use of either a fixed effect (FE) or random effect (RE) method first then other methods such as two-stage least square instrumental variable (IV) to address the problems associated with endogeneity of a predictor if needed. Given that the formation of our sample is largely subject to data availability of banks, the FE estimator is chosen ahead of its RE counterpart.

For our dataset, our key predictors (i.e. monetary policy variables) may not be exogenous. To address this issue, we use 2 SLS IV method. In particular, we use the trade balance $(Tradebalance_{t-1})$ as an IV for *Base rate* and *OMO*[4]. To promote economic growth, emerging market governments often prioritise their economic policies toward more export while limiting import. They will likely take trade balance volume which is the gap between import and export into consideration when making their economic policies such as monetary policies. It is also arguable that there hardly a correlation between trade balance and liquidity creation by each bank. Initially, the correlation matrix presented in Table 3 indicates that *Trade balance* is correlated with *Base rate* and *OMO* but uncorrelated with FLC and NFLC. More significantly, the first stage regression results in Table 5 demonstrate that the trade balance satisfies the conditions for a good IV that is highly correlated with monetary policy

[4] Bank size might be an endogenous variable. However, given the limitation of existing techniques in dealing with multiple IVs when there is an interaction of variable (e.g. monetary policy∗bank size in our model), we only use an IV for monetary policy variables, our main predictors.

Table 3. Descriptive Statistics and correlation matrix.

	Variables	Min	Max	Mean	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	VIF
1	FLC	−15460112	2877186095	131112277	1.000															
2	NFLC	−20910531	1807641550	111070095	.966**	1.000														
3	Size	146156	52954715	8936751	.278**	.282**	1.000													8.839
4	NPL	.000	8.807	2.197	.031	.058	−.100	1.000												1.198
5	NIM	1.177	8.916	3.237	−.026	−.016	−.019	−.084	1.000											1.237
6	Market	0	.285	.044	−.256**	−.270**	.936**	−.053	−.045	1.000										9.926
7	Age	0	60	21.49	−.109	−.119	.658**	.067	−.184*	.724**	1.000									2.318
8	Inflation	−.191	22.673	8.75	.032	.007	−.009	.035	.190*	−.048	−.033	1.000								8.716
9	Trade	−18.02	12.20	−2.2300	−.012	−.023	.002	−.065	.004	−.005	−.007	−.652**	1.000							n/a
10	GDP	5.247	7.129	6.12	.032	.022	.054	−.290**	.013	.055	.007	.295**	−.390**	1.000						1.841
11	Unemploy	2.100	4.650	3.37664	−.034	−.009	−.016	.060	−.222**	.028	.024	−.388**	−.154	−.277**	1.000					6.595
12	Baserate	6.25	15.00	8.2273	−.004	−.006	−.030	−.029	.282**	−.084	−.059	.814**	−.490**	.304**	−.360**	1.000				6.338
13	OMO	−.076	.101	.000395	.007	.025	.020	−.214**	−.092	.052	.012	−.426**	−.056**	.506**	.325**	−.178*	1.000			2.247
14	Bankcap	.03	.96	.108	−.004	.004	−.322**	−.103	.134	−.328**	−.318**	.073	−.014	−.017	−.042	.034	−.027	1.000		1.185
15	Crisis		0	1	.045	.024	.035	−.111	−.177*	.101	.030	−.263**	.214**	.016	.200*	−.439**	.284**	.033	1.000	2.965

Notes: *FLC* is fat liquidity creation (both on- and off-balance sheet activities, in US dollars). *NFLC* is nonfat liquidity creation (on-balance sheet activities only, in US dollars). *Baserate* is a base rate. *Bank size* is measured by the total bank assets (in US dollars). *Bankcap* is measured by the ratio of a bank's equity per total assets. *NIM* is bank net interest margin. *NPL* is bank non-performing loans as a percentage of total bank assets. *Marketshare* is bank share of total market deposits. *Age* is bank age measured in years. *Inflation* is the inflation rate. *Trade* is the trade balance, measured by the gap between export and import. It is calculated in billion US dollars. *Trade balance* is used as the instrumental variable for *Base rate* and *OMO* not an explanatory variable in the main models (i.e. the estimation models with FLC and NFLC as dependent variable), so its VIF value was not calculated in collinearity statistics of the main estimation models.

Table 4. The effects of monetary policy instruments on bank liquidity creation (FE Regression results).

	Dependent variable FLC		Dependent variable NFLC	
	Beta	*p-value*	*Beta*	*p-value*
(Constant)		.316		.498
L.Baserate	**−.130**	**.013**	**−.083**	**.024**
L.OMO	**.082**	**.072**	.080	.728
L.Size	**.227**	**.044**	**.137**	**.034**
L.Baserate∗l.Size	**.108**	**.042**	**.100**	**.033**
L.OMO∗L.Size	.004	.974	.030	.794
L.Bankcap	−.107	.241	−.093	.311
L.Market share	−.091	.775	−.194	.545
L.NPLs	−.016	.069	−.019	.084
L.NIM	−.005	.056	−.024	.097
L.Age	.142	.265	.147	.252
L.GDP	−.017	.937	−.011	.960
L.Inflation	.270	.591	.082	.870
L.UNEM	−.113	.725	−.130	.687
Year dummy	.442	.318	.300	.500
Crisis	.051	.762	.047	.779
R-Square	0.789		0.673	

variables but uncorrelated with bank liquid creation. Accordingly, in this research, we first use FE and report results as baseline models then employ two-stage least square IV (2SLS IV) for robustness check.

5. Empirical Results

Table 3 presents the descriptive statistics of our dataset. As shown, the mean of the dollar amount of liquidity created by the banking sector is US$131,112,276 and US$1,110,700,975 for FLC and NFLC, respectively. The mean value of Bank size is US$ 8,936,751. The average bank age is 22 years. The average *Base rate* is 8.2% over the sample period. The average for *OMO* is roughly 0.03% with relatively high dispersion. The correlation matrix displayed in Table 3 shows that the multicollinearity problem in our dataset is not severe. The non-violation of multicollinearity is further supported by the value of the mean VIFs of less than 10 (Belsley et al., 2005).

Table 4 shows the estimation results using FE on Equation (1). For each specification, the results associated with the liquidity creation measure using on-balance sheet activities (*FLC*) are first presented before the measure using both on- and off-balance sheet activities *(NFLC*). Considering the effect of monetary policy tools on bank liquidity creation, the coefficient of *Base rate* variable is negative and highly significant across all specifications. The effect of *OMO* on bank liquidity is positive and significant but not robust (significant at 10% level for FLC and insignificant for NFLC). This suggests that among two instruments of monetary policies which the central bank applies, the base rate is more effective than open market operations in monitoring bank liquidity in Vietnam.

With respect to the moderating effect of bank size, the coefficient of interaction variable *Banksize∗Baserate*, is significant and positive in all specifications while that of *Banksize∗OMO* is positive but insignificant. This suggests that larger banks generally do not pass through a rate change initiated by the central bank as much as those of smaller sizes. In other words, the change in base rate is a more effective tool for the central bank to

Table 5. The effects of monetary policy instruments on bank liquidity creation (2SLS IV regression results).

Second stage regression								
	Dependent variable FLC		Dependent variable NFLC		Dependent variable FLC		Dependent variable NFLC	
	Beta	*p*	Beta	*p*	Beta	*p*-value	Beta	*p*
(Constant)		.328		.538		.370		.550
L.Baserate	**−.067**	**.044**	**−.039**	**.037**				
L.Baserate∗l.Size	**.095**	**.041**	**.073**	**.077**				
L.OMO					**.003**	**.098**	.025	.890
L.OMO∗L.Size					.003	.980	.025	.827
L.Size	**.228**	**.049**	**.143**	**.021**	**.291**	**.055**	**.199**	**.039**
L.Bankcap	−.104	.251	−.091	.316	−.100	.265	−.088	.329
L.Market share	−.105	.737	−.215	.492	−.131	.627	−.231	.396
L.NPLs	−.013	.088	−.020	.083	−.007	.093	−.026	077
L.NIM	−.008	.092	−.027	.073	−.002	.098	−.022	.081
L.Age	.144	.253	.149	.240	.141	.264	.146	.251
L.GDP	.041	.775	.036	.803	.025	.899	.019	.923
L.Inflation	.122	.696	−.025	.936	.040	.887	−.075	.789
L.UNEM	−.089	.774	−.105	.738	−.111	.728	−.127	.690
Year dummy	.342	.330	.217	.539	.379	.373	.254	.552
Crisis	.084	.551	.075	.595	.112	.379	.091	.479
R-square	0.789		0.672		0.721		0.689	
First stage regression								
	Dependent variable Baserate		Dependent variable OMO		Dependent variable FLC		Dependent variable NFLC	
	Beta	p	Beta	p	Beta	p	Beta	p
Trade Balance	0.714	0.000	−0.057	0.0591	.033	.865	−.045	.816
Other variables	Yes		Yes		Yes		Yes	
R-square	0.843		0.415		0.311		0.426	

Notes: In the first stage, we estimate the effect of the instrumental variable on not only our key predictors (*Base rate* and *OMO*) but also our dependent variables (*FLC* and *NFLC*). In the second stage, we estimate the effect of each monetary policy variable using *Trade balance* as an instrumental variable separately. This is because the current Stata software only enables the use of instrument variables for more than one explanatory variable at one time.

manage the liquidity of small bank than that of a larger bank. However, the coefficient of the interaction variable, $\Delta OMO * Banksize$, is insignificant across all specifications, indicating that bank size does not have any moderating effect on the effectiveness of the central bank's transactions in open markets.

Concerning bank size, its coefficient is always positive and significant. This indicates that larger banks tend to generate a higher level of liquidity as compared to their smaller counterparts.

Regarding the control variables, the results obtained are highly intuitive. Specifically, non-performing loans and net interest margin have negative and significant impacts on liquidity creation. However, bank age and bank share of the deposit market is not a significant predictor of bank liquidity creation.

Table 5 shows the estimation results using 2SLS IV regressions on Equation (1). The upper part of the table shows the second stage regression results. The bottom half of the table presents the first stage regression results. Overall, the second stage regression results related to the impacts of the base rate, bank size and interaction effect of bank size and base rate, on bank liquidity reported in Table 5 are consistent with those reported in Table 4,

indicating that our results associated with these variables are robust. Table 5 shows the significant effect of OMO on bank liquidity for FLC but the insignificant effect for NFLC, implying that findings of the negligible impact of OMO on bank liquidity are consistent across our baseline and robustness check models. The interaction effects of bank size and OMO on bank liquidity are also insignificant, like those reported in Table 4. Therefore, it is reasonable to conclude that our findings are robust.

6. Discussion and Implications for Practice

Overall our results show the significant and adverse effect of the base rate on bank liquidity creation, indicating that a tight monetary policy exerts detrimental impacts on banks' liquidity creation. In contrast, an eased monetary policy promote banks' liquidity creation. Our findings are in line with Chen et al. (2017) who report that banks' riskiness increases when monetary policy is eased, based on their empirical examination of more than 1000 banks in 29 emerging economies during 2000–2012.

The possible explanation can be found from the literature of the credit channel which argues that the number of bank loans may decrease due to a higher interest rate following an increase in the central bank's base rate (Chen et al., 2017). Therefore, our results support the view that expansionary monetary policy that holds interest rates low enough could boost bank liquidity creation. This view still holds in the context of an emerging market, Vietnam. It is believed that due to the less developed stage of the financial market in an emerging economy, reactions to the central bank's monetary policies in emerging economies would be significantly different from those in developed countries. This leads to a discrepancy between monetary policies' impacts on bank liquidity in emerging markets and those in developed countries. However, our study reports the findings somewhat similar to those by Berger and Bouwman (2017). Analysing the sample of US banks, Berger and Bouwman (2017) also find a significant and negative effect of monetary policy instrument on bank liquidity. The effects are also large for small-sized banks and become negligible for a bigger bank, as reported in our study.

In terms of the central bank's transactions in OMO, the results show the negative effect of an increase in the net amount of bonds bought and sold by the central bank in OMO (or commonly known as loose monetary policy) on liquidity creation. However, the effect is not robust. To solve this puzzle, we take a careful look at our data of the Vietnamese banking system. It is revealed that the amounts of bonds purchased and sold, on average, are mainly on par as the mean OMO is roughly 0.04% over the entire sample period. This means that any extra liquidity created due to an expansionary policy action will be offset by an equivalent reduction in liquidity resulting from a contractionary move in the same year. As a result, there may be changes in liquidity creation over a shorter time horizon such as monthly or weekly but does not vary substantially over a year.

In brief, our results imply that in general monetary policy takes effect in monitoring bank liquidity creation. Hence, our results support Acharya and Naqvi's (2012) suggestion that the optimal monetary policy should involve a 'leaning against liquidity' approach. Central banks should employ a tightening monetary policy when there is excessive bank liquidity creation to avoid bank risk-taking and apply an easing monetary policy in times of scarce liquidity creation to promote investment. However, in Vietnam, not all three monetary policy instruments are effectively used by SBV in managing bank liquidity creation.

In more advanced economies, central banks conventionally use interest rates as the main policy instrument. In contrast, in emerging markets, some non-interest rate instruments are often employed to complement, or even substitute, interest rate-based monetary policy (Chen et al., 2017). Our study demonstrates that non-interest rate instruments (e.g. OMO, required reserve ratio) are not useful tools for managing bank liquidity creation. This implies that if the central bank in an emerging economy aims for market stabilisation, they do not need to interfere in the financial market with policy instruments like OMO or required reserve ratio.

Our findings suggest that policymakers in emerging markets should focus on the base rate to manage bank liquidity creation. Central banks should raise the rate when there is excessive bank liquidity creation to avoid bank risk-taking and lower the rate in times of scarce liquidity creation to promote investment. In projecting how much rate change is needed, they should consider bank sizes. We also advise that for required reserved ratio taking effect in managing bank liquidity creation; the central bank may need to vary the ratio over time.

Our study has made an initial step in investigating the effectiveness of monetary policy in an emerging market. Given that our sample is small and has a short time frame due to data unavailability, future research should expand the sample size if more resources are available. Due to the unavailability of monthly or quarterly data for bank liquidity calculations, our estimations using annual data might not reflect a business cycle and use more frequent data (e.g. monthly or quarterly). Another research avenue would be to test the effectiveness of other tools such as Taylor rule deviations or interbank interest rate. All these suggest a rich future research agenda.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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