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Innovations and liquidity risks: Evidence from commercial banks in Vietnam

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Abstract. Our study examines the relationship between innovations and liquidity risk of 37 commercial banks in Vietnam over 2010 – 2020. We employ the Ordinary Least Squares and dynamic system Generalized Method Moments to analyze a sample of 349 annual observations. Our findings show that innovations help commercial banks to reduce liquidity risk. For instance, commercial banks with mobile banking applications have a 0.24% higher liquidity than those without. Moreover, one percentage increase in training and development expenses generates additional 0.1451% liquidity. The impact of mobile banking applications is robust even if we employ alternative risk proxies such as RROA and Loan Loss Provision. Our study recommends that banks should develop mobile banking applications, and improve workforce and service quality via training and development programs.

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1. INTRODUCTION

Commercial banks in Vietnam have enjoyed remarkable growth due to stable economic development. The banks play a critical role in controlling inflation and providing funds to develop the economy (Ekinci & Poyraz, 2019). However, the liquidity problem became apparent during the global financial crisis (Khan *et al.*, 2017). Freixas & Rochet (2008) suggest that liquidity risk arises when banks lack the capacity or time to convert assets into cash promptly or when they can not withdraw cash to mobilize or must mobilize at a high cost. Aside from liquidity risk being seen as a profit-lowering cost, a loan default increases this liquidity risk because of the lowered cash inflow and depreciations it triggers. If liquidity risk occurs, the scope of influence is not limited to one bank but also affects other banks and the entire financial system. As a result, management of the liquidity risks is critical for commercial banks.

Chen and Peng (2020) report a positive relationship between innovation applications and liquidity risk. The use of mobile banking applications improves capital efficiency in the banking industry. However, innovations cause higher risks because their effects are not realized quickly in the short term (Lyons *et al.*, 2007). Jones et al. (2012) suggest that banks develop e-banking and training and development programs to attract customers. Training and development are critical because they aim to improve employees' abilities and qualifications, develop human resources, improve individual and organizational performance, and promote self-esteem. Furthermore, Mirza and Riaz (2012) show that banks save money and time by conducting employee training programs.

Shaikh and Karjaluoto (2015) report that mobile banking applications are becoming increasingly effective in enhancing service quality, transaction speed, and cost savings, such as customer service and stationery costs. Mobile banking applications are portable and, with proper support, can be a friendly transaction method, enabling users to open online saving accounts instantly with flexible saving terms and amounts. Therefore, mobile banking applications significantly attract savings and deposits from customers.

We conduct this study in Vietnam for the following reasons. According to the State Bank of Vietnam, 95% of credit institutions have implemented digital transformation strategies. In addition, the mean liquidity of Vietnamese banks is generally higher than that of other Asia countries, which compares with 1.45% for Indonesian banks, 0.34% for Malaysian banks (Anggun & Waspada, 2019), and 27% for China banks (Tan & Floros, 2018). In 2019, data from the State Bank of Vietnam showed that Vietnam had up to 99% of banks in Vietnam offer payment services via internet banking and mobile banking systems. Bank Vietnam considers the development of digital banking as a target of its strategy.

Moreover, the banking industry offers employees training plans and updating knowledge about business and technology because the Vietnamese government has issued decision number 29-NQ/TW to innovate training programs with highly qualified human resources. Investment in banking through innovative strategies exposes banks to higher risks (Hu & Xie, 2016). Therefore, it is necessary to examine the impact of technology innovations and training development programs on the liquidity risk of commercial banks.

We collect data from 37 commercial banks in Vietnam from 2010 to 2020. To estimate the impacts of innovations on liquidity risk, we employ various estimation methods such as the Ordinary Least squares (OLS) and the dynamic system Generalized Method of Moments (GMM). We also employ the robustness test by employing alternative risk proxies such as RROA and loan loss provisions.

Our study generates striking results. Firstly, our finding documents a negative impact of innovation on liquidity risk. For instance, commercial banks with mobile banking applications have 0.24% higher liquidity than those without mobile banking applications. Moreover, a percentage increase in training and development expenses generates additional 0.1451% liquidity. In short, the innovation activities generate additional liquidity, so they help commercial banks to reduce liquidity risks. Innovations improve employee

performance and efficient services to attract more savings from the public, implying a reduction in liquidity risk. Our findings are inconsistent with Chen and Peng (2020).

Finally, we follow Vo (2020) and Duong *et al.* to conduct the robustness test by employing alternative risk proxies such as RROA and Loan loss provision. Our robustness tests suggest the persistent impacts of training and development programs in reducing bank risk. However, the impacts of mobile banking applications on alternative risk proxies are not robust.

This research is unique because of the following reasons. Our study closely relates to Chen and Peng (2020) because they focus on how innovation applications affect liquidity risk. Our study extends Chen and Peng (2020) as we focus on how innovation in mobile banking applications and training development influences liquidity risk. Chen and Peng (2020) employ the OLS to test the relationship between innovation applications and liquidity risk. However, Driffill *et al.* (1998) demonstrated that the GMM technique outperforms the classic OLS method because it mitigates heteroskedasticity. Therefore, we employ a dynamic system GMM to overcome these issues. Besides, we also include robustness by employing alternative risk proxies. Finally, our study is the first to quantitatively examine innovation in the Vietnamese banking sector. While innovations are widely studied in emerging and developed markets, the data limitations restrain researchers from conducting this topic in Vietnam. Thus, our study is unique because we manually collect the training and development expenses from the supplementary reports of the bank's financial statements.

Our research is structured as follows. Section 2 provides the literature review. Section 3 describes the data and methodology. Section 4 provides empirical results and discussions. Finally, section 5 is a conclusion.

2. LITERATURE REVIEW

2.1. Liquidity risk

Commercial banks and the economy are exposed to more significant risks as the market grows. The banking sector's primary objective is liquidity provision (Holmström & Tirole, 2000), so banks are, by definition, exposed to liquidity risk. Khan *et al.* (2017) and Gefang *et al.* (2011) indicate that liquidity risk is critical in the banking industry, so bank managers must focus on mitigating these risks. Liquidity risk influences a bank's performance and reputation (Jenkinson, 2008). When a bank does not have a timely supply of funds to depositors, this affects their confidence. The bank will lose its position. Moreover, these risks can lead to other hazards with significant impacts on the bank. Freixas and Rochet (2008) argue that liquidity risk will occur when banks lack the ability or time to convert floor assets into cash in a short time or are unable to mobilize or have to mobilize at high costs. To promptly respond to payment needs and financial transactions arising in business operations. As a result, banks will face problems not providing sufficient liquidity to meet immediate liquidity needs (e.g., unable to convert assets to currencies or borrow currency to meet payment needs), managing cash flow internally with technical synergies, or various optimization tools to reduce reliance on external financial sources.

Previous research used several ratio methods to assess liquidity risk. Liquid assets to total assets ratio, liquidity assets to deposits ratio, and liquid assets to customer short-term funding ratio are all used by Ghenimi et al. (2017) and Kim and Sohn (2017), respectively. However, the articles on liquidity discussed above are independent variables and control factors. This essay shall utilize the ratio of liquid assets divided by total assets. A higher liquidity ratio indicates lower liquidity risk.

2.1. Innovation and liquidity risk

Many scholars have also observed how financial innovation affects bank risk, presenting two competing views. Innovation in banking is about improving the quality and providing various services to diversify risks and speed up the bank's expansion and economic growth (Beck et al., 2016). Jones et al. (2012) report that banks should implement employee training programs to attract clients. Training and development are among the most significant components since training programs increase employees' abilities and qualifications, develop human resources, boost individual and organizational performance, and stimulate self-esteem. In addition, Mirza and Riaz (2012) showed that banks save more cost and time by planning and implementing training programs. Therefore, we propose the following hypothesis to test the relationship between training costs and liquidity risk.

Hypothesis 1: Training and Development programs reduce liquidity risk.

Hang et al. (2021) report that mobile banking applications adversely impact liquidity risk. Mobile banking applications allow customers to conduct electronic transactions on a mobile device. Mobile banking application is portable and, with proper support, can be a friendly transaction method, enabling users to open online saving accounts instantly with flexible saving terms and amounts (Elhajjar & Ouaida, 2019). Therefore, mobile banking applications certainly attract savings and deposits from customers. Shaikh and Karjaluoto (2015) argue that mobile banking applications are becoming more advanced in service quality, transaction speed, and cost savings, such as customer service and stationery costs. However, Lasmini et al.(2020) report an insignificant relationship between mobile banking applications and bank performance. Besides, Abubakar et al. (2015) did not find a relationship between mobile banking applications and liquidity risk. We propose the following hypothesis to test the relationship between mobile banking applications and liquidity risk.

Hypothesis 2: Mobile banking applications have negative impacts on liquidity risk.

3. DATA AND METHODOLOGY

3.1. Data

We collected accounting data from FiinPro and the balance sheet accounting or business results. Because the official data source has been censored, the accuracy is high. In this study, the team mainly used denotes from the financial statements and business results of 38 commercial banks in Vietnam. The data sample range is from 2010 to 2020. To deal with the influence of outliers, we follow Duong et al. (2021) to winsorize all of the variables at 0.5% and 99.5% levels. We exclude Agribank because it is a policy bank rather than a conventional commercial bank. We also follow Duong et al. (2021) to exclude observations that do not have sufficient data to calculate the required variable. Finally, the final sample is a balanced data panel with 349 annual observations from 37 commercial banks from 2010 to 2020.

3.2. Variable definitions

The variables discussed in our study include Liquidity, Training and Development costs, mobile banking applications, operating costs, quality of management, inflation, and loans. All these variables are discussed in Appendix A.

3.3. Research methodology

We perform the following research methodology to close the research gaps. Firstly, we employ the Ordinary Least Squares (OLS). However, Greene (2005) indicates that the Generalized Method of Moments (GMM) method is more efficient than Panel Least Squares method. Driffill et al. (1998) demonstrated that the GMM technique outperforms the classic OLS method because it mitigates heteroskedasticity. Therefore, we employ the dynamic system GMM to mitigate the endogeneity issue.

3.4. Model constructions

This paper analyzes the effect of innovation on bank risk in Vietnam. We first create a baseline model to examine the linearity of LQ, MB, and TD. LQ stands for liquidity (liquidity explain for liquidity risk; MB measures mobile banking applications; TD stands for training development expenses. Following Khan et al.(2017), we calculate LQ by dividing the liquidity assets by total assets. We follow Di et al. (2013) to employ mobile banking applications (MB) as a dummy variable, which has the value of one for the banks that have mobile banking applications and 0 otherwise. Training and Development (TD) have data come from finance statements (Jones et al.,2012). Other control variables are operating cost (OC) and quality of management (QOM). We also follow Dahir et al. (2018) to add inflation (INF) into the model. Khan et al. (2017) define loans (LOAN) as the ratios of total loans to total assets. Model 1 is specified as follows:

$LQ_{it} = \beta_0 + \beta_1 MB_{it} + \sum \beta_q control_{i,t-1} + \alpha_i + \alpha_t + \mu_{it}$ (1)

In model 2, we change a variable is MB to TD. TD has measured training development.

$LQ_{it} = \beta_0 + \beta_1 TD_{it} + \sum \beta_q control_{i,t-1} + \alpha_i + \alpha_t + \mu_{it}$ (2)

Finally, we include MB and TD in model 3 to see the influence of innovation proxies on liquidity:

$LQ_{it} = \beta_0 + \beta_1 TD_{it} + \beta_2 MB_{it} + \sum_{t-1} + \alpha_i + \alpha_t + \mu_{it}$ (3)

Where $LQ_{i,t}$ represents the liquidity; $MB_{i,t}$ is a dummy variable with the value of 1 if a bank has mobile banking applications and 0 otherwise; $TD_{i,t}$ is training and development costs; $Control_{i,t}$ are control variables INF, LOAN, OC, QOM. α_i is the firm fixed effect, and α_t is the year fixed effect. μ_{it} is the residual value. All variable definitions are displayed in appendix A.

4. EMPIRICAL RESULTS AND DISCUSSION

4.1. Descriptive statistics

The summary statistics are shown in Table 1. The mean of liquidity is 0.906, and the median is 0.924, which means the liquidity of 37 Vietnam commercial banks is approximately around 90.6%. The mean of liquidity in Vietnam is higher than in other Asia countries, compared with 1.45% for Indonesian banks, 0.34% for Malaysian banks (Anggun & Waspada, 2019), and 27% for China banks (Tan & Floros, 2018). The standard of training development is 0.021. Training costs for bank employees are reasonable costs incurred to upgrade the technical skills represented in Table 1. The average value of MB is 0.493, indicating that half of the commercial banks in Vietnam develop their mobile banking applications. Table 1 also shows the inflation, loans, operation cost, quality of management, and bank age statistics. Finally, the Jarque-Bera probability of our variables indicates that our data come from a normal distribution.

Table 1

Descriptive statistics

	Mean	Median	10th Pct	90th Pct	Std.Dev	Jarque-Bera (Prob.)	Obs
LQ	0.906	0.924	0.8036	0.9683	0.06	<0.0001	349
MB	0.493	0	0	1	0.5006	<0.0001	349
TD	0.0181	0	0	0.0541	0.0497	<0.0001	349
INF	0.0602	0.035	0.027	0.092	0.0492	<0.0001	349
LOAN	0.5574	0.571	0.371	0.7103	0.1214	0.0007	349
OC	0.0157	0.016	0.01	0.022	0.0048	<0.0001	349
QOM	1.435	1.095	0.5602	2.9042	1.0502	<0.0001	349

Note: Table 1 displays the descriptive statistics for the main variables of the research. The sample includes 37 listed commercial banks in Vietnam from 2010 to 2020. All variable definitions are displayed in appendix A. All variables are winsorized at 0.5% and 99.5% levels.
Source: own calculation

4.2. Pearson Correlation Matrix

Table 2

Pearson Correlation Matrix

	LQ	MB	TD	INF	LOAN	OC	QOM	VIF
LQ	1							
MB	0.088* (0.099)	1						1.3159
TD	0.1798*** (0.0007)	0.079 (0.1407)	1					1.0342
INF	-0.2186*** (<0.0001)	-0.469*** (<0.0001)	-0.0744 (0.1652)	1				1.4861
LOAN	0.475*** (<0.0001)	0.239*** (<0.0001)	0.1338** (0.0123)	-0.328*** (<0.0001)	1			1.3153
OC	0.213*** (0.0001)	-0.0348 (0.5171)	0.0489 (0.3621)	0.0037 (0.944)	0.279*** (<0.0001)	1		1.1089
QOM	-0.343*** (<0.0001)	-0.0168 (0.7535)	-0.118 (0.266)	-0.186*** (0.0005)	-0.137** (0.0104)	0.0071 (0.8948)	1	1.116

Note: Table 2 reports the Pearson correlation coefficients of all variables. The data sample was gathered from 37 Commercial banks in Vietnam from 2010 to 2020. The symbol ***, ** and * represents the significant level at 1%, 5% and 10% respectively .
Source: own calculation

Table 2 presents the Pearson correlation matrix. All the coefficient correlations are acceptable with no perfect relationships because all the correlation coefficients are less than 0.8. Noticeably, the highest correlation coefficient between LOAN and LQ is 0.475. Therefore, we conduct the VIF test to check for multicollinearity issues. Table 2 also reports that the maximum value of VIF is 1.4861, so there is no multicollinearity issue (Salihu *et al.*, 2019).

4.3. Estimation results from Ordinary Least Squares (OLS)

We employ the Ordinary Least Squares in three models. Model 1 indicates a negative relationship between MB and liquidity. Our findings indicate that mobile banking applications increase liquidity risk. This result is inconsistent with Hang *et al.* (2021). Model 2 indicates a positive relationship between TD and liquidity. When investing in training and development helps reduce liquidity risk. The results from model 3 show that TD reduces liquidity risk while MB increases the liquidity risk of commercial banks in Vietnam. Finally, table 3 reports that R-squared ranges from 34.4% to 43.51%. It implied that the variation of independent factors explains up to 43.51% of variations of the dependent variable.

Table 3

OLS Regression Results

	Model 1		**Model 2**		**Model 3**	
	Coefficient	**Prob.**	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**
MB	-0.0116*	0.0541			-0.0119**	0.0472
TD			0.0955*	0.076	0.0986*	0.0658
INF	-0.2587***	0.0001	-0.1985***	0.0008	-0.2534***	0.0001
LOAN	0.1733***	<0.0001	0.1653***	<0.0001	0.1699***	<0.0001
OC	1.4509**	0.0127	1.4973***	0.0101	1.422**	0.0143
QOM	-0.0193***	<0.0001	-0.0182***	<0.0001	-0.0187***	<0.0001
C	0.8356	<0.0001	0.8268	<0.0001	0.8352	<0.0001
Firm fixed effect	Yes		Yes		Yes	
Year fixed effect	Yes		Yes		Yes	
R-squared	0.345		0.344		0.351	
Adjusted R-squared	0.335		0.3342		0.34	
F-statistic	36.107		35.937		30.868	
Prob(F-statistic)	<0.0001		<0.0001		<0.00001	

Note: Table 3 summarises the regression results by using the OLS. Our sample includes 37 Vietnamese commercial banks from 2010 to 2020. The sample includes 37 listed commercial banks in Vietnam from 2010 to 2020. All variable definitions are displayed in appendix A. The symbol ***, ** and * represents the significant level at 1%, 5% and 10% respectively.
Source: own calculation

4.4. Estimation results from dynamic system GMM

Table 4 presents the GMM estimations results from 2010 to 2020. Greene (2005) indicated that standard panel regression techniques such as OLS, FEM, and REM have asymptotic efficiency and heterogeneity, resulting in biased conclusions. Therefore, we mitigate endogeneity and unobserved heterogeneity by using the GMM estimations. Furthermore, GMM can overcome omitted bias issues and remove autocorrelation problems. Therefore, we implement the dynamic system GMM with cross-section fixed (first differences) to mitigate the heteroskedasticity and endogeneity issue.

Table 4

GMM regression results

	Model 1		**Model 2**		**Model 3**	
	Coefficient	**Prob.**	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**
LQ (-1)	0.1271***	<0.0001	0.1362***	<0.0001	0.1420***	<0.0001
MB	0.0034***	<0.0001			0.0024***	<0.0001
TD			0.1578***	0.0003	0.1451**	0.014
INF	-0.0424***	<0.0001	-0.0545***	<0.0001	-0.0502***	<0.0001
LOAN	0.1404***	<0.0001	0.1255***	<0.0001	0.1164***	<0.0001
OC	-5.628***	<0.0001	-5.4974***	<0.0001	-5.4150***	<0.0001
QOM	-0.0021***	<0.0001	-0.0010***	0.0008	-0.0009***	0.0047
Cross-section fixed (first differences)	Yes		Yes		Yes	
J-statistic	28.9801		28.344		28.433	
Prob(J-statistic)	0.4661		0.4995		0.4416	
N	276		276		276	

Note: Table 4 employs the results of dynamic system GMM estimations. The sample includes 37 listed commercial banks in Vietnam from 2010 to 2020. All variable definitions are displayed in appendix A. The symbol ***, ** and * represents the significant level at 1%, 5% and 10% respectively.
Source: own calculation

Model 3 documents a positive relationship between training and development costs and liquidity. Our finding suggests that a 1% increase in training and development costs leads to a 0.1451% increase in liquidity. Training courses and seminars improve the service and workforce quality of the entire banking system. They indicated that the training to the employee raises the understanding of the product, better consulting, and better customer service. Then customers will deposit more money in the bank, increasing the bank's liquidity. Our findings support hypothesis 1, indicating a negative relationship between training and development programs and liquidity risk.

Model 3 documents a positive relationship between Mobile banking applications and liquidity. Our finding suggests that banks with mobile banking applications have 0.24% higher liquidity than banks without mobile banking applications, implying lower liquidity risk. Mobile banking applications create new payments and entertainment services. Therefore, customers must deposit their money to use online payment services, which helps banks reduce liquidity risk. Our finding aligns with Hang et al. (2021) and supports hypothesis 2.

Table 4 also reports the negative relationship between INF and liquidity. In all three models, the inflation rate variable is negative with liquidity and is significantly at a 1% level. However, Dahir *et al.*(2017) report that the inflation rate is negative with the liquidity risk. The positive and significant coefficient of the loans (LOAN) suggests that an increase in the loans would imply an increase in the bank's liquidity by 11,64% at a 1% significance level. Table 4 reports that the higher operating cost increases the liquidity risk of commercial banks in Vietnam. Finally, table 4 reports that the quality of management has an insignificant impact on liquidity risk.

4.5. Robustness Tests

This section tests whether our main findings are robust by employing alternative risk proxies. We follow Vo (2020), and Duong *et al.* (2022) employ alternative risk proxies such as loan loss provisions (LLP)

and standard deviation of return on assets before tax (RROA). While Duong et al. (2022) consider the Nonperforming Loan Ratio (NPL) as a risk proxy, we estimate the LLP because it assesses asset quality, directly affecting a bank's earnings and interest rates. Besides, a higher provision for loan losses indicates that banks use riskier assets. If the value of loss loan provision is high, it leads to a high risk's commercial banks. We follow Vo (2020) to estimate that the RROA is the ROA divided by the static standard deviation of ROA. The higher value of RROA indicates a lower risk for commercial banks.

Table 5 reports that banks with mobile banking applications have 0.04% LLP lower than banks without mobile banking applications. Moreover, a 1% increase in training and development costs leads to a 0.575% decrease in LLP. These findings suggest that training and development programs support banks in reducing the risks. Besides, we figure out that only mobile banking applications strongly impact RROA. Specifically, commercial banks with mobile banking applications have a 16.85% RROA higher than banks without mobile banking applications, implying that mobile banking applications reduce the risks for commercial banks. Mobile banking application is an advanced service quality that increases banks' credibility (Zhu *et al.,*2021). Banks can thus increase the number of depositors and save costs. Besides, training and development programs are intangible assets that increase employees' abilities and qualifications and develop human resources. In short, our robustness tests report the persistent impacts of training and development programs in reducing bank risk. The impacts of mobile banking applications on alternative risk proxies are not robust.

Table 5

Robustness test by employing alternative risk proxies

	LLP	**RROA**
	Coefficient	**Coefficient**
Dependent variable (-1)	0.2872***	0.4918***
	(<0.0001)	(<0.0001)
MB	0.0004***	0.1685***
	(0.0018)	(<0.0001)
TD	-0.575***	0.909
	(0.0004)	(0.1424)
INF	0.0056**	3.268***
	(0.0152)	(<0.0001)
LOAN	-0.0034**	2.329***
	(0.0318)	(<0.0001)
OC	0.4829***	8.3577***
	(<0.0001)	(<0.0001)
QOM	-0.0003	-0.212***
	(0.1207)	(<0.0001)
Cross-section fixed (first differences)	Yes	Yes
J-statistic	27.4668	31.3743
Prob (J-statistic)	0.5465	0.301
Instrument rank	36	36
N	276	276

Note: Table 5 presents the robustness test, which studied 37 Vietnamese commercial banks from 2010 to 2020; our final data consists of 276 observations. The alternative proxies of the dependent variable are LLP and RROA. Independent variables are described in Appendix A. The symbol ***, ** and * represents the significant level at 1%, 5% and 10% respectively.

Source: own calculation

5. CONCLUSION

This paper examines how innovation activities affect the liquidity risk in a commercial bank in Vietnam. We collect data from the financial statements of 37 commercial banks in Vietnam from 2010 to 2020. Moreover, Vietnam has experienced rapid developments both in terms of economy and technology in recent years. We employ OLS and GMM estimations to examine whether innovations affect liquidity risk in Vietnam, a transition country in Asia.

Our results show that increasing innovation increases liquidity, implying a lower liquidity risk for commercial banks in Vietnam. Training and development programs improve the banking system's service and workforce quality, attracting additional customers. Mobile banking applications also attract deposits and increase funding because customers can perform online payment services. Finally, our study reports the persistent impacts of training and development programs in reducing bank risk, while the impacts of Mobile banking applications on alternative risk proxies are not robust.

Our study contributes the following implications for bank managers and policymakers to develop the banking sector sustainably. Firstly, the rapid emergence of various electronic banking platforms has impacted banks' liquidity. The appearance of mobile banking applications reflects economic development within the country (Zhu *et al.*,2021). Mirza and Riaz (2012) found that banks can save more cost and time by planning and implementing the training. Stoica et al. (2015) discovered that effective financial innovation strategies positively affected banking efficiency on cost-oriented and Internet-based innovation techniques. Beck et al. (2016) stated that financial innovation fosters competitive advantages to increase risk-taking. Moreover, financial innovations also improve risk management, product diversification, capital allocation efficiency, and economic growth. Our study recommends that banks should develop mobile banking applications, workforce, and service quality via training and development programs. Our findings are helpful for bank managers in Vietnam and other emerging markets.

Although our study has a marginal contribution, it has data limitations because we only focus on the data from Vietnam, a country in Asia. Therefore, our findings may be different from emerging and developed markets. Moreover, we encounter missing value issues in collecting the innovation data from financial statements. Therefore, we suggest that future studies complement our study by conducting cross-country analysis to generate in-depth insights about this topic.

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APPENDIX A. VARIABLE DEFINITIONS

Variables	Acronyms	Formulas	Reference
Dependent variable			
Liquidity	LQ	The ratios of liquidity assets to total assets	Khan *et al.* (2017).
Independent variables			
Training and Development	TD	The natural logarithm of Training and development expenditures.	Jones *et al.* (2012).
Mobile banking applications	MB	If the bank did not have a mobile banking application, MOBI = 0; else, MOBI = 1	Di *et al.* (2013).
Control variables			
Inflation	INF	The annual inflation rate.	Dahir *et al.* (2018).
Loans	LOAN	The ratio of total loans to total assets.	Khan *et al.* (2017).
Operating cost	OC	The ratio of operating costs to total assets.	Suu *et al.* (2020).
Quality of management	QOM	The ratio of operating costs to net income.	Suu *et al.* (2020).