"The impact of liquidity on profitability – evidence of Vietnamese listed commercial banks"

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THE IMPACT OF LIQUIDITY ON PROFITABILITY – EVIDENCE OF VIETNAMESE LISTED COMMERCIAL BANKS

Abstract

Profitability is a matter of concern for all economic organizations, including banks. The economic problem always poses for banks in maintaining growth and ensuring sustainable stability. Liquidity is always a concern of banks in maintaining profitability. The article aims to test the relationship between liquidity and profitability of Vietnamese listed banks. Data include 18 Vietnamese listed commercial banks for a period of 9 years from 2011 to 2019. The article uses the time series method with the ordinary least square. The results show that liquidity has a positive relationship with the profitability of listed banks including return on assets, return on equity, and net interest margin. As for net interest margin, the liquidity ratio of loans to deposit plus short-term borrowings and short-term bills payable has the opposite effect. To contribute to the stable and sustainable growth of the banking system, the article proposes the policies for the Vietnamese banking system by fully implementing the regulations on liquidity based on the Bank for International Settlements and should forecast the financial developments in the region and the world to have flexible responses to avoid uncertainties, as well as the need to form and maintain funds to timely support for liquidity in the entire banking system.

Keywords   bank performance, economic growth, monetary policy, net interest margin, return on assets, return on equity

JEL Classification   E52, G21, M21

INTRODUCTION

The bank system was formed and developed in association with the growth of the commodity economy to solve the needs of capital distribution, payment, and expansion of production and business of economic organizations and individuals. Liquidity refers to a bank's ability to meet its obligations, especially those of depositors. The appropriate level of liquidity will contribute to increasing the bank's profitability (Ongore & Kusa, 2013). Managing liquidity requires a flexible adaptation to circumstances and conditions. The poor liquidity is the main reason leading to risks and losses for the bank. Liquidity risks will affect the profitability of banks (Almazari, 2014). Liquidity is important to the success of the bank because of the specificity of the business lines of money. It is a measure of the ability of a bank's liquid assets to be easily sold and to get cash quickly (Elliot, 2015). A measure of a bank's performance is often determined by a bank's profitability. Profitability is the creation of a profit by earning more income than operating expenses (Kamande, 2017).

In that context, Vietnam is a developing country in Asia, and some financial crises have arisen in the banking system recently. Some commercial banks went bankrupt due to bad debts. The Central

bank of Vietnam was forced to acquire and merge those commercial banks with state-owned banks. The main reason is the loss of liquidity in business operations (Central bank of Vietnam, 2018a). This shows that, in recent years, the credit growth of commercial banks has been hot due to investment in real estate so it has led to difficulties for banking and finance. Moreover, Vietnam needs to comply with the regulations in the banking and financial system according to international standards. The liquidity regulation requires banks to determine the amount of their capital that may affect their ability to obtain liquidity. Banks must supervise and control liquidity risks. Basel III specifies the liquidity coverage ratio and liquidity risk monitoring tools (Basel Committee on Banking Supervision, 2013). These are the major challenges to achieving banking regulatory standards related to liquidity. To closely monitor liquidity, the State bank of Vietnam has issued a liquidity regulation in the supervision of the banking system (Central bank of Vietnam, 2020). That contributes to the development and stability of the national banking system that is in the stage of maturity. Therefore, the relationship between liquidity and profitability of banks should be taken into account to have a valid view of harmonizing economic problems. This is even more meaningful in the global economic situation with certain difficulties, complicated fluctuations, and unpredictable developments.

1. LITERATURE REVIEW

Stemming from the liquidity risks of the banking system, Basel Committee on Banking Supervision (2013) issued Basel III with some regulations on the liquidity coverage ratio and liquidity risk monitoring tools. This is an important template to help ensuring safety in the banking sector. Liquidity ensures that banks have sufficient quality liquid assets that can be easily and instantly converted into cash to meet their liquidity needs. The development and stability of the banking system must be in conditions to ensure its liquidity.

Recently, the Central bank of Vietnam (2020) has issued regulations on limits and guarantee ratios in bank operations. Accordingly, commercial banks must manage credit assets, debt assets and ensure the maintenance of their solvency and liquidity ratios; managing liquidity, controlling the maturity difference of assets, debt assets based on cash inflow, cash flow; identifying, measuring, monitoring, and controlling risk information about solvency and liquidity; early warning criteria about the risk of lack of solvency and liquidity. The Central bank of Vietnam is concerned with the liquidity reserve ratio. A liquidity reserve ratio intended to hold highly liquid assets for the reserve to meet your payment needs and unexpected arising payments. The liquidity is determined according to seven items specifically:

1) cash, gold;

2) payment deposits (including compulsory reserves), overnight deposits, and collateral deposits at the State bank;

3) types of securities used in transactions of the State bank;

4) money on the current account, overnight deposit at correspondent banks, minus amounts committed for specific payment purpose;

5) demand deposits, overnight deposits at other credit institutions, foreign bank branches in the country and abroad, except for amounts committed or agreed to use for specific purposes;

6) bonds, bills issued or underwritten by governments, the Central banks of countries rated AA and above;

7) corporate bonds rated AA- or above and listed on the market.

The measure of liquidity is mentioned in several studies. Vodová (2011) reviewed four different liquidity ratios of Czech commercial banks such as L1 should give information about the general liquidity shock absorption capacity of a bank; L2 uses the concept of liquid assets as well; L3 measures the share of loans in total assets and L4 re-

lates illiquid assets with liquid liabilities. For the liquidity ratio relating to liquid liabilities, L2 refers to deposits and short-term borrowings, while L4 refers to deposits and short-term financing. Accordingly, the liquidity ratio related to the liquid liabilities of L2 and L4 is used to measure deposits, short-term borrowings, and bills payable. However, according to the regulations of the Central Bank of Vietnam, the liquidity ratio relating to liquid liabilities is measured by deposits, short-term borrowings, and short-term bills payable (Central Bank of Vietnam, 2018b).

There are many views on profitability, depending on the research field. Fry (2005) said that profitability is the result achieved in economic activity by the difference between the result achieved and the cost to get it. All are based on cost savings and increased income. In terms of measuring the profitability of the banking sector. Mishkin et al. (2009) said that the basic measure of a bank's profitability is ROA or net interest margin (NIM) which provides useful and necessary information about a bank's profitability. Meanwhile, the principal interest of a bank owner is usually measured by ROE. In the banking sector, some previous studies have measured performance on ROA (Almazari, 2014; Cekrez, 2015; Duah, 2015; Kamandei et al., 2016; Kamande, 2017; Kohlscheen et al., 2018; Onyango & Olando, 2020) or ROE (Duraj & Moci, 2015) or a combination of ROA and ROE (Lall, 2014). However, to have a more diversified view, most of the previous studies looked at all three indicators including ROA, ROE, and NIM (San & Heng, 2013; Ongore & Kusa, 2013; Acaravci & Claim, 2013; Nuriyeva, 2014; Nkegbe & Ustarz, 2015).

The theories related to economic efficiency are mentioned from many different points of view. Keynes (1883–1946) mentioned the theory of economic growth. This theory is intended to maintain and promote economic growth. Keynes's theory considers growth, economic efficiency, and the gain of economic units. This theory refers to key contents such as the balance of the economy to ensure optimal levels, the role in increasing output of the economy to maintain stable development, and the main policies on the management and control for economic growth (Keynes, 1936). Keynes's application of growth theory to explain issues related to the content of the profitability in

Vietnamese listed commercial banks. Accordingly, economic efficiency must be considered in a harmonious relationship between liquidity and profitability of these banks. This ensures stability and maintains growth.

Previous studies have looked at the relationship between liquidity and the profitability of banks. Some studies show that this relationship is in the same direction. Lall (2014) separately identified the effect of bank-specific and beyond the bank's control on the profitability of banks in the United States during the financial crisis of 2007–2013. The article estimates using OLS. The results show that liquidity affects the same direction as ROA and ROE. Duah (2015) considered the factors affecting the profitability of commercial banks. This study examines the impact of bank-specific as well as macroeconomic factors on the profitability of listed banks in the Ghanaian stock exchange from 2004 to 2013. The article uses a panel regression. The experimental results show that liquidity has a strong influence in the same direction on both ROA and ROE. Nkegbe and Ustarz (2015) checked the determinants of bank performance in Ghana from 2000 to 2010. The article uses panel data estimation techniques. The results show that liquidity affects the same direction as ROA, ROE, and NIM. Petria et al. (2015) evaluated the main determinants of the profitability of 27 EU banks in the period 2004–2011. The results show that liquidity has a positive effect on the profitability of banks, both ROAA and ROAE. Kamandei et al. (2016) determined the impact of bank-specific factors on the profitability of commercial banks in Kenya over five years period, from 2011 to 2015. Results show that liquidity affects the same direction as ROA. Kamande (2017) identified the effect of specific factors on the profitability of 11 commercial banks listed in Kenya from 2011 to 2015. The research concludes that liquidity affects the same direction on ROA. Kohlscheen et al. (2018) analyzed the key determinants of bank success based on 534 banks from 19 emerging market economies. The results show that liquidity affects the same direction as ROA.

Some studies show an inverse relationship between liquidity and the profitability of banks. San and Heng (2013) investigated the impact of bank-specific characteristics and macroeconomic

conditions on the profitability of Malaysian commercial banks, from 2003 to 2009. This study uses regression models. The results show that liquidity has a positive impact on ROE and NIM. Nuriyeva (2014) studied the factors affecting the profitability of Azerbaijan banks from 2006 to 2012. The article examines the external and internal factors that affect the profitability of banks. Secondary data is collected from financial reporting banks of the period from 2006 to 2012. The results show that liquidity has a negative effect on ROA, ROE, and NIM. Cekrez (2015) checked factors influencing the profitability of Albanian commercial banks. A sample includes 16 domestic and foreign banks from 2010 to 2013. The results elicit that liquidity has the opposite result with ROA. Onyango and Olando (2020) analyzed the impact of bank-specific factors on the profitability of commercial banks in Kenya. This study uses a descriptive research design that employs 43 commercial banks. The study collects secondary data from the financial statements of the previous year and other financial reports for the period 2012 to 2016. The results show that liquidity has a negative effect on ROA.

Some studies show that this relationship can be in the same direction or opposite direction with the profitability of banks because it depends on the measurement of the dependent variable. Acaravci and Claim (2013) examined bank-specific and macroeconomic factors affecting the profitability of Turkish commercial banks from 1998 to 2011. This study uses the cointegration test method. The results show that liquidity has a negative effect on ROA but in the same direction as ROE and NIM. Almazari (2014) studied the internal factors affecting the profitability of banks. A sample of 23 Saudi Arabian and Jordanian banks from 2005 to 2011. The results indicate that there is a positive correlation between the liquidity and ROA of Saudi banks but this relationship is not significant for Jordanian banks.

Some studies show no relationship between liquidity and profitability of banks. Ongore and Kusa (2013) studied the impact of factors on the profitability of banks. The article uses OLS on panel data to estimate the parameters. The results show that bank-specific factors significantly affect the ROA, ROE, and NIM of commercial banks in Kenya, except for the variable liquidity. Duraj

and Moci (2015) investigated the determinants of macroeconomics, relating to specific banking and industry to the profitability of banks. The article uses OLS and using samples of 16 Albanian banks from 1999 to 2014. The results show that liquidity has no effect on the ROE of Albanian banks.

In Vietnam, some studies have looked at the factors that affect the profitability of banks. However, the factors are viewed on some different aspects and have not focused research on liquidity. Trinh and Nguyen (2013) studied the factors affecting the profitability of 39 commercial banks in Vietnam, period 2005–2012. This article uses OLS to test the model. The results show that the ratio of lending to total assets has a significant impact on ROE. Nguyen and Tran (2013) analyzed the factors affecting the profitability of 21 Vietnamese commercial banks in the period 2007–2011. The authors use the Tobit regression model for analysis. The results show that the ratio of deposits to loans, the ratio of overdue debt to total outstanding loans, and the number of employees has a negative impact on ROE. Tran (2017) studied the factors affecting the profitability of Vietnamese listed commercial banks in the period 2010–2016. The article uses quantitative research methods according to table data and OLS. The results show that the three factors that the ratio of total operating costs to total revenue, lending to total assets, and equity to total assets have the opposite effect, while the value of an investment in machinery equipment and software applied on total assets have a positive impact on ROE.

2. METHODOLOGY

The article uses quantitative methods and OLS through the data panel time series (data panel) to test the regression model. SPSS 20 software is used to test the regression model. The data of this study are collected from the website of the State securities commission in Vietnam.

Currently, Vietnamese 18 commercial banks are listed at the stock exchange of Vietnam. The data use all information of these listed banks. The time series include the last 9 years, from 2011 to 2019. Therefore, the research data include 180 samples.

Table 1. Description of the variables used in the regression model

Variable	Description	Measurement	Summary of related previous studies
Dependent variable			
ROA	Return on assets	Net income / Total assets, 100%	San and Heng (2013), Ongore and Kusa (2013), Acaravci and Claim (2013), Nuriyeva (2014), Nkegbe and Ustarz (2015)
ROE	Return on equity	Net income / Total equity, 100%	
NIM	Net interest margin	Net interest income / Total assets, 100%	
Independent variable			
LIQUID_ assest	The ratio of liquid assets to total assets	Liquid assets / Total assets, 100%	Vodova (2011), Acaravci and Claim (2013), Almazari (2014), Nuriyeva (2014), Kohlscheen et al. (2018)
LIQUID_ liabilities	The ratio of liquid assets to liabilities such as deposits, short-term borrowings, and short-term bills payable	Liquid assets / (Deposits + Short-term borrowings + Short – term bills payable), 100%	Vodova (2011), San and Heng (2013), Kamandei et al. (2016), Kamande (2017), Onyango and Olando (2020)
LIQUID_ reserve	The ratio of the liquidity reserve	Liquid assets / Total liabilities, 100%	Central bank of Vietnam (2018b)
LOANS_ assest	The liquidity ratio of loans to total assets	Loans / Total assets · 100%	Vodova (2011), Cekrez (2015)
LOANS_ liabilities	The liquidity ratio of loans to deposit plus short-term borrowings and short-term of bills payable	Loans / (Deposits + Short – term borrowings + Short – term of bills payable), 100%	Vodova (2011), Ongore and Kusa (2013), Duah (2015), Nkegbe and Ustarz (2015), Petria et al. (2015)

The independent variables of the model that are described and measured and identified in the previous studies related to each variable are summarized in Table 1.

Currently, previous studies consider the factors affecting the profitability of banks, among those factors that mention liquidity. The consideration of separate variables on liquidity affecting the profitability of banks has not been interested in research. According to some experts of the State Bank of Vietnam and Vietnamese managers listed commercial banks, it is necessary to have a proper perception of this relationship separately. Liquidity is important to the financial business of banks. This has important implications for the growing financial system of a developing country like Vietnam. This will be by Vietnamese characteristics and economic conditions as well as Vietnamese listed commercial banks' regulations. Therefore, the multivariate regression model is designed as follows:

$$
\begin{aligned}
PROFIT\left(ROA,\ ROE,\ NIM\right) = \\
= \beta + \beta_1 \cdot LIQUID\_assest + \\
+ \beta_2 \cdot LIQUID\_liabilities + \\
\beta_3 \cdot LIQUID\_reserve + \\
+ \beta_4 \cdot LOANS\_assest + \\
+ \beta_5 \cdot LOANS\_liabilities + \varepsilon.
\end{aligned}
\tag{1}
$$

3. RESULTS

The statistical results of Table 2 show that *PROFIT* (*ROA, ROE, NIM*) of Vietnamese listed commercial banks over the past 9 years, from 2011 to 2019 is quite good, with an average rate of 2.51%, 26.19%, and 3.53%. The standard deviation of *PROFIT* (*ROA, ROE, NIM*) is negligible. This result reflects the current profitability of these banks because they are the top listed banks with effective operating results in Vietnam. For liquidity-related variables, there is generally a negligible standard deviation. For variables such as *LIQUID_assest*, *LIQUID_liabilities*, and *LIQUID_reserve* to ensure a stable level, with a specific average rate of 10.09%, 9.27%, and 14.22%. However, the variables including *LOANS_assest* and *LOANS_liabilities* are quite high with an average ratio of 80.19% and 124.71%, respectively. These rates are still within acceptable limits.

Horn and Johnson (1994) examined the adjusted R-squared as the condition in the correlation between the dependencies and the independent variables. Table 3 showed that the adjusted R square corresponding to the model *PROFIT* (*ROA, ROE, NIM*) is 0.508, 0.642, and 0.650. This meant that the independent variable explained *PROFIT* (*ROA, ROE, NIM*) 50.8%, 64.2%, and 65% of the variation of the dependent variable. The figures show a guarantee of statistical significance.

Table 2. Descriptive statistics

Variables	N	Minimum	Maximum	Mean	Std. deviation
ROA	180	1.55	3.65	2.51	.0127
ROE	180	22.78	37.73	26.19	.2821
NIM	180	2.26	4.92	3.53	.0089
LIQUID_assest	180	8.11	13.89	10.09	.3257
LIQUID_liabilities	180	6.02	11.16	9.27	.6189
LIQUID_reserve	180	7.42	16.27	14.22	.5451
LOANS_assest	180	76.51	86.72	80.19	1.1699
LOANS_liabilities	180	116.25	142.84	124.71	4.3341
Valid N (listwise)	180	–			

Table 3. Model summary

Model	R	R square	Adjusted R square	Std. error of the estimate
ROA	.712	.641	.508	.001482
ROE	.764	.701	.642	.006734
NIM	.794	.706	.650	.004182

Horn & Johnson (1994) said that F-test in variance analysis was the hypothesis of the suitability of the overall linear regression model. This test considers the linear relationship between all independent variables and the dependent variable. The results from Table 4 show the significances corresponding to PROFIT (ROA, ROE, NIM) were 0.000 less than 0.05. This showed that hypothesis H0 was rejected. So, the model of PROFIT (ROA, ROE, NIM) ensured reliability.

On the basis of ensuring the relevance of the model, the article performed a regression analysis with five independent variables related to liquidity, specifically:

The results of regression in Table 5 show that LIQUID_reserve has a positive effect on PROFIT (ROA, ROA, NIM). Furthermore, LOANS_liabilities have a negative effect on PROFIT (NIM). The specific results are as follows:

$PROFIT\ (ROA) = 0.293 LIQUID\_reserve$

$PROFIT\ (ROE) = 0.214 LIQUID\_reserve$

$PROFIT\ (NIM) =$
$= 0.204 LIQUID\_reserve - 0.384 LOANS\_liabilities$

Overall, the research results show a positive relationship between liquidity and profitability of Vietnamese listed banks. This result is similar to some previous studies such as Nkegbe and Ustarz (2015), Kamande (2017), Kohlscheen et al. (2018). Particularly in the case of PROFIT (NIM), the results show that LOANS_liability has a negative impact on NIM. This study result is also consistent with the judgment of some experts in the Central bank of Vietnam and Vietnamese-listed commercial banks.

For LIQUID_reserve, this liquidity has a positive relationship with PROFIT (ROA, ROA, NIM) of

Table 4. Anova

	Model	Sum of squares	df	Mean square	F	Sig.
ROA	Regression	.212	5	.042	9.163	.000
	Residual	.388	175	.005	–	–
	Total	.600	180	–	–	–
ROE	Regression	.314	5	.051	11.092	.000
	Residual	.408	175	.003		
	Total	.722	180	–	–	–
NIM	Regression	.417	5	.051	12.482	.000
	Residual	.428	175	.001		
	Total	.825	180	–	–	–

Table 5. Coefficients

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.	Collinearity statistics	
		B	Std. error	Beta			Tolerance	VIF
ROA	(Constant)	.014	.001	−	6.014	.000		
	LIQUID_assest	.013	.001	.063	0.251	.509	.956	1.041
	LIQUID_liabilities	.302	.027	.203	0.301	.412	.943	1.038
	LIQUID_reserve	.041	.004	.293	3.227	.001	.978	1.056
	LOANS_assest	−.116	.042	−.104	−.206	.641	.909	1.012
	LOANS_liabilities	−.438	.095	−.274	−.128	.762	.917	1.031
ROE	(Constant)	.016	.004	−	8.901	.000	−	−
	LIQUID_assest	.024	.002	.102	0.231	.641	.838	1.012
	LIQUID_liabilities	.418	.011	.354	0.214	.727	.914	1.028
	LIQUID_reserve	.153	.004	.216	4.038	.000	.932	1.061
	LOANS_assest	−.298	.022	−.291	−.102	.862	.814	1.009
	LOANS_liabilities	−.716	.045	−.483	−.068	.904	.917	1.033
NIM	(Constant)	.036	.005	−	11.864	.000	−	−
	LIQUID_assest	.036	.001	.102	0.361	.802	.941	1.084
	LIQUID_liabilities	.402	.026	.335	.412	.348	.905	1.032
	LIQUID_reserve	.134	.011	.204	3.012	.000	.895	1.014
	LOANS_assest	−.317	.019	−.316	−.114	.596	.884	1.002
	LOANS_liabilities	−.416	.095	−.384	−4.125	.000	.901	1.024

Vietnamese listed commercial banks. This result is a consistent reflection of the operational status of the banking industry and the situation of Vietnam's economic development during the past 9 years. The past world financial crises have been widespread and lengthy. This affected the generally difficult situation of the economy, so bad debts were formed and gradually increased. As a result, maintaining liquidity has helped listed commercial banks be efficient. This is even more meaningful when the Central bank of Vietnam in 2020 had to issue a regulation on liquidity in the banking system. This supports ensuring growth, stability, and sustainability. This result has reflected exactly the characteristics of the economy of Vietnam, a developing country with a growing financial market, so its stability should be considered and ensured. This result may differ from some previous studies because developed countries have different financial policies by the development direction of their financial markets.

For *LOANS_liability*, this liquidity has an inverse relationship with *PROFIT* (*NIM*) of Vietnamese listed commercial banks. This shows that in the difficult situation of the economy, the capital absorption of economic organizations is limited. Therefore, listed commercial careful loans. Increasing loans from listed commercial banks will increase interest expenses and this reduces *NIM*. Therefore, the listed commercial banks need to be carefully considered for loans during this period.

CONCLUSION

Liquidity is always a concern of banks. The harmonious balance between the profitability of banks and safety as well as sustainability is always a difficult problem for the banking industry. The article is based on an empirical survey of 18 Vietnamese listed commercial banks over 9 years from 2011 to 2019. The results show that the liquidity and profitability of listed banks have a supply relationship by ROA, ROE, and NIM. Particularly *LOANS_liability* has a negative impact on NIM. On that basis, the article proposes that the Central bank of Vietnam should issue liquidity regulations under Bank for International Settlements, namely Basel III; regularly supervise liquidity in the entire banking system; set up a budget fund to promptly solve unpredictable reactions. This creates

stability and sustainability for the national financial system. Vietnamese listed commercial banks need to strictly comply with liquidity regulations; increase judgment on financial developments in the region and the world to have flexible responses; be careful with loans and can restructure these loans to be more suitable. This contributes to ensuring the profitability of listed banks while maintaining stable and long-term sustainable growth.

Policy recommendations

From the above experimental research results, the article proposes some policy recommendations for the Central bank of Vietnam as well as the Vietnamese listed commercial banks to ensure the profitability of banks but ensuring stability and sustainable growth. Whereby, the Central bank of Vietnam needs to fully applies regulations under Basel III as well as issues related to the liquidity of the Bank for International Settlements. This supports the growing banking system of Vietnam to ensure stability and avoid uncertainties that cause financial crises in the banking sector. Next, the Central bank should strengthen inspection and supervision of the enforcement of the liquidity regulations of listed commercial banks in particular and commercial banks in general. This will ensure the strictness of financial supervision to avoid instability for Vietnam's financial market in the face of fluctuations. Furthermore, the Central bank should form and maintain a fund budget to timely support the commercial banks when there are financial crisis fluctuations. It helps in stable and long-lasting stability. Finally, the Central bank should accurately forecast the macroeconomic to prepare the spirit for the financial and monetary market fluctuations.

Vietnamese listed commercial banks should strictly comply with liquidity regulations. In the wake of economic hardship, listed commercial banks require special attention in terms of liquidity. The profitability of banks is essential, but in the long term, it is necessary to create stability and sustainability for growth. Listed commercial banks should avoid immediate benefits as credit growth can easily lead to unpredictable consequences. Listed commercial banks are always interested in the balance of daily cash flows to control liquidity well. Managers of listed commercial banks need to speculate on regional and international financial developments to come up with timely plans to handle the uncertain situations that may arise. Managers of listed commercial banks should carefully review the loans that are suitable for each period and can restructure loans to ensure safety and suitability for business operations.

AUTHOR CONTRIBUTIONS

Conceptualization: Le Xuan Thuy.
Data curation: Le Xuan Thuy.
Formal analysis: Tran Quoc Thinh, Dang Anh Tuan.
Investigation: Le Xuan Thuy, Dang Anh Tuan.
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Visualization: Le Xuan Thuy.
Writing – original draft: Tran Quoc Thinh, Le Xuan Thuy.
Writing – reviewing & editing: Tran Quoc Thinh.

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