THE IMPACT OF TECHNOLOGY INVESTMENT TO LIQUIDITY RISK OF COMMERCIAL BANKS IN VIETNAM

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ABSTRACT

The research investigated factors that affect the liquidity risk of commercial banks (CBs) in Vietnam, especially in the context of Industry 4.0, a development stage in which businesses in general and commercial banks, in particular, must change the traditional business model to a digital business model. Hand-crafted transactions must be replaced by automation. Instead of customers having to go to a bank to transact, they can conduct transactions and research anywhere in the world. The author wants to analyze the relationship between technology investment and liquidity risk by estimating the RE regression model with the dependent variable, the ratio of liquidity assets to total assets. The independent variables are factors affecting the liquidity risk of Vietnamese commercial banks based on secondary data (financial statements) collected from 27 banks for the period 2010-2018. The estimation results show that technology investment will reduce the liquidity risk of commercial banks. In addition, the bank size, the ratio of Provision for Credit Losses (PCL) to the total credit outstanding, the ratio of equity to total assets, the bank's net interest margin, the ratio of loans to total assets, the ratio of cost to income and economic growth have affected to the liquidity risk of commercial banks in Vietnam. Therefore, the study proposes the investment and exploitation implications to technology in Vietnamese commercial banks to manage liquidity effectively.

Keywords: Technology Investment, Liquidity Risk, Joint-Stock, Commercial Bank

INTRODUCTION

On May 6, 1951 President Ho Chi Minh signed Decree No. 15/SL establishing the Vietnam National Bank. On 21 January 1960, the National Bank of Vietnam was renamed the State Bank of Vietnam. Nowadays, Vietnam's banking system has grown in both quantity and size and expanded its products and services to meet the development requirements of the economy. The structure of Vietnam's banking components is as follows:

1. State-owned commercial banks: State-owned commercial banks are established and organized as one-member limited liability companies wholly owned by the State. Currently, there are four state-owned commercial banks.
2. Joint-stock commercial banks: Banks are established in the form of joint-stock companies. Capital is contributed by shareholders, including State enterprises, credit institutions, other organizations, and individuals, who contribute capital following the regulations of the State Bank. There are recently 31 joint-stock commercial banks.
3. Joint-venture commercial banks: Banks are established with contributed capital of Vietnamese and foreign parties based on joint-venture contracts. Joint venture bank is a Vietnamese legal entity headquartered in

Vietnam, operating under an establishment license and relevant laws. Currently, there are four joint-venture banks.

4. 100% foreign-owned commercial banks and foreign bank branches. Foreign credit institutions are allowed to present commercially in Vietnam in the form of representative offices, joint-venture banks, banks with 100% foreign capital, branches of foreign banks, joint-venture financial companies, 100% foreign-owned finance companies, and joint ventures venture finance leasing companies, 100% foreign-owned finance leasing companies. There are now nine banks of this type in Vietnam.

During the last operation period, the commercial banking system has many risks, and the liquidity risk is considered to be a very dangerous risk. Banks have good liquidity when they always have available capital with reasonable costs to meet customers' needs. Banks will lose their solvency and lead to bankruptcy, by contrast, when they do not have enough funds for the market demand. For instance, the series of Mergers and Acquisitions (M&A) of insolvent commercial banks happened in the last decade, such as First Bank; Trust bank; Saigon bank; Hanoi Housing Development Bank; Dai A Bank, Western Bank, Dai Tin Bank, etc. In addition, the lending on the mobilization of CBs is very high to increase profit while the bad debts are growing, which could lead to liquidity risk and bankruptcy.

The world is now entering the fourth industrial revolution (Industry 4.0). Technologies such as virtual reality, Internet of Things, 3D printing, big data, and artificial intelligence are applied in all socio-economic areas. This revolution is a significant trend, affecting the socio-economic development of each country, each region, and the world, including Vietnam. Besides, Vietnamese commercial banks have partially used new technologies in their business processes, such as:

1. The Internet of Things – IoT: banks have not yet collected data through smart devices and sensors; not managed all products on intelligent devices and communication between digital devices.
2. Biotechnology has been applied to reduce customer risk.
3. Automatic Robots deploys to perform transactions at counters.
4. Machine learning software has been implemented to analyze data for the bank's business activities automatically.
5. Banks are thus forced to invest in technology to run business. And this technology investment affects the liquidity of banks? Banks need to ensure liquidity and profits for investors.

While they remain, the strong competitive ability is a difficult problem for bank managers. Therefore, it is necessary to study the technology investment factor's impact on banks' liquidity because it helps commercial banks limit liquidity risk and helps increase their competitiveness. This is the reason why the author wants to study this factor.

THEORETICAL BASIS AND PREVIOUS RESEARCHES

Theoretical Basis

Based on Basel II, liquidity is the ability to pay cash amounts to customers when they need to withdraw money. In other words, liquidity means having enough assets used to pay debts to promptly meet the financial obligations when they are due within the acceptable losses.

According to Basel II: Liquidity risk comes from the inability of banks to increase capital sources to finance the increase of bank assets. Besides, Kleopatra Nikolaou (2009) mentioned that it is essential for a bank manager to consider the liquidity risk, whether the bank has enough current assets such as cash or high liquid securities to meet depositors' financial obligations, especially in the economic recession. Without solvency, the bank is considered a financial crisis. Toby proposed the origin of liquidity risk in the American banking industry (2006) named shift ability theory. This

theory explains that a bank's liquidity depends on its ability to move its assets (short-term open market instruments) to others at a given price.

Berger & Bouwman (2009) claimed that two theories described the relationship between the creation of bank liquidity and the ratio of bank capital. Firstly, the 'risk absorption' hypothesis (Berger & Bouwman, 2009; Cornett et al., 2011) has shown that a higher capital ratio may allow banks to create more liquidity. The second theory is the Financial Fragility theory (Diamond & Rajan, 1999), which proposes that the higher the bank capital, the less liquidity creation. Fungacova, et al., (2010) suggested that when banks increase capital, this will eliminate any form of short-term deposits or borrowings then the creation of bank liquidity may be restrained.

Transaction Cost Theory: The first concept was mentioned by Ronald Coase in his famous article titled "The Nature of Business" in 2017. Foss later developed this theory in 1996 with the idea that technology investment would reduce production costs and lead to lower prices, and then the transaction costs would be reduced for buyers, who could buy cheap product with constant quality. In 2004, Chen researched technology and productivity and concluded that using technology would increase productivity and reduce transaction cost transaction costs, including the time and costs of negotiation, drafting, and executing transactions or contracts. s. This cost will be reduced for the banking industry if the bank applies technology that supports customer transactions. Instead of going to the bank to request transactions, customers now freely make transactions when they need. In addition, the transaction cost theory shows that using new technology in the banking industry will change the quality of products and the efficiency of customer service and measure how the transaction costs changed.

Previous Studies

Aspachs, et al., (2005) analyzed the factors affecting the liquidity risk of 57 commercial banks in the UK from the first quarter of 1985 to the fourth quarter of 2003. Regression by GMM model showed that loan growth, net interest margin, economic growth, and interest rate adjusted by the monetary policy were positively correlated with the bank's liquidity risk. At the same time, bank size and profit are negatively associated with liquidity risk.

Akhtar, et al., (2011) used the OLS regression model to test the factors affecting the liquidity risk of commercial banks in Pakistan from 2006 to 2009. The results showed that equity was negatively correlated with liquidity risk. Vodova (2011) mentioned equity, credit risk, policy interest rate, and profit are negatively associated with the bank's liquidity risk, while inflation and economic growth are positive correlation. The study used OLS regression on commercial banks in the Czech Republic from 2001 to 2009. Malik & Rafique (2013) explained the impact of banking-related factors and macroeconomic factors on the liquidity risk of 26 commercial banks in Pakistan in the period 2007-2011 by using the OLS regression method. The author found that credit risks, profits, bank size, and interest rates adjusted by monetary policy showed a negative correlation with banks' liquidity risks. In addition, inflation showed a positive impact on the bank's liquidity risk.

Vodova (2013) analyzed the factors affecting the liquidity risk of commercial banks in Hungary from 2001-2010 by using OLS regression. The results showed that equity, profit, and economic growth are negatively correlated with liquidity risk. On the other hand, bank size and interest rates are positively associated with the bank's liquidity risk. Moussa (2015) used GMM method to analyze the factors affecting the liquidity risk of commercial banks in Tunisia from 2000-2010. The author concluded equity, operating cost, economic growth is negatively correlated with the bank's liquidity risk, while profits and inflation are positive correlation.

Singh & Sharma (2016) applied the OLS regression method to their study about the liquidity risk of commercial banks in India from 2000 to 2013. The results showed that banks that had low equity, low returns, low deposits, large scale, high economic growth, low unemployment, and low

inflation are more likely to face liquidity risks higher than other banks. Al - Harbi (2017) analyzed the factors affecting the liquidity risk of 686 commercial banks in the Organisation of Islamic Cooperation countries from 1989 to 2008. Research results showed that the bank's capital, credit risk, economic growth, inflation, and tight monetary policy negatively correlated with the bank's liquidity risk. While operating expenses, non-interest income, net interest income, and bank size are positively associated with the liquidity risk.

Ahamad & Rasool (2017) used OLS regression model to test the factors affecting the liquidity of 37 commercial banks in Pakistan between 2005-2014. The results showed that the ratio of equity to total capital and economic growth positively impacts the liquidity of commercial banks. In contrast, the ratio of bad debt and bank size have adverse effects.

Ojha (2018) studied the factors affecting the liquidity risk of commercial banks in Nepal from 2010-2016 by using the OLS regression method. The author found that bank capital and economic growth negatively correlate with the bank's liquidity risk at a significance level of 1%;. In contrast, profitability, credit risk, and interbank interest rates were positively correlated with bank liquidity risks at sig<1%. Sopan & Dutta (2018) analyzed the factors impacting the liquidity risk of commercial banks in India from 2005 – 2016 with the OLS regression method. In this study, the authors used the ratio of liquid assets to total assets to represent banks' liquidity risk, in which the higher the ratio, the lower the liquidity risk. Factors such as deposit, equity, and inflation negatively correlate with the bank's liquidity risk, while bank size, profit, cost of capital, credit risk, and economic growth are positively correlated with the liquidity risk. In other words, banks that have less deposit, low equity, large size, high income, high cost of capital, high credit risk, and increased economic growth rate might face higher liquidity risk than others.

Al-Homaidi, et al., (2019) analyzed the factors affecting the liquidity risk of commercial banks in India from 2008 to 2017. With the GMM regression method, the authors concluded that bank size, equity, deposits, performance, profit (ROA), and the exchange rate negatively correlate with the bank's liquidity risk at a significance level 1%. Meanwhile, lending, asset management, profitability (ROE), and interest rates positively correlate with the bank's liquidity risk at a 1% significance level. Moreover, small-scale banks, low equity, fewer deposits, low operational efficiency, low ROA, high lending, high ROE, and increased economic interest rate policy with low exchange rates are likely to face higher liquidity risks than other banks. Tran, et al., (2019) analyzed the factors affecting the liquidity risk of 35 commercial banks in Vietnam from 2010-2015 using the OLS method. The study found that equity, liquidity reserves, credit risk, interbank lending, and economic growth negatively affected the bank's liquidity risk. The banks have more significant equity, higher liquidity reserve, higher credit risk, more interbank lending, and a high economic growth rate; they usually have lower liquidity risk than other banks.

The above studies indicate that factors affecting bank liquidity risk include: Assets size; the liquid reserve ratio; Dependence on external funding sources; the ratio of equity capital to total assets; Loan to total assets ratio; Allowance for credit losses on total debt outstanding; Economic growth; Inflation change; the change of money supply. In this study, the author will inherit the above factors of those studies with amendment variables in terms of technological development, specifically:

Investment of Technology (ITECH): The economies in general, particularly the financial services industry, have been significantly affected by the "information technology revolution" that has erupted in recent decades. Therefore, the development of information technology is essential for the financial services industry. The banking industry, for instance, is undoubtedly leading the change by implementing information technology-based solutions. This change has brought many advantages: the total cost of the information technology system has been significantly reduced; Customer information on the main channels becomes more consistent; The time for marketing and innovative products is greatly reduced due to the higher degree of automation with the direct

procession. Thus service standards are strengthened, and risk is reduced. When the system is faster and more effective, it will make the bank more likely to scale up and reduce costs.

The impact of technology is to help banks increase productivity and thereby reduce operating costs that lead to increased profits and labor force savings. However, banks must invest in information technology, human resources, and infrastructure to deploy when technology changes. Therefore, it is necessary to evaluate the effectiveness of technology investment so that bank managers can improve investment efficiency. Campanella, et al., (2017) empirically studied 3190 banks located in 17 countries, period 2008-2011. Empirical research results showed a negative relationship between financial leverage and technological innovation.

Thus, technology investment is the cost that banks spend on equipment, machines, software to serve their business. Therefore, the current assets of commercial banks will increase, while liquidity assets theoretically will decrease. However, modern technology helps banks boost customer services, sales and reduce salary costs. This is a new factor compared to previous studies. Commercial banks in Vietnam do not invest in technology confidently due to high costs and quickly out-of-date. Besides, it will affect the bank's liquidity, and the manager must consider how to invest in technology to ensure that all bank activities are developed stably. The total assets of commercial banks reflect bank size and measure it and increase the competitiveness of banks. According to research by Muhammad Farhan Akhtar, Khizer All & Shama Sadaqat (2011); Agnieszka Wofcik-Mazur & Marek Szajt (2015); Al-Homaidi, et al., (2019), the size of a bank is one of the main determinants of the bank's liquidity risk.

According to the Circular 02/2013/TT-NHNN dated January 21, 2013, credit risk provisions is an expense set aside as an allowance for uncollected loans and loan payments of financial institutions. Ganic Mehmed (2014) studied the effect of credit risk provision on banks' liquidity in Bosnia and Herzegovina from 2002 to 2012. According to Decision 457 and the Law on Credit Institutions, equity is defined by "the actual value of charter capital, fund reserves, other "Debt" assets of a credit institution under the State Bank's regulations, "and equity is the basis for calculating prudential ratios in banking activities. The researches of Ganic Mehmed (2014); Mohamed Aymen Ben Moussa (2015); Pavla Vodova (2011) show that the Equity-to-Asset ratio has a positive effect on liquidity risk.

Net Interest Margin (NIM): measures the difference between interest income and interest payments that banks can achieve through tightly controlling profitable assets and low-cost capitals. Mohamed Aymen Ben Moussa (2015); Agnieszka Wofcik-Mazur & Marek Szajt (2015) show a positive relationship between net interest marginal and liquidity risk.

Loan-to-Asset ratio (LTA): High lending activities will reduce the bank's reserves. Therefore, it will create a shortage of money in banks when customers want to withdraw. According to Mohamed Aymen Ben Moussa (2015), the loan-to-asset ratio has a negligible impact on liquidity risk. The Cost-To-Income Ratio (CTIR): is an essential financial indicator, especially in assessing banking performance. It shows the correlation between expenses and the income of banks.

Gross Domestic Product can affect the performance of banks when the economy grows sharply, production and business act energetically. The demand for capital and guarantee services, L/C, payments, and other banking services also rise, contributing to the development of commercial banks. In contrast, when the economy grows ploddingly, the goods produced by enterprises cannot be sold; the working capital fails to meet the operational needs and the liquidity of enterprises, which makes solvency or even bankruptcy for companies, leading to heavy losses for commercial banks. Assessing the impact of GDP on banks' liquidity, Yi-Kai Chen, et al., (2018) showed that GDP would increase liquidity risk. Lee Kar Choon's (2013) study argued that GDP negatively relates to the bank's liquidity. Inflation is the phenomenon of money, when money supply exceeds the demand in circulation, causing them to depreciate and the prices of most goods increased simultaneously. Inflation affects the actual value of cash flows in the expenses and revenues of all

entities in the economy. Moderate inflation can have positive effects on the economy with negligible harm. However, galloping inflation and hyperinflation will have significant adverse impacts on the economy. According to Vodova's research (2011), it shows that inflation harms liquidity, while Samuel Siaw (2013) mentions inflation has a positive impact on liquidity.

DATA AND RESEARCH METHODS

Data

The study has used panel data collected from the financial statements of 27 Vietnamese Joint Stock Commercial Banks for the period 2010-2018.

Table 1 VARIABLES SELECTED FOR THE ANALYSIS		
Variables	Description	Measurement of Variables
LR	Liquidity (liquidity risk)	Liquid Assets/Total Assets
ITECH	Technology Investment	Investment costs for technology
SIZE	Bank Size	Total Assets of Bank
LLP	Loan Loss Provision	Credit risk provision/ Total loan outstanding
ETA	Equity-To-Asset Ratio	Equity/Total Assets
NIM	Net Interest Margin	Net Income/Interest Assets
LTA	Loan-to-Asset Ratio	Loans outstanding/Total Assets
CTIR	Cost-to-Income Ratio	Operating Expenses/Total Revenues
GDP	Economic Growth	GDP rate
INF	Inflation	Inflation rate
Sources. Authors' statistics		

The Research Model

Based on the model used by Vodova (2011), the author proposed the estimation equation as follows:

$$LR_{it}=\beta_0+\beta_1 ITECH_{it}+\beta_2 SIZE_{it}+\beta_3 LLP_{it}+\beta_4 ETA_{it}+\beta_5 NIM_{it}+\beta_6 LTA_{it}+\beta_7 CTIR_{it}+\beta_8 GDP_{it}+\beta_9 INF_{it}+\varepsilon i$$

Where:

LR_{it}: The liquidity of bank i at time t; $ITECH_{it}$: The investment cost for technology of bank i at time t.

$SIZE_{it}$: Total asset of bank i at time t; LLP_{it}: the loan loss provision measured by the ratio of credit risk provision on total loans outstanding of bank i at time t.

ETA_{it}: Equity-to-Asset ratio of bank i at time t; NIM_{it} Net Interest Margin computed by Net income/Interest Assets of bank i at time t; LTA_{it}: Loans outstanding on total assets of bank i at time t; $CTIR_{it}$: Cost-to-Income ratio of bank i at time t.

GDP_t: Gross Domestic Product growth rate at time t; INF_t: inflation rate of economy at time t; β_0 is the Y-intercept, β_{1-9} is the correlation coefficient and $\mu_{i,}$ u_{it} is regression errors. Based on the model above, the author uses RE regression Model.

RESEARCH RESULTS

Descriptive Statistics

Table 2 DESCRIPTIVE STATISTICS OF VARIABLES				
Variables	**Mean**	**Standard deviation**	**Minimum**	**Maximum**
LR	18.3007	9.0483	4.5018	61.0376
ITECH	21.316	12.138	0.1832	106.3072
SIZE	196.8356	264.3677	8.2254	1313.0380
LLP	1.1024	0.8409	-0.9918	5.0699
ETA	9.4873	4.2316	4.0618	25.6425
LTA	53.9359	13.3581	13.9821	78.5850
NIM	3.6726	1.4317	-1.3325	8.9917
CTIR	54.0159	15.9242	22.5069	190.7738
GDP	6.2327	0.5760	5.2474	7.0758
INF	6.5684	4.9944	0.8786	18.6755
Source. Authors' statistics from Stata 13				

According to the statistics, the average liquidity of 27 banks in the period of 2010-2018 is 18.3%, and the average level of technology investment is 21 trillion VND. The average asset size of banks is 197 trillion VND. The average Equity records for nearly 9.5% of total assets. The average credit risk provision ratio is 1.1%. The average rate of return on total assets is 11.6%. The average of net interest margin is 3.67%. The average ratio of cost-to-income is 54.02%.

Regression Results

Multi collinearity Test: VIF values of each independent variable are very low, and Mean VIF=1.93 is less than 10, so that there is no collinearity phenomenon in the model. Heteroskedasticity Test: Wald Test has Prob value>chi2=0.000, so the model encounters heteroscedastic. Autocorrelation Test: Wooldridge test: The test results show that the value of Prb > F=0.000 is less than 0.05, so the model encountered the autocorrelation errors.

From the results of the three tests, it can be concluded that the model met two errors which are the heteroscedasticity and autocorrelation. Thus, the FE model results are inappropriate. The author used the FGLS (feasible generalized least squares model) to simultaneously handle the heteroscedasticity and the autocorrelation of the residuals; then using the Random effects (RE) model to regress (Table 3).

Table 3 RANDOM EFFECTS REGRESSION RESULTS (RE)		
Independent Variables	**R-Coefficient**	**P-value**
ITECH	1.52	0.0179**
SIZE	2.87	0.0037***
LLP	-5.77	0.000***
ETA	-0.421	0.02391**
LTA	-2.965	0.000***
NIM	1.27	0.0412**
CTIR	-0.48	0.0234**
GDP	1.64	0.0781*
INF	3.56	0.1754
Constant	39.0946	0.000
Observations	243	
Number of banks	27	
Note: * Sig. 10%, ** Sig. 5%, *** Sig. 1%. (Source: Authors' statistics from Stata 13)		

The results showed that technology investment has a positive impact on the liquidity of commercial banks is 1.52. This can be explained that technology investment increases by 1%, it

will increase liquidity by 1.52% (assuming other factors remain unchanged). In addition, the results also show that the liquidity (LR) of commercial banks is affected by: asset size; credit risk provision ratio; net income on total assets ratio; net interest margin; the ratio of loans to total assets; cost-to-income ratio, and economic growth. In which bank size, marginal interest rate, and GDP are the positive effects with LR. That is, increasing those variables leads to liquidity increases, and then the liquidity risk decreases. The results are similar to Samuel Siaw (2013); Lee Kar Choon, et al., (2013) and consistent with Vietnam's practice. Otherwise, the factors: the rate of credit risk provisions; The ratio of net income to total assets, the cost-to-income ratio, the loan-to-assets ratio harm the liquidity of Vietnamese commercial banks. This result is similar to the research by Pavla Vodova (2011).

CONCLUSION

During the 4th industrial revolution that has changed customers' habits, commercial banks also have to change their business models to respond to the development of technology and meet the diverse needs of consumers to compete with competitors. The study of 27 Vietnamese commercial banks from 2010 to 2018 showed that technology investment did not increase liquidity risk. It helps the bank limit the risk by exploiting technology effectively, thus reducing operating costs and improving performance efficiency. Bank managers are now more confident to invest in technology. In addition, banks' liquidity is also affected by factors such as bank size, credit risk provision ratio; rate of interest income on total assets; rate of interest cost on income; net interest margin; the ratio of loans to total assets economic growth.

POLICY RECOMMENDATIONS

Based on this research results, the author proposes some policy implications as follows:

First: The technology investment to improve business: the research shows that technology investment in business activities reduces the liquidity risk. Thus banks should have a plan to invest technology properly in each development stage. The practical study also mentions that commercial banks in Vietnam have some new technologies that are only partially used in their business processes, such as

1. The Internet of Things – IOT: Banks have not yet collected data through intelligent devices and sensors not managed all products on intelligent devices and communication between digital devices
2. Biotechnology has not been applied to reduce customer risk
3. Automatic Robots do not deploy to perform transactions at counters
4. Machine learning software has not been implemented to analyze data for the bank's business activities automatically.
5. In Industry 4.0, the technology will develop fast in businesses outside the banking industry because it is beneficial and convenient for customers.

If banks do not invest in advanced technologies, they will lose market share in non-financial businesses. Therefore, banks consider investing more technology to meet the set targets. Finally, banks need to maximize the utilization of implanted technologies to serve businesses more effectively. For instance, staff training in bank staff and customer guidance to use the technology because nowadays Vietnamese people think trading *via* technology has potential risks.

Second: The research results show that other factors affect liquidity risk. Thus, banks also need to make positive adjustments to those factors to limit liquidity risks, expressly:

1. Increasing the size of assets by issuing more shares, converting debts into equity capital. Increasing chartered capital, increasing capital from current shareholders, domestic and foreign investors, there by investing more assets following the bank's business requirements.
2. Appropriate and sufficient loan loss provision. In addition, it is necessary to control loans firmly to limit credit risks.
3. Effectively cost control such as operating cost savings
4. reasonably adjusting the number of liquid assets to increase profitable business activities.

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