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MONETARY STIMULUS AND BANK LIQUIDITY HOARDING IN AN EMERGING MARKET

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ABSTRACT

The paper examines the impact of monetary policy on bank liquidity hoarding. Using novel measures to capture bank liquidity hoarding in Vietnam during 2007–2019, we find that banks decrease total liquidity hoarding and all three liquidity hoarding components (asset-, liability-, and off-balance sheet items) when the central bank injects more money into the economy. An interesting result appears when we document that banks hoard more liquidity in the event of lowered interest rates. Our additional analysis indicates that the extent to which bank liquidity hoarding responds to monetary policy changes is clearer in lower-risk banks.

Keywords: bank liquidity hoarding, bank risk, emerging market, monetary policy tools, monetary stimulus.

INTRODUCTION

The link between monetary policy and banking activities has received particular attention in recent literature over the years. Under the bank lending channel, when central banks reduce their policy rates to stimulate the economy, the

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volume of loans could increase (Bernanke & Blinder, 1988). It is widely acknowledged that monetary policy could drive bank income when it modifies interest rates that banks charge their borrowers and borrow from their depositors. It is also established that the expansion of monetary policy may alter banks' perception or tolerance toward risk, leading to excessive risk-taking as predicted by the literature stream on the bank risk-taking channel (Borio & Zhu, 2012). Apart from interest rates, central banks may also purchase financial assets under open market operations, with the desire to promote lending and spur economic activities (Chakraborty et al., 2020).

This study aims to explore a new channel of monetary policy transmission through the banking system, specifically focusing on the impact of monetary policy on bank liquidity hoarding. When analysing bank liquidity hoarding, we should be aware of critical undesirable outcomes that it may cause. Banks' primary function is to create liquidity (Berger & Bouwman, 2009), to contribute to the growth of the economy. In this vein, excessive bank liquidity hoarding is extremely costly since it restricts bank liquidity creation capacity, and the lack of finance is usually regarded as one of the most significant constraints on economic growth (Nketcha Nana & Samson, 2014). In some extreme cases, bank liquidity hoarding could cause systemic risk via spillover effects as the initiation of liquidity hoarding and asset fire sale actions by stressed banks could hamper other banks (Diamond & Rajan, 2011). With respect to the link with monetary policy, bank liquidity hoarding is central to the process of monetary implementation and transmission. By changing the monetary policy stance, central banks may modify banking activities on- and off-balance sheets, and through such modification, they can drive the real economy (Berger & Sedunov, 2017).

Our study considerably differs from other previous works on the link between monetary policy and bank activities since we focus on bank liquidity hoarding that we measure using a comprehensive novel approach suggested by Berger et al. (2020). The existing literature has only considered liquid assets or other simple ratios to explore bank liquidity hoarding. Not focus on one or a few items on bank balance sheets or income statements, our bank liquidity hoarding measure combines all banking items on the asset-, liability- and off-balance sheet-sides. Following Berger et al. (2020), we examine the total bank liquidity hoarding measure and all three components, which are inclusive of liquidity hoarding on the asset-side, liability-side, and off-balance sheet-side. Such aggregate and disaggregate research designs are necessary given the fact that previous papers do not separate liquidity hoarding components, so the stimulus effects on these liquidity hoarding types are commingled.

We also recognise that different monetary policy tools induce different impacts on economic variables in different routes. For example, while the impacts of interest- and quantitative-based tools might be similar in some aspects, certain distinctions could exist given the unprecedented magnitude of the central bank's intervention and the nature of the tools (Varlik & Berument, 2017). We address this issue by investigating different policy tools in an emerging market with a multiple-tool regime. In this regard, Vietnam has emerged as an ideal candidate. The State Bank of Vietnam (SBV) proposes multiple targets when implementing its monetary policy (such as economic growth, inflation control, and macroeconomic stability), with no primary one defined (Dang & Nguyen, 2021). Accordingly, the SBV combines various policy tools to achieve its complicated targets. In which, some essential tools are used frequently than others, including policy rates and open market operations. Interestingly, the SBV issues administrative commands to directly adjust the commercial interest rate framework that banks charge their customers. In addition to the features of the monetary policy framework, the role and the change of the banking system also make analysis using the Vietnamese context more relevant. Banking activities have been considered the core interest of the economy when Vietnam's capital market is rated as underdeveloped (Dang & Huynh, 2020). This fact could make monetary policy transmission through the banking system even more pronounced. It should also be noted that the Vietnamese banking system has experienced comprehensive reforms during the last decades, so the bank characteristics of financial structure, productivity, and business model have changed significantly.

We perform our tasks in this paper by employing a sample of Vietnamese commercial banks during 2007–2019. Different regression techniques and alternative variables are utilised. Our robust findings suggest that banks decrease total liquidity hoarding and all three liquidity hoarding components when the central bank injects more money into the economy using open market operations. Interestingly, we document that banks tend to hoard more liquidity in the event of lowered interest rates. In this manner, the potency of the monetary policy stimulus by decreased interest rates may be limited and not as expected since banks rebalance their portfolios towards liquidity hoarding. We also observe how bank liquidity holding responds to changes in monetary policy based on bank risk levels. The findings collectively imply low-risk banks' liquidity hoarding is more responsive to changes in monetary shocks.

This paper offers several important contributions. First, understanding the impact of monetary policy on bank liquidity hoarding is a key contribution of this paper. In this literature strand, we are the first to employ comprehensive

novel measures of bank liquidity hoarding suggested by Berger et al. (2020) that account for all uses and sources of liquidity, both on- and off-balance sheets. We also employ a series of monetary policy tools that the central bank uses when implementing its monetary policy so that we can point out the meaningful distinctions between interest- and quantitative-based policy tools in a multiple-tool environment. Our approach combining the novel liquidity measure of Berger et al. (2020) with different interest- and quantitative-based monetary policy tools is not performed in the existing empirical literature on how monetary policy drives the economy through the banking system (Dang & Nguyen, 2021; Kandrac & Schlusche, 2017; Lambert & Ueda, 2014; Lucchetta, 2007; Peydró et al., 2021). In fact, after proposing the novel measure of bank liquidity hoarding, Berger et al. (2020) employ it to determine how banks hoard liquidity in response to economic policy uncertainty. Different from them, we pay attention to the impact of monetary policy on bank liquidity hoarding. Second, we take into account the differences across banks in different risk levels. Our results on the difference between low-risk and high-risk banks in this vein are entirely novel, thus indicating evidence in favour of the strategic motive rather than the precautionary motive when the central bank stimulates the economy by relaxing monetary policy.

RELATED LITERATURE

Monetary policy is theorised to influence bank activities on- and off-balance sheet through various routes. Under the bank lending channel (Bernanke & Blinder, 1988), decreased interest rates also lead to a rise in the volume of loanable funds and support bank lending. During monetary expansion, one observes that banks prefer long-term loans (Diamond & Rajan, 2006). Along with the changes in interest rates, the central bank's money injection to the banking system is conventionally expected to reach the real sectors by expanded credit supply. Besides, the central bank's financial asset purchases may increase asset prices, known as the 'portfolio balance' channel (Tobin, 1969). Since banks cannot consider cash as a perfect substitute for the assets sold to the central bank, they may invest their available funds in high-yield and illiquid assets. Overall, based on the arguments mentioned above, we realise that banks may reduce liquidity hoarding after a monetary policy stimulus.

Smith (2002) claims that lower interest rates may alleviate opportunity costs of banks (i.e., costs of holding cash – the interests that could be made when banks invest cash in alternative investments such as loans). This alleviation will encourage banks to hold liquid assets. Valencia (2014) suggests that decreased

interest rates lead to lower funding costs, thus incentivising banks to build up enormous financial leverage. Kane (1989) demonstrates that higher interest rates lead to a decline in banks' net worth, and thus risky strategies may become more attractive from the perspective of banks. In another route, the central bank's money injection via asset purchases might signal negative economic outlooks, making banks more prudent with their investments (Christensen & Rudebusch, 2016). In this situation, banks increased their liquidity to absorb expected losses in the face of greater uncertainty. Bank liquidity could be exhibited on the balance sheet, such as cash and securities, or off-balance sheet, such as derivative contracts that function similarly to liquid assets (Berger et al., 2020). Gale and Yorulmazer's (2013) theoretical work has modelled that banks hoard liquidity due to the precautionary motive. In this vein, banks may store liquidity if they expect a temporary liquidity shortage because of the financial market's difficulty. Taken together, the above discussions imply that banks may hoard more liquidity when the central bank relaxes its monetary policy, which is a contrasting route to the one mentioned earlier.

Regarding the items off-balance sheet, the impacts of monetary policy are also found to be mixed. On the one hand, customers who receive more direct loans (after the monetary stimulus by the central bank) may decrease their demand for loan commitments and other off-balance sheet guarantees (Thakor, 2005). On the other hand, banks may choose to provide more guarantees due to greater availability of loanable funds that are also accompanied by reduced funding costs. Given the complementarities between fund receiving (such as deposits) and loan commitment issuing, an increase in deposits may incentivise banks to grant more liquidity to their customers in the form of loan commitments (Kashyap et al., 2002). Overall, how bank liquidity hoarding reacts to monetary policy changes is theoretically ambiguous and constitutes an interesting empirical question to be addressed.

The empirical literature on the effects of monetary policy on bank liquidity hoarding is scarce. We know of some studies slightly related to ours in this regard. Lucchetta (2007) examines the impacts of monetary policy on bank liquidity in European markets, and some mixed patterns emerged. Concretely, different results are found when the author uses risk-free interest rates and interbank interest rates as monetary policy indicators in the function of liquid asset investments. Peydró et al. (2021) explore how banks' asset portfolios respond to the central bank's large liquidity injection. Their results indicate that banks prefer security holdings to loans grating after monetary relaxing. They claim that it could be easier for banks to 'reach for yield' with liquid assets rather than illiquid ones, and security purchases may crowd out loans to the real

economy. Dang and Nguyen (2021) document that during monetary expansion, banks tend to extend their leverage (on the liability side) and narrow their liquidity (on the asset side). Lambert and Ueda (2014) investigate the impacts of unconventional monetary policy on bank balance sheets. They conclude that central banks' asset purchase may decrease financial leverage and the ratios of short-term debts but increase the share of risk-weighted assets in the asset structure. Analysing the quantitative easing program, Kandrac and Schlusche (2017) suggest that this program leads to higher loan growth and increased riskier loans. In sum, prior studies only employ bank liquid assets, illiquid assets, bank leverage, or other simple measures to exploit bank liquidity hoarding. We now advance the state of this topic with much more comprehensive liquidity hoarding measures.

METHODOLOGY AND DATA

Variables

Constructing the dependent variables by bank liquidity hoarding measures using the novel procedure proposed by Berger et al. (2020) is the key point in this study. Their procedure assigns both on- and off-balance sheet items weights of +0.5 and –0.5, varying based on the core mechanism that the items contribute to or subtract from liquidity hoarding. More precisely, banks can hoard liquidity by holding liquid assets (on the balance sheet, such as cash and securities) and derivative contracts that work similarly to liquid assets (off-balance sheet), so such items are assigned positive weights. Illiquid assets (such as loans) and illiquid off-balance sheet guarantees (such as loan commitments) are assigned negative weights because reducing these items improves current and future liquid assets. Besides, banks can hoard liquidity by attracting more deposits to build up liquid assets; thus, liquid liabilities (such as deposits) are assigned positive weights.

We follow Berger and Bouwman (2009) to classify bank activities (both on- and off-balance sheets) and assign weights to classified groups. We only keep items classified as liquid and illiquid, which can drive bank liquidity hoarding measures, and eliminate items classified as semiliquid (assigned with zero weights), which are not demanded for liquidity hoarding estimates. Following Berger et al. (2020), we calculate total bank liquidity hoarding as follows:

$$\begin{aligned}\text{Liquidity hoarding (total)} &= \text{Liquidity hoarding (asset)} \\ &+ \text{Liquidity hoarding (liability)} + \text{Liquidity hoarding (off)}\end{aligned} \quad (1)$$

where the liquidity hoarding components are calculated as follows:

$$\text{Liquidity hoarding (asset)} = (+0.5) \times \text{Liquid assets} + (-0.5) \times \text{Illiquid assets} \quad (2)$$

$$\text{Liquidity hoarding (liability)} = (+0.5) \times \text{Liquid liabilities} \quad (3)$$

$$\text{Liquidity hoarding (off)} = (+0.5) \times \text{Liquid derivatives} + (-0.5) \times \text{Illiquid guarantees} \quad (4)$$

Overall, we gain one measure of total bank liquidity hoarding and three measures of liquidity hoarding components (see Table 1). To obtain the desired dependent variables, we normalise bank liquidity hoarding measures by gross total assets when entering the regression analyses to ensure that our variables are comparable across banks.

Table 1
Bank liquidity hoarding calculation

Liquid assets (weight = 0.5)	Liquid liabilities (weight = 0.5)	Liquid derivatives (weight = 0.5)
Total securities	Customer deposits	All derivatives
Cash and due from other institutions	Trading liabilities	
Illiquid assets (weight = –0.5)		Illiquid guarantees (weight = –0.5)
Corporate loans		Commitments of loan guarantee
Consumer/Retail loans		Letters of credit commitments
Other assets		

Notes: We calculate bank liquidity hoarding as follows. Liquidity hoarding (total) = Liquidity hoarding (asset) + Liquidity hoarding (liability) + Liquidity hoarding (off), where Liquidity hoarding (asset) = (+0.5) × Liquid assets + (–0.5) × Illiquid assets, Liquidity hoarding (liability) = (+0.5) × Liquid liabilities, and Liquidity hoarding (off) = (+0.5) × Liquid derivatives + (–0.5) × Illiquid guarantees.

Turning to the choice of main explanatory variables, we utilise a series of monetary policy indicators in this study. This approach is motivated by the stylised facts that the SBV combines multiple tools to implement its monetary policy, and the transmission potency of different monetary tools is found to be heterogeneous (Varlik & Berument, 2017). Inspired by Dang and Nguyen (2021), we approach two groups of interest- and quantitative-based monetary tools in Vietnam. For the former, we select short-term lending rates, refinancing rates, and rediscounting rates. The SBV usually issues administrative commands to

regulate the framework of lending rates in the banking market. Simultaneously, as a national last-resort lender, it charges commercial banks by refinancing rates (for short-term loans) and rediscounting rates (for the discounts of valuable papers). For the latter, given that the SBV can buy/sell securities under its open market operations to inject/withdraw money in the economy, we collect the SBV's claims on government (displayed in the SBV's balance sheets). Following Mamatzakis and Bermpei (2016), we take the natural logarithm of this value when entering the regression section. Our choice of monetary policy indicators here could also be supported by the context that other crucial monetary policy tools in Vietnam, including base interest rates and required reserves, have remained unchanged for long times.

Based on the construction of our monetary policy indicators, we could speculate that an increase in interest-based indicators suggests monetary contraction, while a decrease indicates monetary stimulus. The opposite mechanism works for the quantitative-based monetary indicator. As the literature theorizes that monetary stimulus might encourage banks to produce more liquidity in the market, we expect interest-based indicators to be positively correlated with bank liquidity hoarding measures, contrary to the quantitative-based indicator.

This study belongs to the literature strand on the determinants of bank liquidity hoarding. Except for monetary policy, the extent to which banks hoard liquidity has been found to be linked with some key bank-specific and macroeconomic factors. To better examine the impacts of monetary policy on bank liquidity hoarding, we control for the potentially relevant factors identified from the previous literature. We include bank size, calculated by the natural logarithm of gross total assets, to control for the effect that large banks gain easier access to other sources of funding and can operate with less liquidity (Delechat et al., 2012). The ratio of loan loss provisions to gross customer loans is included since banks are likely to hoard more liquid assets due to the precautionary motive when the level of expected loan losses is higher (Ashraf, 2020). We also control bank capitalisation, computed by the ratio of equity capital to gross total assets, since we are aware that banks with smaller capital buffers have a stronger incentive to invest in risk-free liquid assets to improve their capital adequacy ratios (Affinito et al., 2019). Besides, bank liquidity hoarding may be associated with the changes in business cycles and the operations of the stock market. Banks hoard less liquidity when the economy grows at higher rates (measured by the growth rate of GDP), and the stock market yields better returns (captured by the growth rate of the VNindex) (Aspachs et al., 2005).

Sample Data

We use bank-level data from yearly financial reports of Vietnamese commercial banks. The period covered is from 2007 to 2019. The data must contain a detailed breakdown that is necessary for bank liquidity hoarding calculations. We exclude banks whose financial reports lack required items to design liquidity hoarding measures.

The data for monetary policy and macroeconomic factors come from different sources. Refinancing rates and rediscounting rates are obtained from the SBV's database. We source the data for the central bank's claims on government and the average short-term lending rates from the International Financial Statistics (IFS). The stock market data are collected from the Vietstock database, while the economic growth data are gained from the World Development Indicators (WDI). Ultimately, our research sample constitutes an unbalanced panel with a total of 391 observations from 31 Vietnamese banks, on average, making up about 90% of the Vietnamese banking industry's total assets.

Model Specification and Econometric Method

This study empirically investigates the impact of monetary policy on bank liquidity hoarding. To this end, we employ the following equation:

$$LH_{i,t} = \alpha_0 + \alpha_1 \times LH_{i,t-1} + \alpha_2 \times MP_{t-1} + \alpha_3 \times Bank_{i,t-1} + \alpha_4 \times Macro_{t-1} + u_{i,t} \quad (5)$$

where the dependent variable $LH_{i,t}$ is the measure of liquidity hoarding by bank i in year t and is the indicator for monetary policy in year $t-1$. We utilise alternatively four measures of liquidity hoarding (total liquidity hoarding, asset-side liquidity hoarding, liability-side liquidity hoarding, and off-balance sheet-side liquidity hoarding) and four monetary policy indicators (lending rates, rediscounting rates, refinancing rates, and the central bank's claims). The lagged dependent variable in the right-hand side of the equation is to highlight our panel's dynamic property. $Bank_{i,t-1}$ is a vector of bank-level control variables $Macro_{t-1}$ and contains a matrix of macroeconomic controls, as elaborated previously. $u_{i,t}$ is the error term. To mitigate the impact of the potential endogeneity as well as reflect that banks cannot react immediately to changes in external/internal factors, we take the one-year lags of all explanatory variables in the model.

We employ the two-step system GMM estimator, which utilises both in-level and in-difference variables as instruments to handle the endogeneity problem thoroughly (Arellano & Bover, 1995; Blundell & Bond, 1998). Following Roodman (2009), we limit the number of lags used as instruments to avoid the 'too many instruments' problem. To validate the consistency of the GMM estimator, we rely on the Arellano-Bond tests for the autocorrelation in residuals and the Hansen test for over-identifying restrictions that indicate the appropriateness of the instrument set.

RESULTS AND DISCUSSIONS

Preliminary Analysis

Table 2 presents the summary statistics of all variables used in the study. The mean of total normalised bank liquidity hoarding is 18.126%, suggesting that banks hoard liquidity of 18.126% of gross total assets on average. The mean of asset-side normalised bank liquidity hoarding is negative (−14.198%) when banks often hold more illiquid assets (such as loans) than liquid assets (such as cash and securities) in the asset structure. The liability-side liquidity hoarding measure averages 30.964%, and the off-balance-sheet liquidity hoarding averages 1.219%, which are due to the dominance of loan commitments. There exists a wide dispersion across Vietnamese banks, considering the large difference between extreme values and the high standard deviations of liquidity hoarding measures. We now pay attention to the statistical distributions of monetary policy indicators. All indicators possess significant variations, which confirms that monetary policy implementation has been changing across years and highlights the need to exploit monetary policy during the sample period as selected.

Table 3 outlines the pairwise correlations between variables. We realise that the total bank liquidity hoarding measure is relatively correlated with the asset-side liquidity hoarding measure (0.650) and the off-balance-sheet liquidity hoarding measure (0.470), but almost has no correlation with the liability-side liquidity hoarding measure (0.030). Besides, other remaining correlation coefficients are less than 0.80, revealing that the problem of severe multicollinearity is not a concern.

Table 2
Summary statistics of all variables

Variables	Mean	SD	Min	Max	Definitions
Bank liquidity hoarding measures					
Liquidity hoarding (total)	18.126	10.165	−1.289	36.823	Total bank liquidity hoarding measure/ Gross total assets (%)
Liquidity hoarding (asset)	−14.198	11.388	−31.224	6.954	Asset-side liquidity hoarding measure/ Gross total assets (%)
Liquidity hoarding (liability)	30.964	6.596	17.599	41.676	Liability-side liquidity hoarding measure/ Gross total assets (%)
Liquidity hoarding (off)	1.219	4.618	−4.461	16.112	Off-balance sheet-side liquidity hoarding measure/Gross total assets (%)
Bank-level factors					
Risk	1.253	0.509	0.502	2.499	Loan loss provisions/ Gross customer loans (%)
Capital	10.072	4.647	4.939	21.884	Equity capital/Gross total assets (%)
Size	31.972	1.233	29.943	34.269	Natural logarithm of gross total assets
Monetary policy indicators					
Lending rates	10.400	3.328	6.960	16.954	Average short-term lending rates (%)
Refinancing rates	8.042	2.547	6.000	15.000	Refinancing rates by the SBV (%)
Rediscounting rates	5.894	2.660	3.500	13.000	Rediscounting rates by the SBV (%)
Central bank's purchases	31.042	0.813	29.982	32.040	Natural logarithm of the SBV's claims on government
Macroeconomic factors					
Stock return	7.425	29.655	−65.953	56.761	The growth rate of the VNindex (%)
Economic growth	6.245	0.642	5.247	7.130	The growth rate of GDP (%)

Table 3
Matrix of correlation coefficients

	Liquidity hoarding (total)	Liquidity hoarding (asset)	Liquidity hoarding (liability)	Liquidity hoarding (off)	Risk	Capital	Size	Lending rates	Refinancing rates	Rediscounting rates	Central bank's purchases	Stock return	Economic growth
Liquidity hoarding (total)	1.000												
Liquidity hoarding (asset)	0.650	1.000											
Liquidity hoarding (liability)	0.030	−0.560	1.000										
Liquidity hoarding (off)	0.470	−0.120	0.110	1.000									
Risk	−0.050	−0.090	0.130	−0.090	1.000								
Capital	−0.150	0.150	−0.380	−0.100	−0.270	1.000							
Size	0.100	−0.270	0.450	0.200	0.430	−0.720	1.000						
Lending rates	−0.250	0.260	−0.520	−0.410	0.080	0.330	−0.330	1.000					
Refinancing rates	−0.200	0.200	−0.460	−0.310	0.120	0.240	−0.220	0.910	1.000				
Rediscounting rates	−0.170	0.190	−0.420	−0.270	0.100	0.220	−0.190	0.890	0.980	1.000			
Central bank's purchases	−0.100	0.050	−0.170	−0.140	0.080	0.040	−0.030	0.140	0.270	0.210	1.000		
Stock return	0.030	−0.080	0.140	0.060	0.010	−0.130	0.080	−0.550	−0.530	−0.650	0.040	1.000	
Economic growth	0.150	−0.120	0.150	0.380	−0.190	−0.250	0.210	−0.440	−0.380	−0.340	−0.160	−0.040	1.000

Main Estimation Results

This part presents the estimation results for the impact of monetary policy on total bank liquidity hoarding (Table 4) and three bank liquidity hoarding components (Table 5). Across all regressions reported, there exists significant persistence of our dependent variables, suggesting that the bank liquidity hoarding behaviour is not significantly varying but remains rather stable after each period. The *p*-values for the Hansen test show no evidence against the validity of instruments, while those of the AR(1)/AR(2) tests indicate that there is first-order but no second-order autocorrelation. These results justify the use of the GMM estimator in the dynamic panel model.

Table 4
Impact of monetary policy on total bank liquidity hoarding

Dependent variable: Total bank liquidity hoarding/Gross total assets				
	(1)	(2)	(3)	(4)
Lagged dependent variable	0.550*** (0.026)	0.552*** (0.029)	0.560*** (0.028)	0.622*** (0.028)
Lending rates	−0.413*** (0.076)			
Refinancing rates		−0.414*** (0.071)		
Rediscounting rates			−0.422*** (0.075)	
Central bank's purchases				−0.393*** (0.132)
Size	0.745 (0.456)	0.986** (0.405)	1.001*** (0.386)	1.369*** (0.430)
Capital	0.333*** (0.071)	0.326*** (0.059)	0.319*** (0.056)	0.408*** (0.080)
Risk	0.455* (0.252)	0.223 (0.198)	0.208 (0.214)	−0.250 (0.364)
Economic growth	−0.357 (0.347)	−0.158 (0.318)	−0.180 (0.319)	0.248 (0.303)
Stock return	−0.010 (0.008)	−0.004 (0.006)	−0.010 (0.007)	0.019*** (0.006)

(*continue on next page*)

Table 4 (*continued*)

Dependent variable: Total bank liquidity hoarding/Gross total assets				
	(1)	(2)	(3)	(4)
Observations	360	360	360	360
AR(1) test (*p*-value)	0.000	0.000	0.000	0.000
AR(2) test (*p*-value)	0.735	0.826	0.839	0.761
Hansen test (*p*-value)	0.287	0.351	0.386	0.423

Notes: The estimation results are obtained using the two-step system GMM dynamic panel model with robust standard errors (in parentheses). ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

In Table 4, the estimation result displays that the coefficient on the SBV's asset purchases is significantly negative at the 1% level (column 4), thus confirming our expectation that banks tend to hold less liquidity as a whole amid monetary expansion by money supply of the central bank. Regarding the estimation results of interest-based monetary indicators, some starling results have emerged. We observe that in all regressions (columns 1–3), the coefficients on three types of interest rates are negative and statistically significant at the 1% level. These results reveal that banks tend to hoard more liquidity when the central bank decides to relax monetary policy in the form of lower interest rates.

The economic significance of the results also reinforces our findings. Taking column 1 as an example, we can speculate that a one-percentage-point decrease in lending rates may lead to an increase of 0.413 percentage points in total bank liquidity hoarding relative to gross total assets. Looking into column 4, the magnitude of the coefficient suggests that a one-percentage-point increase in the SBV's asset purchases may cause a decrease of 0.393 percentage points in total bank liquidity hoarding relative to gross total assets.

To refine our findings, we decompose the total bank liquidity hoarding measure into the asset-, liability- and off-balance sheet-side bank liquidity hoarding components. Estimation analyses indicate that more asset purchases of the SBV result in statistically and economically significant decreases in all three liquidity hoarding components (columns 4, 8 and 12). Hence, we argue that total liquidity hoarding is explained together with items on- and off-balance sheets when the central bank injects its funds into the market. In a slightly different route, the results of interest-based monetary indicators exhibit that asset- and off-balance sheet-side liquidity hoarding components react negatively to monetary policy shocks, while the remaining result suggests that banks' liability-side liquidity hoarding decreases (e.g., banks attract fewer deposits) in response to the monetary

Table 5
Impact of monetary policy on components of bank liquidity hoarding

	Dependent variable: Asset-side liquidity hoarding/Gross total assets				Dependent variable: Liability-side liquidity hoarding/Gross total assets				Dependent variable: Off-balance sheet-side liquidity hoarding/Gross total assets			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Lagged dependent variable	0.563***	0.532***	0.542***	0.551***	1.003***	0.950***	0.908***	0.716***	0.843***	0.870***	0.874***	0.873***
	(0.024)	(0.024)	(0.024)	(0.029)	(0.043)	(0.028)	(0.025)	(0.015)	(0.016)	(0.014)	(0.015)	(0.018)
Lending rates	−0.244***				0.510***				−0.220***			
	(0.082)				(0.060)				(0.020)			
Refinancing rates		−0.361***				0.547***				−0.136***		
		(0.059)				(0.038)				(0.010)		
Rediscounting rates			−0.385***				0.475***				−0.130***	
			(0.059)				(0.035)				(0.012)	
Central bank's purchases				−0.537***				−0.699***				−0.791***
				(0.123)				(0.060)				(0.058)
Size	−1.322***	−1.498***	−1.487***	−1.279***	0.107	−0.033	0.011	0.373***	0.330***	0.412***	0.421***	0.388***
	(0.266)	(0.294)	(0.293)	(0.259)	(0.162)	(0.171)	(0.175)	(0.125)	(0.057)	(0.054)	(0.057)	(0.040)
Capital	0.173*	0.111	0.096	0.106	−0.021	−0.029	−0.024	−0.040	0.033***	0.027***	0.025***	0.026***
	(0.089)	(0.099)	(0.096)	(0.088)	(0.055)	(0.053)	(0.052)	(0.040)	(0.006)	(0.005)	(0.008)	(0.005)
Risk	0.455	0.328	0.291	−0.134	0.419	0.583*	0.678**	0.922***	−0.447***	−0.493***	−0.511***	−0.632***
	(0.430)	(0.377)	(0.379)	(0.366)	(0.324)	(0.307)	(0.334)	(0.276)	(0.097)	(0.115)	(0.116)	(0.056)
Economic growth	−1.504***	−1.368***	−1.349***	−0.917***	1.265***	1.101***	1.021***	0.531***	0.020	0.139***	0.134***	0.127***
	(0.254)	(0.208)	(0.207)	(0.201)	(0.190)	(0.153)	(0.163)	(0.099)	(0.036)	(0.028)	(0.028)	(0.012)
Stock return	0.003	0.002	−0.004	0.019***	0.010***	0.005*	0.009***	−0.015***	−0.008***	−0.002***	−0.003***	0.004***
	(0.008)	(0.006)	(0.006)	(0.005)	(0.003)	(0.003)	(0.003)	(0.002)	(0.001)	(0.001)	(0.001)	(0.000)

(*continue on next page*)

Table 5 (*continued*)

	Dependent variable: Asset-side liquidity hoarding/Gross total assets				Dependent variable: Liability-side liquidity hoarding/Gross total assets				Dependent variable: Off-balance sheet-side liquidity hoarding/Gross total assets			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Observations	360	360	360	360	360	360	360	360	360	360	360	360
AR(1) test (p-value)	0.001	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.001	0.001	0.001	0.001
AR(2) test (p-value)	0.983	0.818	0.782	0.768	0.628	0.419	0.435	0.976	0.783	0.800	0.800	0.738
Hansen test (p-value)	0.402	0.416	0.432	0.576	0.166	0.114	0.111	0.136	0.144	0.122	0.124	0.155

Notes: The estimation results are obtained using the two-step system GMM dynamic panel model with robust standard errors (in parentheses). ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

stimulus by lower interest rates. The negative effect of asset- and off-balance sheet-side liquidity hoarding may dominate any effect of liability-side liquidity hoarding given the fact that banks hoard the vast majority of their liquidity on the asset side and off-balance sheets. In sum, these decomposing analyses offer more insight into our main findings.

Overall, our findings indicate that the central bank's liquidity injection to commercial banks may reach the real sectors in the economy by means of increased liquidity supply by banks, consistent with the motivation and target of monetary policy stimulus. In sharp contrast, when the central bank cuts down interest rates to stimulate the economy, the quantity of bank liquidity hoarding does not decrease but increases instead. Our evidence is consistent with the argument that decreased interest rates in the banking industry do not necessarily encourage banks to supply more liquidity into the economy. There are two fundamental mechanisms to interpret this finding here. In the theoretical model proposed by Gale and Yorulmazer (2013), banks may hoard liquidity due to the precautionary motive (protection against future liquidity shocks) and the strategic motive (taking advantage of potential investments). First, for the strategic motive, lower interest rates depress banks' opportunity costs (i.e., costs of cash holdings), potentially incentivising banks to hold more liquid assets (Smith, 2002). In other words, security investments (or derivatives contracts) becomes more attractive relative to granting loans (or credit commitments). Second, for the precautionary motive, decreased interest rates may signal that the economic outlook is downward, making banks more cautious with their investments (Christensen & Rudebusch, 2016). In this vein, banks usually keep in mind that liquidity should be hoarded to absorb higher expected losses. Furthermore, during such time, lower interest rates fail to stimulate the economy's demand for credit.

Heterogeneity Across Banks of Different Risk Levels

The existing literature strand on the effect of monetary policy on bank operations has widely discussed the moderating roles of bank-level factors representing banks' financial strength. Thus far, one of the most significant shortcomings in this strand is that it has commonly employed standard indicators (such as bank size, ownership and capitalisation) to capture the marginal effects. However, such factors are not profound enough to account for the difference in banks' willingness/decisions to extend loans or restructure their balance sheets (Altunbas et al., 2010). Instead, the bank risk level is ideal for reflecting bank incentives towards risk-taking behaviour, which could alter banks' investment decisions.

Moreover, according to the precautionary motive, banks may hoard more liquidity if their expected losses last more seriously (Ashraf, 2020). In this vein, we may expect banks with more risks to be more sensitive to monetary shocks (e.g., hoarding more liquidity) due to the precautionary motive. Taken together, the above arguments offer a strong motivation for further analysis, considering the modifying role of bank risk in the impact of monetary policy on bank liquidity hoarding.

To do that, we split our original sample into two new subsamples based on banks' risk levels. More precisely, banks with a risk level (defined by the loan loss provision ratio) higher than the median value are categorised as high-risk banks; meanwhile, banks with a risk level at or below the median value are categorised as low-risk ones. We re-estimate our proposed model using two subsamples and report the results in Table 6. We realise that the coefficients on interest- and quantitative-based monetary policy indicators are statistically and economically significant with unchanged signs, once again supporting our main findings obtained previously. In further detail, across all regressions for low-risk banks, monetary policy indicators' coefficients are larger in magnitude than those of high-risk banks. These results collectively imply that low-risk banks' liquidity hoarding is more responsive to changes in monetary shocks.

Our result suggests that monetary expansion aimed at stimulating the economy by money injection from the central bank would be more effective if the banking system suffers less credit risk. In contrast, banks' liquidity hoarding behaviour in the event of lower interest rates is strengthened by a decrease in credit risk. We cannot offer evidence supporting the notion that banks may hoard more liquidity if they suffer more from expected severe losses. These results may cast some doubt about bank liquidity hoarding due to the precautionary motive. Though our econometric model cannot detect the exact direction through which the effect of monetary policy on bank liquidity hoarding is more pronounced for low-risk banks than high-risk banks, a potential reason for our finding could be as follows. Low-risk banks may have competitive advantages (such as reduced asymmetric information, lower funding costs, or faster accumulation of bank capital) than their high-risk counterparts. Hence, these low-risk banks may be more proactive in responding to monetary policy changes (i.e., they are qualified to quickly and easily hoard/produce liquidity to a more considerable extent as they wish).

Table 6
Heterogeneity across banks of different risk levels

Dependent variable: Total bank liquidity hoarding/Gross total assets								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	High risk	Low risk	High risk	Low risk	High risk	Low risk	High risk	Low risk
Lagged dependent variable	0.734***	0.709***	0.725***	0.645***	0.721***	0.638***	0.576***	0.805***
	(0.026)	(0.027)	(0.023)	(0.029)	(0.021)	(0.029)	(0.046)	(0.029)
Lending rates	−0.245***	−0.334***						
	(0.057)	(0.106)						
Refinancing rates			−0.206***	−0.288***				
			(0.044)	(0.104)				
Rediscounting rates					−0.219***	−0.292***		
					(0.042)	(0.112)		
Central bank's purchases							−0.670***	−1.691***
							(0.230)	(0.195)
Size	−0.146	1.207**	−0.024	1.686***	−0.002	1.695***	1.679**	−0.240
	(0.186)	(0.605)	(0.203)	(0.628)	(0.207)	(0.631)	(0.784)	(0.236)
Capital	0.186***	0.418***	0.194***	0.379***	0.202***	0.370***	0.388***	0.177**
	(0.039)	(0.126)	(0.053)	(0.107)	(0.057)	(0.105)	(0.127)	(0.071)
Risk	0.979*	−1.121*	0.808	−3.765***	0.815	−3.887***	−3.876***	1.138**
	(0.551)	(0.595)	(0.541)	(1.327)	(0.525)	(1.285)	(1.111)	(0.489)
Economic growth	−0.093	−0.350	0.033	−0.833**	0.031	−0.846**	−1.184***	0.275
	(0.248)	(0.498)	(0.227)	(0.382)	(0.224)	(0.376)	(0.452)	(0.247)

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Table 6 (*continued*)

Dependent variable: Total bank liquidity hoarding/Gross total assets								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	High risk	Low risk	High risk	Low risk	High risk	Low risk	High risk	Low risk
Stock return	0.011*	−0.009	0.015***	−0.004	0.012**	−0.006	−0.001	0.028***
	(0.006)	(0.008)	(0.005)	(0.009)	(0.006)	(0.010)	(0.009)	(0.004)
Observations	189	171	189	171	189	171	189	171
AR(1) test (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
AR(2) test (*p*-value)	0.919	0.650	0.932	0.529	0.937	0.535	0.527	0.972
Hansen test (*p*-value)	0.356	0.581	0.340	0.794	0.341	0.798	0.576	0.294

The estimation results are obtained using the two-step system GMM dynamic panel model with robust standard errors (in parentheses). The regressions for high-risk or low-risk banks are indicated at the top of each column. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Robustness Checks

This subsection displays some additional tests to identify if our results obtained thus far still hold when we employ different variables and econometric techniques. We first replace the current calculation of the SBV's asset purchases with an alternative one that is also commonly employed in the related literature. Concretely, we measure the SBV's claims on government normalised by the GDP, in accordance with previous studies (Brei et al., 2013; Lambert & Ueda, 2014). We next modify our model by eliminating the lagged dependent variable in the right-hand side and then apply the static panel model with fixed/random effects. The use of the static panel model as a robustness check, apart from the dynamic panel model, has been extensively employed in the literature (see Mamatzakis & Bermpei [2016] for more detailed explanation).

We report new sets of results in Tables 7–8. In all regressions, monetary policy indicators enter negative and significant with the dependent variable of total bank liquidity hoarding, regardless of banks' risk levels. Thus, these results strongly confirm that banks hoard more liquidity as the central bank relaxes its monetary policy by cutting interest rates but hoard less liquidity amid monetary stimulus from the central bank's funding injection. Besides, we also observe that bank liquidity hoarding in response to monetary policy shocks is more pronounced for low-risk banks rather than high-risk banks, thus casting doubt on the precautionary motive when banks hoard liquidity during interest-based monetary expansion.

Table 7
Robustness checks in static panel models

Dependent variable: Total bank liquidity hoarding/Gross total assets								
	Fixed effect model				Random effect model			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lending rates	−0.944*** (0.062)				−0.957*** (0.082)			
Refinancing rates		−0.853*** (0.143)				−0.871*** (0.174)		
Rediscounting rates			−0.842*** (0.138)				−0.856*** (0.163)	
Central bank's purchases (normalised)				−1.341*** (0.236)				−1.378*** (0.274)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	360	360	360	360	360	360	360	360
R^2	0.185	0.166	0.158	0.159	0.164	0.136	0.131	0.138
F-test (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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Table 7 (*continued*)

Dependent variable: Off-balance sheet-side liquidity hoarding/Gross total assets								
	Fixed effect model				Random effect model			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Lending rates	−0.495*** (0.112)				−0.616*** (0.126)			
Refinancing rates		−0.327*** (0.078)				−0.396*** (0.079)		
Rediscounting rates			−0.302*** (0.087)				−0.350*** (0.075)	
Central bank's purchases (normalised)				−0.439** (0.187)				−0.636** (0.211)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	360	360	360	360	360	360	360	360
R^2	0.403	0.373	0.368	0.365	0.247	0.161	0.151	0.169
F-test (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: The estimation results are obtained using the fixed and random effect static panel model with Driscoll-Kraay standard errors (in parentheses). The dependent variables are total bank liquidity hoarding/gross total assets (columns 1–8) and off-balance sheet-side liquidity hoarding/gross total assets (columns 9–16). We allow for the presence of control variables but do not show their results for the sake of brevity. *** and ** denote significance at the 1% and 5% levels, respectively.

Table 8
Heterogeneity across banks of different risk levels in static panel models

Dependent variable: Total bank liquidity hoarding/Gross total assets								
Fixed effect model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	High risk	Low risk	High risk	Low risk	High risk	Low risk	High risk	Low risk
Lending rates	−0.935***	−1.027***						
	(0.225)	(0.158)						
Refinancing rates			−0.824**	−0.918***				
			(0.277)	(0.223)				
Rediscounting rates					−0.698**	−0.960***		
					(0.273)	(0.233)		
Central bank's purchases (normalised)							−0.671*	−2.043***
							(0.353)	(0.388)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	189	171	189	171	189	171	189	171
R^2	0.190	0.204	0.165	0.187	0.152	0.186	0.217	0.140
F-test (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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Table 8 (*continued*)

Dependent variable: Total bank liquidity hoarding/Gross total assets								
Random effect model	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
	High risk	Low risk	High risk	Low risk	High risk	Low risk	High risk	Low risk
Lending rates	−0.917*** (0.153)	−1.052*** (0.216)						
Refinancing rates			−0.869*** (0.193)	−0.944*** (0.277)				
Rediscounting rates					−0.733** (0.247)	−0.982*** (0.270)		
Central bank's purchases (normalised)							−0.638** (0.286)	−2.193*** (0.358)
Control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	189	171	189	171	189	171	189	171
R^2	0.138	0.181	0.134	0.132	0.127	0.128	0.194	0.118
F-test (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: The estimation results are obtained using the fixed and random effect static panel model with Driscoll-Kraay standard errors (in parentheses). The dependent variable is total bank liquidity hoarding/gross total assets. We allow for the presence of control variables but do not show their results for the sake of brevity. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

CONCLUSION

This paper extends the literature on monetary policy transmission by investigating a new potential channel through which monetary policy may drive the real economy in the form of altering bank liquidity hoarding. Using banking data of the Vietnamese market during 2007–2019, we build comprehensive new bank liquidity hoarding measures combining items on- and off-balance sheets as developed by Berger et al. (2020). Multiple robust results have emerged.

Our empirical investigation indicates that banks decrease total liquidity hoarding and all three liquidity hoarding components when the central bank injects more money into the economy. A starling result appears when we document that banks tend to hoard more liquidity in the event of monetary stimulus in the form of lowered interest rates. In this manner, the potency of the monetary policy stimulus by decreased interest rates may be limited and not as expected since banks rebalance their portfolios towards liquidity hoarding. Our further analysis shows that the response in bank liquidity hoarding to monetary policy changes is strengthened at low-risk banks rather than high-risk counterparts. Though we gain empirical evidence supporting the strategic motive rather than the precautionary motive when banks hoard liquidity during the period of monetary stimulus by decreased interest rates, we leave more rigorous empirical research to offer more insight into such motives to future works.

Our study provides several policy implications, at least from the perspective of emerging markets. The empirical evidence from Vietnam reveals that interest- and quantitative-based monetary policy tools applied by the central bank are dissimilar in transmitting economic stimulus. Asset purchases under open market operations appear to be an appropriate monetary tool to stimulate the economy when the unintended consequences of decreased interest rates demonstrate that this is not a useful tool for fuelling the economy. As an additional concern, monetary authorities must be vigilant for the dark side that low-risk banks are more proactive in hoarding liquidity when the central bank cuts interest rates. Since excessive bank liquidity hoarding is detrimental to the real economic output, such banks' behaviour may have amplified adverse consequences in this regard.

We acknowledge that our study is limited by focusing on only one single small economy. So, we suggest future works to extend our findings with other individual markets and/or cross-country perspectives. Besides, interacting monetary policy indicators with macroeconomic variables (such as economic

policy uncertainty) is a valuable tool to investigate the demand-side effect of monetary policy transmission. This research strand could be a potential direction for future work.

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