Economic Cycle and Bank Liquidity Hoarding: Are They Procyclical or Countercyclical?

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Abstract: The paper empirically examines bank liquidity hoarding fluctuations over the economic cycle and provides further evidence on the heterogeneous cyclicality of bank liquidity hoarding across different banks in Vietnam for the period 2007–2019. Using both static panel models with the fixed-effects regression using corrected Driscoll-Kraay standard errors and dynamic panel models with the two-step system generalized method of moments estimator, we find that the liquidity hoarding of banks is procyclical. Concretely bank liquidity hoarding on- and off-balance sheets tends to increase during economic upturns and decrease during economic downturns. Our additional analysis yields a consistent pattern that financially weaker banks are more procyclical than their stronger counterparts. During booms and busts, the behaviour of hoarding liquidity is more pronounced for banks with smaller sizes, less capital, more risk, and less profit. This heterogeneity also contributes to understanding the core mechanism behind our main findings, further confirming the precautionary motive of bank liquidity hoarding.

Keywords: cyclical banking, economic cycle, liquidity hoarding, precautionary motive
JEL classification: G21, O47

1. Introduction

One of the banks' essential functions is liquidity creation, which may exert favourable impacts on the economy (Berger & Bouwman, 2009). In contrast, we should be aware of undesirable consequences related to the liquidity hoarding behaviour of banks. Excessive bank liquidity hoarding is detrimental because it restrains bank liquidity creation capacity to the public (Caballero & Krishnamurthy, 2008) and depresses the potency of monetary policy potency (Agénor & Aynaoui, 2010). From the banks' perspective, hoarding liquidity is inefficient since liquid assets commonly gain lower yields than productive illiquid assets. In the extreme situation, bank liquidity hoarding could cause systemic risks through spillover effects because the initiation of bank liquidity hoarding and asset fire sale actions by stressed banks would trigger down other banks (Diamond & Rajan, 2011).

Previous studies on bank liquidity hoarding have been well positioned in the literature, mostly focusing on the motivations of holding bank liquidity. To test the

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hypotheses, abundant empirical research has been done on the determinants of bank liquidity hoarding. In this stream, the literature typically considers liquid assets or other simple liquidity proxies to analyse bank liquidity hoarding. For example, many authors capture bank liquidity using liquid assets, loans, deposits, or some off-balance sheet items. Several recent studies approach the liquidity guidelines under Basel III Accords to indicate bank liquidity profiles, including the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR) (Abdul-Rahman et al., 2018; DeYoung & Jang, 2016).

Most recently, academics noted an important initiative by Berger et al. (2020) in quantifying bank liquidity hoarding through a considerably comprehensive measure. Their method emphasises both the sources and uses of liquid funds, which constitutes bank liquidity hoarding using all items on- and off-balance sheets of banks. As clearly explained in the seminal paper of Berger et al. (2020), their liquidity hoarding measure is much more comprehensive than any liquidity measure seen in the literature, which generally only utilises part of the asset- and liability-side liquidity hoarding.

This paper aims to explore the cyclical behaviour of bank liquidity hoarding. In this vein, the cyclicality of bank liquidity hoarding is defined as the linkage between economic cycles and liquidity hoarding behaviour, specifically: a positive association denotes the procyclicality of bank liquidity hoarding while a negative link displays the countercyclicality. Theoretically, a cyclical liquidity hoarding behaviour could induce essential effects by alleviating/amplifying the recessions/overheating of the economy. Regardless of the critical implications for the economy, very limited studies to the best of our knowledge explore how bank liquidity hoarding reacts to business cycle fluctuations. Instead, they often exploit the cyclicality of bank lending, bank capital, and bank risk-taking.

To fulfil our tasks with an entirely different approach compared to the literature, we employ a novel and comprehensive procedure proposed by Berger et al. (2020) to measure bank liquidity hoarding. Accordingly, we take into account not only bank liquid assets but also all the liquidity sources from other assets, liabilities, and off-balance sheet activities. To further deepen our research, we also analyse the heterogeneous cyclical behaviour of bank liquidity hoarding in this paper. Our concept here is that the cyclicality of bank liquidity hoarding could be asymmetric across different banks, which frequently exhibit differences in raising external finance and the precautionary motive of liquidity hoarding. Inspired by the existing literature, we employ four bank-level characteristics to explore the heterogeneous cyclicality, including bank size, capitalization, bank risk, and return profiles.

We conduct our research for the Vietnamese banking system and use both macro- and micro-data from 2007–2019. Vietnam offers a favourable laboratory for our experiments. First, the financial market in Vietnam highlights the role of the banking system, particularly bank credits in the context that the capital market here is still relatively underdeveloped (Dang & Nguyen, 2020). In other words, bank liquidity hoarding accordingly can be viewed as a considerably important financial and economic indicator. Second, Vietnam's economy has expanded considerably over the past decade, making it continuously one of the world's fastest-growing economies (Dang & Huynh, 2020). Therefore, it is of importance to find out how bank liquidity hoarding responds to the economic cycle, as an amplifying effect on an overheating economy may cause

great concern. Third, comprehensive reforms in regulations and business strategies have been a prominent feature of the banking system in Vietnam in recent years (Batten & Vo, 2019). As a result, they have significantly changed the intrinsic characteristics of banks throughout the system, in both financial structure and business performance. This event creates a significant differentiation among banks and makes the research on the asymmetric nature of cyclical behaviour ideal for investigating.

The paper offers some contributions to the related literature. First, it expands the emerging literature investigating the association between economic cycles and bank behaviours, for example, the cyclicality of bank capital, bank lending, and bank risk-taking. We add to this literature stream by exploring the cyclicality of bank liquidity hoarding. Second, we contribute to research on bank liquidity hoarding by using a novel measure that takes into account all liquidity hoarding contributions from all liquid and illiquid assets, liabilities, and off-balance sheet items. Looking into the theoretical and empirical bank liquidity hoarding measures previously employed, we realise that they include only some of the banking activities we incorporate in this study. Third, we offer more insight into bank liquidity hoarding behaviour by identifying how the cyclicality of bank liquidity hoarding varies across different banks. A unified pattern in favour of the precautionary motive of Vietnamese banks' liquidity hoarding is delivered through a variety of aspects utilised to evaluate a bank's financial strength, thereby providing reliable and robust evidence to explain the core mechanism behind our main findings obtained in the paper.

To obtain these contributions, we proceed with the rest of the paper as follows. Section 2 reviews the related literature on bank liquidity hoarding and the cyclicality of bank behaviour. Section 3 describes our empirical framework before we report and discuss results in section 4. Finally, section 5 concludes the paper.

2. Bank Liquidity Hoarding and Cyclicality of Bank Behaviour

The paper relates to two main strands of literature. The first deals with bank liquidity hoarding and the second focuses on the cyclicality of bank behaviour. We briefly discuss each of these two segments in this section.

Exploring the first literature stream on bank liquidity hoarding, many works have paid close attention to the reasons why banks hoard liquidity. Accordingly, for precautionary and strategic reasons, banks may hold more liquidity to protect themselves against liquidity shocks and potential funding difficulties that would force them to sell illiquid assets and/or miss lucrative investment opportunities in the future (Diamond & Rajan, 2011; Gale & Yorulmazer, 2013). The liquidity could be in the form of liquid assets on bank balance sheets (e.g., cash and securities) or off-balance sheets in the form of derivatives that effectively function similarly to liquid assets (Berger et al., 2020). Banks may also hoard liquidity by attracting liquid deposits and other liquid liabilities in case they assume that they cannot obtain interbank loans amid temporary liquidity shortages (Acharya & Naqvi, 2012; Allen & Gale, 2004).

The empirical literature on bank liquidity hoarding mainly investigates levels or differences in various aspects of bank liquidity, such as liquid assets (Cornett et al., 2011; Gale & Yorulmazer, 2013), loans (Afonso et al., 2011), deposits (Heider et

al., 2015), and unused loan commitments (Cornett et al., 2011). After the Basel III guidelines had first introduced bank liquidity rules, scholars turned their attention to two new liquidity ratios, namely the LCR and the NSFR. The former is required to deal with short-term liquidity risk that features monthly cash inflows and outflows, whereas the latter is designed to nurture long-term bank liquidity that particularly highlights the stable funding sources (Abdul-Rahman et al., 2018; DeYoung & Jang, 2016). In sum, all of these liquidity measures fail to consider all the sources and uses of liquid funds to compute bank liquidity hoarding using all items on- and off-balance sheets of banks as the novel measure suggested by Berger et al. (2020).

Regarding the literature stream on the cyclicality of bank behaviour, various papers examine whether bank behaviour is procyclical or countercyclical with regard to business cycles. Focusing on the link between economic cycles and bank capitalisation, various papers show inconclusive results. Shim (2013) and Stolz and Wedow (2011) display evidence in favour of the countercyclicality of bank capital buffers. Contrary to these findings, Carvallo et al. (2015) and Grosse and Schumann (2014) exhibit that bank capital follows the procyclical pattern. In a further effort, Jokipii and Milne (2008) explore a panel of savings, commercial, and co-operative banks, as well as small versus large banks. They ultimately indicate that different banks have different cyclicality of bank capital. Examining the cyclicality of bank risk-taking, Bouheni and Hasnaoui (2017) illustrate that bank financial stability is procyclical. This finding implies that banks mitigate their risk levels in good periods and tend to be less risk-averse in bad periods. Previously, Bikker and Metzemakers (2005) and Laeven and Majnoni (2003) document that loan loss provisions are negatively associated with business cycles proxied by the GDP growth rate. In another well-known stream that is closely related to our present work, scholars explore the cyclicality of bank lending. Zins and Weill (2018) reveal the procyclicality of bank lending from 20 countries in Africa. This finding is previously displayed in the paper of Bertay et al. (2015), who employ a whole global sample for their analysis. However, Bertay et al. (2015) also observe that the lending behaviour is countercyclical in high-income countries.

Bank liquidity hoarding is proved to be changed with economic cycles. Aspachs et al. (2005) examine the determinants of bank liquidity holdings in the UK. The authors employed two alternative bank liquidity ratios obtained on bank balance sheets: the first is the ratio of liquid assets to total assets, which captures the split between liquid and illiquid assets, and the second is the ratio of liquid assets to total deposits, which denotes the liquidity mismatch. Their regression results reveal that banks in the UK tend to hold larger (smaller) volumes of liquidity, relative to both total deposits and total assets, in times of weaker (stronger) economic growth. Referring to this work, Acharya et al. (2011) argued that the macroeconomic environment could well explain the behaviour of liquidity hoarding, as bank liquidity hoarding is countercyclical: banks are more likely to increase their liquidity buffers during economically stressed times and reduce them in prosperous times. However, these authors do not provide any empirical evidence to support this implication that they draw from the analysis of Aspachs et al. (2005).

At an initial glance, we might expect that bank liquidity hoarding is countercyclical as commonly demonstrated by previous studies. Moreover, the countercyclicality of bank liquidity hoarding could be supported by the stylised fact that bank liquidity

hoarding decreases with more lending, and there has been extensive evidence on the procyclicality of bank lending. However, bank liquidity hoarding is a more comprehensive measure that considers all on- and off-balance sheet items and theoretically speaking, there are also several mechanisms in favour of the procyclicality of bank liquidity hoarding. For instance, a prosperous time may increase bank liquidity since residents could have more money circulated in the financial market (Abdul-Rahman et al., 2018). Also, a faster-growing economy may offer more alternative high-yield investment opportunities, potentially leading to increased liquidity holdings, such as securities and derivatives (Dietrich et al., 2014). Hence, it is interesting to evaluate if empirical evidence in this paper confirms the countercyclicality or procyclicality of bank liquidity hoarding.

3. Data and Methodology

3.1 Data

The study employs yearly data from financial reports of Vietnamese commercial banks between 2007 and 2019. Our final sample contains 31 commercial banks with a total of 391 observations, forming an unbalanced panel that covers about 90% of the banking industry's total assets in Vietnam. To mitigate the problem of extreme outliers, we then winsorise our bank-level variables at the 2.5% and 97.5% percentiles. For the macroeconomic indicators, we collect the data for the growth rate of the GDP and the inflation rate from the *World Development Indicators*, while the short-term lending rates are obtained from the *International Financial Statistics*.

3.2 Bank Liquidity Hoarding Measures

As a striking aspect of this paper, we utilise the novel and comprehensive procedure of Berger et al. (2020) to calculate bank liquidity hoarding measures. In this vein, based on the critical mechanism that banking activities could boost or depress bank liquidity hoarding, we assign on- and off-balance sheet activities the weights of +0.5 and –0.5. Also taking into account the specific background of the banking system in Vietnam, we employ the original metrics of Berger and Bouwman (2009) with some modifications of Berger et al. (2019) and Dang (2020) to classify banking items (both on- and off-balance sheets) more effectively and appropriately. Next, inspired by Berger et al. (2020), we compute bank liquidity hoarding measures (total, on- and off-balance sheet components) as follows:

$$\textit{Total liquidity hoarding (LHtotal)} = \textit{On-balance sheet liquidity hoarding (LHonbalance)} + \textit{Off-balance sheet liquidity hoarding (LHoffbalance)} \quad (1)$$

where:

$$\textit{On-balance sheet liquidity hoarding (LHonbalance)} = (+0.5)\times\textit{Liquid assets} + (-0.5)\times\textit{Illiquid assets} + (+0.5)\times\textit{Liquid liabilities} \quad (2)$$

$$\textit{Off-balance sheet liquidity hoarding (LHoffbalance)} = (+0.5)\times\textit{Liquid derivatives} + (-0.5) \times \text{Illiquid off-balance sheet items} \quad (3)$$

The classification method of banking items with different weights is displayed in Table 1. Ultimately, we normalise liquidity hoarding volumes by total assets to construct the targeted dependent variables for the regression stage. This treatment is to ensure that our variables are comparable across all banks in the system.

Table 1. Liquidity hoarding measures

Liquid assets (0.5)	Liquid liabilities (0.5)	Liquid off-balance sheet items (0.5)
Cash and due from institutions	Deposits	All derivatives
All securities	Trading liabilities	
Illiquid assets (–0.5)		Illiquid off-balance sheet items (–0.5)
Corporate loans		Loan commitments
Retail loans		Letters of credit commitments
Other assets		Loan guarantees

Note: Please refer to the seminal work of Berger et al. (2020) for more detail on the procedures to calculate bank liquidity hoarding measures.

3.3 Empirical Model and Method

To empirically investigate the cyclicality of bank liquidity hoarding, we first employ the static panel model with fixed effects. Following prior empirical studies on the cyclicality of bank behaviour (Bouheni & Hasnaoui, 2017; Zins & Weill, 2018), our specific model is thus written as follows:

$$LH_{i,t} = \alpha_0 + \alpha_1 \times GDP_t + \alpha_2 \times X_{i,t} + \alpha_3 \times Z_t + u_i + \varepsilon_{i,t} \quad (4)$$

where $LH_{i,t}$ is the measure of bank liquidity hoarding by bank i in year t. *GDPgrowth* is the indicator for the business cycle, captured by the annual growth rate of GDP as proposed in almost every earlier study (e.g., Bouheni & Hasnaoui, 2017; Stolz & Wedow, 2011; Zins & Weill, 2018). X indicates a vector of bank-specific controls, and Z contains multiple macroeconomic factors. u_i captures unobserved bank fixed effects and $\varepsilon_{i,t}$ denotes the error term.

Looking into the model specification, we argue that a negative sign of coefficient on the GDP growth rate variable indicates an inverse relationship between bank liquidity hoarding and the business cycle, implying that bank liquidity hoarding rises in busts and declines in booms. Alternatively speaking, a negative (positive) coefficient of the business cycle indicator exhibits a countercyclical (procyclical) variation of bank liquidity hoarding over business cycles.

Consistent with the former literature on the determinants of bank liquidity hoarding, we control some key bank-level variables, including bank size, capitalisation, bank risk, and bank return. The rationales of using these controls are explained as follows. Large banks may have easier access to various funding sources, and thus they can comfortably run with a smaller buffer of liquidity (Delechat et al., 2012). Regarding bank capitalisation, the literature reveals that lower-capitalised banks may have a stronger

incentive to place their investments in the form of risk-free liquid assets to enhance the capital adequacy ratio (Affinito et al., 2019). For bank risk and return, we realise that as a result of the precautionary motive and strategic movie, banks tend to hold more liquid assets when their risk level is high and hold less liquid assets if their profitability is low, respectively (Ashraf, 2020).

Besides the bank-level controls, we also allow for the presence of macroeconomic conditions in our model. Taking into account the opportunity cost of cash holdings, we include lending rates as inspired by the notion that banks may invest their cash in alternative assets (e.g., loans) when interest rates are high enough (Nketcha Nana & Samson, 2014). Also, with regard to inflation, one could argue that high inflation may weaken the drivers of business growth at firms, making it difficult for banks to expand their financing activities (Louhichi & Boujelbene, 2017). In sum, both lending rates and inflation are included in our economic model. The detailed calculations of all control variables are exhibited in Table 2.

We estimate the first baseline model with Driscoll-Kraay standard errors, using the correction procedure proposed by Hoechle (2007). Despite such efforts, the endogeneity problem remains a concern, given the potential existence of reverse causality or omitted variables. To overcome the possible risky endogeneity and also capture the dynamic nature of bank liquidity hoarding, we employ the two-step system generalized method of moments (GMM) estimator after adding a lagged dependent variable into the right-hand side of the baseline equation (Arellano & Bover, 1995; Blundell & Bond, 1998). The Hansen and AR(1)/AR(2) tests must be done to confirm the validity of our instruments and detect the first-order but no second-order serial correlation on the estimated residuals.

Table 2. Summary statistics of employed variables

	Mean	SD	Min	Max	Definitions
Bank liquidity hoarding variables					
LHtotal	18.273	11.346	–8.810	46.402	Total bank liquidity hoarding/total bank assets (%)
LHonbalance	16.825	9.702	–8.810	35.798	On-balance sheet liquidity hoarding/ total bank assets (%)
LHoffbalance	1.448	6.144	–8.477	26.913	Off-balance sheet liquidity hoarding/ total bank assets (%)
Macroeconomic variables					
GDP	6.245	0.642	5.247	7.130	Annual growth rate of GDP (%)
Inflation	7.424	29.654	–65.953	56.761	Annual inflation rate (%)
Interest rates	10.400	3.328	6.960	16.954	Average short-term lending rates (%)
Bank-level variables					
Size	31.967	1.294	29.404	34.630	Natural logarithm of total bank assets
Capital	10.280	5.351	4.384	29.008	Bank equity/total bank assets (%)
Risk	1.254	0.545	0.299	2.763	Loan loss provisions/gross loans (%)
Return	0.923	0.684	0.023	2.609	Return/total bank assets (%)

4. Results and Discussions

4.1 Preliminary Analysis

The descriptive statistics of all variables are presented in Table 2. We observe that total, on- and off-balance-sheet liquidity hoarding measures (as a proportion of total assets) average 18.273%, 16.825%, and 1.448%, respectively. This pattern suggests that liquidity hoarding in the form of liquid assets and liquid liabilities overwhelm the liquidity creation in the form of illiquid assets on the balance sheets of Vietnamese banks, while the dominant positions off-balance sheets are witnessed for derivatives instead of illiquid guarantees and commitments. We also pay close attention to the economic cycle indicator in Vietnam, which has a mean of 6.245% per year. This considerably high level of economic growth rate supports the argument that Vietnam has been among the fastest-growing world economies during the years 2007–2019.

We present the matrix of pairwise correlation coefficients between all variables in Table 3. The results display that all correlation coefficients (except for the case of liquidity hoarding variables) are less than 0.80, revealing that the issue of severe multi-collinearity in our empirical regressions could be safely neglected. Additionally, the matrix provides an interesting preliminary result before entering the regression stage: the correlation coefficients between the business cycle and different bank liquidity hoarding measures are positive, implying the potential procyclicality of bank liquidity hoarding.

Table 3. Correlation coefficient matrix

	LHtotal	LHonbalance	LHoffbalance	GDP	Inflation	Interest rates	Size	Capital	Risk	Return
LHtotal	1.000									
LHonbalance	0.810	1.000								
LHoffbalance	0.520	–0.070	1.000							
GDP	0.170	0.040	0.370	1.000						
Inflation	–0.190	–0.040	–0.300	–0.370	1.000					
Interest rates	–0.250	–0.050	–0.370	–0.440	0.430	1.000				
Size	0.110	0.020	0.180	0.220	–0.330	–0.340	1.000			
Capital	–0.140	–0.120	–0.080	–0.230	0.340	0.340	–0.420	1.000		
Risk	–0.060	0.000	–0.090	–0.190	–0.010	0.070	0.440	–0.290	1.000	
Return	0.020	0.040	0.010	0.040	0.260	0.290	–0.110	0.260	–0.160	1.000

4.2 Baseline Estimation Results

Table 4 reports our baseline estimation results using all three bank liquidity hoarding measures as dependent variables. In all regressions, we find that the economic cycle indicator enters positive and significant with three dependent variables. These results suggest that bank liquidity hoarding shows positive co-movement with business cycles; in other words, we present evidence that bank liquidity hoarding is likely to fluctuate

procyclically. The procyclicality of bank liquidity hoarding in this regard is observed both on- and off-balance sheets. Quantitatively, the coefficient estimates in Table 4 display that a one percentage point increase in the economic growth leads to an economically significant increase of 2.160 and 2.843 percentage points in on- and off-balance-sheet

Table 4. Baseline estimation results

	Fixed-effects regression with Driscoll-Kraay standard errors			Two-step system GMM estimator		
	(1) LHtotal	(2) LHonbalance	(3) LHoffbalance	(4) LHtotal	(5) LHonbalance	(6) LHoffbalance
Lagged LHtotal				0.599*** (0.023)		
Lagged LHonbalance					0.751*** (0.021)	
Lagged LHoffbalance						0.872*** (0.011)
GDP	1.911*** (0.553)	2.160*** (0.627)	2.843*** (0.909)	0.983*** (0.265)	0.452*** (0.173)	0.841*** (0.029)
Inflation	0.315** (0.107)	0.326* (0.164)	0.244*** (0.078)	0.128* (0.077)	–0.080 (0.055)	0.100*** (0.008)
Interest rates	–1.245*** (0.145)	–0.702** (0.259)	–0.795*** (0.170)	–0.571*** (0.143)	–0.106 (0.126)	–0.320*** (0.019)
Size	–0.404 (0.857)	–1.409 (1.325)	–2.335*** (0.435)	–0.806** (0.398)	–0.486** (0.215)	–0.204*** (0.048)
Capital	0.146** (0.054)	0.136 (0.102)	0.271** (0.112)	0.349*** (0.069)	0.349*** (0.061)	0.015 (0.009)
Risk	1.538* (0.739)	–1.019 (0.904)	–0.874 (0.559)	0.636* (0.353)	0.310 (0.415)	–0.466*** (0.054)
Return	–0.218 (0.526)	–1.410** (0.637)	1.182 (0.757)	–0.377 (0.473)	–1.383*** (0.488)	0.123*** (0.038)
Observations	360	360	360	360	360	360
F-test	0.000	0.000	0.000			
R-squared	0.212	0.221	0.347			
Banks	31	31	31	31	31	31
Instruments				29	29	29
AR(1) test				0.000	0.000	0.012
AR(2) test				0.860	0.389	0.820
Hansen test				0.499	0.350	0.220

Notes: The estimation results are obtained using the fixed-effects regression with Driscoll-Kraay standard errors (columns 1–3) and the two-step system GMM estimator (columns 4–6). The dependent variables are shown at the top of each column. Standard errors are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

liquidity hoarding (columns 2 and 3, respectively). The magnitude of the impacts slightly changes in the estimations using the dynamic GMM model, but our findings' economic significance still holds.

Overall, the bank liquidity hoarding behaviour cannot amplify the business cycle, i.e., during economic upturns, bank liquidity hoarding increases, and during economic downturns, bank liquidity hoarding decreases. Our findings differ from those obtained by Aspachs et al. (2005), who demonstrate the countercyclical behaviour of bank liquidity holdings in the UK when using liquid assets as the liquidity hoarding indicators. Therefore, we claim that the situation could be different, given that we are trying to answer the same question but using the context of Vietnam and the comprehensive procedure to measure bank liquidity hoarding considering all items on- and off-balance sheets. Some potential mechanisms could explain our findings here. Notably, the riskiness in asset portfolios may increase during high economic growth (Crockett, 2002). Being aware of this issue along with the precautionary motive in case banks believe that they will be unable to deal with temporary liquidity shortages in booming economies (Allen & Gale, 2004), banks tend to nurture a larger liquidity buffer rather than create excessive liquidity for the economy during the upturns. In another vein, a faster-growing economy may offer more alternative higher-yield investment opportunities, potentially leading to more liquidity holdings (such as securities and derivatives) instead of more loans made by the bank (Dietrich et al., 2014).

Turning to the discussion of control variables, some significant results consistent and at odds with the former literature have emerged. There is a negative link between size and bank liquidity hoarding, suggesting that larger banks tend to hoard less liquidity, thereby lending support to the argument of Delechat et al. (2012). Bank capital induces significantly positive impacts on liquidity hoarding in most regressions, implying that banks with a large capital buffer may hold more liquidity in Vietnam. Our finding is at odds with Affinito et al. (2019), who find out that the motivation for banks to improve capital adequacy ratios is illustrated in the form of liquidity storage. Our results also validate the hypothesis of cash holdings' opportunity cost since we document a negative relationship between lending rates and bank liquidity hoarding (Nketcha Nana & Samson, 2014). Finally, we find that banks may hoard more liquidity during a period of high inflation. This finding accords with those of Louhichi and Boujelbene (2017), who argue that high inflation mitigates the credit demands of firms and then makes it difficult for banks to expand their financing segments.

4.3 Heterogeneous Cyclicality of Bank Liquidity Hoarding

In this subsection, we aim to offer more insight into bank liquidity hoarding behaviour by testing how the cyclicality of bank liquidity hoarding varies across different banks. To this end, we expand the baseline specification model by adding the interaction terms between the economic cycle indicator and some bank-specific characteristics. By looking into the coefficients on the interaction terms, we could determine whether there is an asymmetry in the cyclicality of bank liquidity hoarding.

Our approach is inspired and well supported by the literature. Under the bank lending channel, the transmission potency of monetary policy is more pronounced at

more vulnerable financial institutions, which have less access to alternative external funding (Altunbas et al., 2010; Gambacorta, 2005; Kashyap & Stein, 2000; Orzechowski, 2017). If banks encounter more difficulty in raising external finance (heavier borrowing constraints and higher financing costs), they tend to hoard more liquidity when it comes to the precautionary motive of liquidity hoarding. Therefore, if these mechanisms are also at work when the economic cycle fluctuates more generally, it could be expected that the cyclicality of bank liquidity hoarding would be more conspicuous at financially weaker banks. In line with the prior empirical literature, we allow for four standard bank-level characteristics to denote banks' financial weakness/strength: bank size, bank capitalisation, bank risk, and bank profitability. More precisely, smaller banks, lower-capitalised banks, riskier banks, and less profitable banks are considered financially weaker banks.

We separately include the interaction terms in each regression to make our econometric model parsimonious and avoid the potential multicollinearity. The regression results are presented in Tables 5–8 with both the fixed-effects static regression and the dynamic GMM estimator. In most specifications, the coefficients on the standalone economic cycle indicator are positive and statistically significant. These results once again confirm that bank liquidity hoarding increases in response to higher economic growth. Moving to the interaction terms of primary interest, we find that the coefficients on *GDP×Size*, *GDP×Capital*, *GDP×Return* are significantly negative in most regressions, while those on *GDP×Risk* are significantly positive in most columns. These results lead to a uniform pattern that financially weaker banks are more cyclical than their stronger counterparts. During booms and busts, the desire to hoard liquidity is more relevant for banks that are more financially vulnerable with smaller sizes, less capital, more risk and less profit. This heterogeneity contributes to understanding the core mechanism behind our main findings obtained previously, further confirming the precautionary motive of Vietnamese banks' liquidity hoarding.

4.4 Robustness Checks

In this part we perform some robustness checks to validate our findings obtained thus far. We first replace novel liquidity hoarding measures by Berger et al. (2020) with alternative indicators of bank liquidity holding that are conventionally used in the banking literature, including the ratio of liquid assets to total assets and the ratio of liquid assets to deposits plus short-term borrowing. Next, we winsorise all bank-level variables at 5% and 95% to further rule out the impact of outliers (instead of the interval of 2.5% and 97.5% as previously employed). Finally, we estimate our model specification using a different econometric methodology – the corrected least square dummy variable (LSDV) approach. This estimator could conduct perfect alternative regressions for the widely-used GMM estimators when the panel is unbalanced and the number of individuals is small (these are also verified in our dataset) (Bruno, 2005).

We combine all procedures as discussed above and obtain the results reported in Tables 9–10. Overall, we document consistent evidence that the economic cycle indicator is positively associated with alternative measures of bank liquidity hoarding in all regressions. Also, we still find that the coefficients on the interaction terms between

Table 5. Cyclicality of bank liquidity hoarding according to bank size

	Fixed-effects regression with Driscoll-Kraay standard errors			Two-step system GMM estimator		
	(1) LHtotal	(2) LHonbalance	(3) LHoffbalance	(4) LHtotal	(5) LHonbalance	(6) LHoffbalance
Lagged LHtotal				0.579*** (0.024)		
Lagged LHonbalance					0.746*** (0.023)	
Lagged LHoffbalance						0.870*** (0.010)
GDP	0.318 (0.822)	2.082*** (0.643)	2.377*** (0.642)	15.961*** (5.077)	17.557*** (4.470)	0.857 (0.678)
Inflation	0.271 (0.157)	0.326* (0.161)	0.092 (0.137)	0.194*** (0.070)	–0.081 (0.057)	0.096*** (0.009)
Interest rates	–1.181*** (0.229)	–0.719*** (0.227)	–0.379* (0.174)	–0.724*** (0.125)	0.094 (0.133)	–0.314*** (0.022)
GDP×Size	–0.059*** (0.015)	–0.010 (0.015)	–0.072*** (0.021)	–0.519*** (0.150)	–0.524*** (0.138)	–0.001 (0.020)
Size	–0.093 (1.033)	–1.232 (1.178)	–0.819 (0.745)	–2.428*** (0.713)	–2.511*** (0.765)	–0.223* (0.119)
Capital	0.140** (0.056)	0.138 (0.103)	0.256* (0.120)	0.273*** (0.066)	0.335*** (0.057)	0.014 (0.008)
Risk	–1.413* (0.672)	–1.104 (0.963)	–0.264 (0.624)	0.630* (0.336)	0.459 (0.412)	–0.480*** (0.060)
Return	–0.256 (0.534)	–1.394** (0.620)	1.069 (0.661)	–0.079 (0.410)	–1.396*** (0.500)	0.115** (0.047)
Observations	360	360	360	360	360	360
F-test	0.000	0.000	0.000			
R-squared	0.214	0.276	0.376			
Banks	31	31	31	31	31	31
Instruments				30	30	30
AR(1) test				0.000	0.000	0.012
AR(2) test				0.823	0.323	0.821
Hansen test				0.366	0.324	0.214

Notes: The estimation results are obtained using the fixed-effects regression with Driscoll-Kraay standard errors (columns 1–3) and the two-step system GMM estimator (columns 4–6). The dependent variables are shown at the top of each column. Standard errors are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 6. Cyclicality of bank liquidity hoarding according to bank capital

	Fixed-effects regression with Driscoll-Kraay standard errors			Two-step system GMM estimator		
	(1) LHtotal	(2) LHonbalance	(3) LHoffbalance	(4) LHtotal	(5) LHonbalance	(6) LHoffbalance
Lagged LHtotal				0.612*** (0.027)		
Lagged LHonbalance					0.747*** (0.017)	
Lagged LHoffbalance						0.869*** (0.010)
GDP	2.382** (0.780)	0.027 (0.667)	2.481** (0.837)	1.633*** (0.249)	0.269 (0.198)	0.796*** (0.029)
Inflation	0.351** (0.138)	0.096 (0.127)	0.216** (0.079)	0.131 (0.092)	–0.033 (0.046)	0.103*** (0.008)
Interest rates	–1.233*** (0.152)	–0.341* (0.164)	–0.804*** (0.157)	–0.496*** (0.172)	0.152 (0.116)	–0.333*** (0.020)
GDP×Capital	–0.060 (0.036)	–0.111*** (0.015)	–0.046 (0.028)	–0.074*** (0.011)	–0.078*** (0.009)	–0.006*** (0.002)
Size	0.389 (0.767)	–2.278* (1.036)	–2.347*** (0.464)	0.179 (0.377)	–0.122 (0.238)	–0.266*** (0.038)
Capital	0.336*** (0.106)	0.207* (0.096)	0.125 (0.076)	0.455*** (0.085)	0.494*** (0.068)	0.007 (0.009)
Risk	–1.442* (0.795)	–0.436 (1.028)	–0.948 (0.584)	0.497 (0.331)	0.357 (0.517)	–0.474*** (0.070)
Return	0.001 (0.609)	–1.060 (0.658)	1.013 (0.688)	–0.075 (0.425)	–1.201*** (0.436)	0.115*** (0.041)
Observations	360	360	360	360	360	360
F-test	0.000	0.000	0.000			
R-squared	0.227	0.121	0.362			
Banks	31	31	31	31	31	31
Instruments				30	30	30
AR(1) test				0.000	0.000	0.012
AR(2) test				0.833	0.337	0.823
Hansen test				0.332	0.292	0.226

Notes: The estimation results are obtained using the fixed-effects regression with Driscoll-Kraay standard errors (columns 1–3) and the two-step system GMM estimator (columns 4–6). The dependent variables are shown at the top of each column. Standard errors are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 7. Cyclicality of bank liquidity hoarding according to bank risk

	Fixed-effects regression with Driscoll-Kraay standard errors			Two-step system GMM estimator		
	(1) LHtotal	(2) LHonbalance	(3) LHoffbalance	(4) LHtotal	(5) LHonbalance	(6) LHoffbalance
Lagged LHtotal				0.600*** (0.022)		
Lagged LHonbalance					0.757*** (0.019)	
Lagged LHoffbalance						0.878*** (0.012)
GDP	1.857*** (0.416)	0.327 (0.434)	2.274*** (0.698)	0.988*** (0.249)	0.301** (0.151)	0.755*** (0.024)
Inflation	0.298** (0.115)	0.194* (0.104)	0.066 (0.090)	0.130 (0.080)	–0.081 (0.054)	0.105*** (0.020)
Interest rates	–1.228*** (0.160)	–0.521*** (0.158)	–0.622*** (0.101)	–0.572*** (0.150)	0.152 (0.124)	–0.341*** (0.051)
GDP×Risk	0.140 (0.601)	1.359** (0.612)	1.481*** (0.436)	0.017 (0.072)	0.160* (0.090)	0.082** (0.039)
Size	–0.324 (0.945)	–1.467 (1.157)	–1.483** (0.597)	–0.812** (0.409)	–0.530** (0.239)	–0.134** (0.057)
Capital	0.144** (0.058)	0.132 (0.099)	0.255** (0.115)	0.351*** (0.070)	0.336*** (0.062)	0.020** (0.009)
Risk	–2.320 (3.573)	6.957** (3.086)	–9.129*** (2.344)	0.631 (0.412)	0.713 (0.552)	–0.580*** (0.193)
Return	–0.217 (0.525)	–1.476** (0.591)	1.190* (0.634)	–0.438 (0.494)	–1.375*** (0.476)	0.175*** (0.042)
Observations	360	360	360	360	360	360
F-test	0.000	0.000	0.000			
R-squared	0.212	0.376	0.375			
Banks	31	31	31	31	31	31
Instruments				30	30	30
AR(1) test				0.000	0.000	0.011
AR(2) test				0.860	0.395	0.845
Hansen test				0.508	0.320	0.271

Notes: The estimation results are obtained using the fixed-effects regression with Driscoll-Kraay standard errors (columns 1–3) and the two-step system GMM estimator (columns 4–6). The dependent variables are shown at the top of each column. Standard errors are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 8. Cyclicality of bank liquidity hoarding according to bank return

	Fixed-effects regression with Driscoll-Kraay standard errors			Two-step system GMM estimator		
	(1) LHtotal	(2) LHonbalance	(3) LHoffbalance	(4) LHtotal	(5) LHonbalance	(6) LHoffbalance
Lagged LHtotal				0.622*** (0.028)		
Lagged LHonbalance					0.755*** (0.023)	
Lagged LHoffbalance						0.811*** (0.015)
GDP	1.910*** (0.551)	0.833* (0.447)	2.826*** (0.779)	1.277*** (0.380)	0.261 (0.302)	0.342*** (0.074)
Inflation	0.278 (0.157)	0.400** (0.160)	–0.143 (0.225)	0.131 (0.082)	–0.092 (0.063)	0.112*** (0.017)
Interest rates	–1.196*** (0.259)	–0.840*** (0.164)	–0.294 (0.263)	–0.508*** (0.174)	0.178 (0.126)	–0.409*** (0.050)
GDP×Return	–0.178 (0.602)	–1.758*** (0.422)	–1.840** (0.809)	–0.156 (0.121)	–0.116 (0.103)	–0.423*** (0.016)
Size	0.291 (0.907)	–1.124 (1.257)	1.158 (1.053)	–0.911** (0.402)	–0.563** (0.244)	–0.004 (0.067)
Capital	0.141** (0.060)	–0.099 (0.091)	0.220* (0.112)	0.402*** (0.077)	0.378*** (0.074)	0.083*** (0.010)
Risk	–1.513* (0.703)	–0.868 (1.025)	–0.609 (0.714)	0.602 (0.393)	0.342 (0.431)	–0.087 (0.134)
Return	–1.327 (4.113)	–9.503*** (2.318)	–10.298* (5.120)	–0.191 (0.469)	–1.293** (0.572)	0.644*** (0.119)
Observations	360	360	360	360	360	360
F-test	0.000	0.000	0.000			
R-squared	0.212	0.076	0.375			
Banks	31	31	31	31	31	31
Instruments				30	30	30
AR(1) test				0.000	0.000	0.009
AR(2) test				0.848	0.387	0.932
Hansen test				0.398	0.268	0.532

Notes: The estimation results are obtained using the fixed-effects regression with Driscoll-Kraay standard errors (columns 1–3) and the two-step system GMM estimator (columns 4–6). The dependent variables are shown at the top of each column. Standard errors are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 9. Robustness checks with the traditional ratio of liquid assets to total assets

	Dependent variable: Liquid assets/Total assets				
	(1)	(2)	(3)	(4)	(5)
Lagged Liquid assets/ Total assets	0.542*** (0.024)	0.451*** (0.030)	0.536*** (0.024)	0.504*** (0.029)	0.529*** (0.026)
GDP	2.154*** (0.108)	0.640*** (0.218)	3.043*** (0.167)	2.791*** (0.284)	2.621*** (0.132)
Inflation	0.243*** (0.062)	0.672*** (0.100)	0.224*** (0.066)	0.084 (0.081)	0.677*** (0.083)
Interest rates	–0.036 (0.109)	–0.560*** (0.160)	0.041 (0.110)	–0.434*** (0.158)	–0.599*** (0.139)
GDP×Size		–0.064*** (0.003)			
GDP×Capital			–0.105*** (0.008)		
GDP×Risk				0.749*** (0.237)	
GDP×Return					–2.214*** (0.280)
Size	–0.093 (0.151)	–0.900*** (0.210)	–0.919*** (0.136)	0.091 (0.290)	0.072 (0.140)
Capital	0.278*** (0.051)	0.202*** (0.057)	0.501*** (0.034)	0.212*** (0.066)	0.246*** (0.037)
Risk	–1.757*** (0.457)	–1.174** (0.547)	–1.610*** (0.401)	0.063 (0.667)	–1.791*** (0.403)
Return	0.672* (0.379)	1.618*** (0.405)	1.320*** (0.391)	0.407 (0.422)	14.443*** (1.915)
Observations	360	329	360	360	360
Banks	31	31	31	31	31

Notes: The estimation results are obtained using the corrected LSDV regression (Arellano-Bond). Other corrected LSDV regressions (Anderson-Hsiao and Blundell-Bond) yield similar results, but we do not report them for brevity. Bank-level data are winsorised at 5% and 95%. Bootstrapped standard errors are in parentheses. Standard errors are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Table 10. Robustness checks with the traditional ratio of liquid assets to deposits plus short-term borrowing

	Dependent variable: Liquid assets/Deposits				
	(1)	(2)	(3)	(4)	(5)
Lagged Liquid assets/ Deposits	0.657*** (0.022)	0.662*** (0.024)	0.638*** (0.031)	0.591*** (0.044)	0.604*** (0.031)
GDP	1.946*** (0.258)	3.488*** (0.317)	2.754*** (0.278)	3.794*** (0.335)	2.821*** (0.744)
Inflation	–0.036 (0.063)	0.461*** (0.071)	–0.034 (0.076)	0.263*** (0.072)	0.647*** (0.096)
Interest rates	–0.391** (0.157)	–0.334** (0.170)	–0.520*** (0.173)	–1.282*** (0.222)	–0.738*** (0.199)
GDP×Size		–0.103*** (0.011)			
GDP×Capital			–0.095*** (0.015)		
GDP×Risk				1.994*** (0.397)	
GDP×Return					–5.670*** (0.808)
Size	–0.472 (0.299)	–1.024*** (0.320)	–0.854*** (0.205)	0.347 (0.370)	0.065 (0.320)
Capital	0.221** (0.094)	0.122 (0.097)	0.545*** (0.111)	0.146** (0.065)	0.253*** (0.077)
Risk	0.179 (0.335)	0.131 (0.481)	0.397 (0.318)	5.042*** (1.156)	–0.913** (0.383)
Return	–0.404 (0.451)	–0.022 (0.320)	–0.272 (0.402)	–0.913* (0.486)	34.156*** (4.761)
Observations	360	329	360	360	360
Banks	31	31	31	31	31

Notes: The estimation results are obtained using the corrected LSDV regression (Blundell-Bond). Other corrected LSDV regressions (Anderson-Hsiao and Arellano-Bond) yield similar results, but we do not report them for brevity. Bank-level data are winsorised at 5% and 95%. Bootstrapped standard errors are in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

economic cycle with bank size, capital and return are significantly negative, while those with bank risk are significantly positive. Interestingly, the coefficients on both the standalone economic cycle indicator and the interaction terms provide much-improved significance levels, thus strongly confirming our findings in the paper.

5. Conclusions

An emerging research stream explores how bank behaviour reacts to business cycle fluctuations and finds potential amplifying roles of banks in economic booms and busts. We enrich this literature by examining another cyclical behaviour of banks that may strongly influence the economy – the cyclicality of bank liquidity hoarding. Concretely, we investigate how bank liquidity hoarding responds to the economic cycle and highlight the asymmetry in the cyclicality of bank liquidity hoarding in Vietnam from 2007–2019. As a key contribution of this paper, we employ a novel and comprehensive measure of bank liquidity hoarding recently suggested by Berger et al. (2020) to compute total, on- and off-balance sheet liquidity hoarding.

Regression analysis reveals that higher economic growth results in statistically and economically significant rises in total liquidity hoarding, which is further decomposed into increases in both on- and off-balance sheet liquidity hoarding. These results indicate that bank liquidity hoarding is procyclical. Further empirical evidence reveals the heterogeneous procyclicality of bank liquidity hoarding. Concretely, financially weaker banks have a more procyclical liquidity hoarding behaviour than financially stronger banks. Consistent with the former literature, we define banks that are smaller, lower-capitalised, riskier and less profitable are financially weaker. This asymmetric pattern thus lends support to the precautionary motive when Vietnamese banks hoard liquidity. All of our findings are robust to the use of both static and dynamic regression estimators, both baseline and extended economic models with interaction terms, and across aggregate and disaggregate liquidity hoarding measures.

Our main findings imply that the procyclicality of bank liquidity hoarding does not exacerbate the economic cycle, which is in the upward or downward trend. This behaviour is favourably sound in the context of emerging markets with aggressive economic expansion in recent years. This implication should be more insightful here given that as widely demonstrated in the literature, banks tend to weaken their credit standards and generate excessive credit during economic booms that substantially contribute to costly financial crises (e.g., Acharya & Naqvi, 2012; Berger & Bouwman, 2017). Importantly, our work also highlights striking heterogeneity in the behaviour of liquidity hoarding across banks of different financial weakness/strength depending on their bank-specific characteristics. Understanding such heterogeneity is crucial in the banking system of numerous reforms where banking institutions have shown much differentiation over time. We would suggest that, for example, when there is a desire to reduce the cyclicality of liquidity hoarding behaviour (to promote economic growth further), regulators need to focus on the right group of banks (i.e., stronger banks) and have policies to increase the financial capacity of other banks in the system.

This study is the first to empirically examine the cyclicality of bank liquidity hoarding using the novel and comprehensive measures specified in the seminal study of

Berger et al. (2020). However, we acknowledge that our settings and findings have some limitations when confined to only one emerging economy. So, we call for other research in the future to extend the current work to other emerging/advanced markets, which could either confirm or challenge our conclusions and then offer a better understanding of the issue explored.

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