Determinants of Investment in Technology of Banks in Vietnam

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ABSTRACT

Investment is crucial to economic growth. Technological investment is even more important for a developing economy to keep pace with or even surpass their more advanced peers in shorter periods. The study of the determinants of technological investment in banks in Vietnam was meaningful due to the lack of empirical research and it being a bank-dominated developing economy. Using a sample of 30 commercial banks from 2010 to 2022 in Vietnam, the study investigated the drivers for banks' investment in technology. The results suggested that banks that are larger tended to invest less, while banks with more equity capital also demonstrated less interest in technological investment. Furthermore, there was some evidence in support of the argument that banks innovate to reduce cost, and that profitable banks tend to be engaged in more innovation. Finally, banks with female CEOs tended to increase investment in technology.

Keywords: Banks, Technological investment, Gender, Determinant

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INTRODUCTION

The importance of investment to an economy cannot be overemphasized, because investment serves as an instrument for achieving full employment and economic growth. Technological innovations have been introduced to allow banks to offer services to customers in a more efficient manner. There are several examples, including the invention of automated teller machine and the advent of internet banking and mobile banking (Kaur et al., 2021; Alkhowaiter, 2020; Glavee-Geo et al., 2020; Shaikh & Karjaluoto, 2015; Karjaluoto et al., 2019).

Due to the advancement of the internet, banking systems all over the world have been inspired to reconsider their information technology strategies (Al-Qeisi & Hegazy, 2015; Dadoukis et al., 2021; Theiri & Hadoussa, 2024; Khamees, 2023). Banks rely on the use of telecommunications and data processing powers to gather and analyze information from diverse sources to gain competitive advantage. Furthermore, leveraging technology in banking allows banks to gauge and manage risk exposures in a more efficient way. A classic example would be for banks to use information technology and data analytics to overcome the issues of adverse selection and/or moral hazards that prevail in lending activities.

The banking field has many imperfections due to it being highly regulated, subject to information asymmetry and moral hazards. In this context, innovations are constantly being introduced to benefit financial institutions in performing their intermediary role and harmonizing new requirements. Financial innovations can be thought of as efforts to reduce costs and risks for both banks and theircustomers (process innovation), or to bring about improved products and services that better satisfy market demands (product innovation).

There is immense literature on what motivates financial innovation and the benefits of innovation (Khamees, 2023; Sharma & Munjal, 2024; Hasan et al., 2021). Innovation occurs due to many reasons. It could be because banks wish to respond to new market demands or enter new geographic markets (Drucker, 1998). In turn, new market demands could come from demographic and perception changes, industry and market changes. Banks might also innovate because they want to manage the quality of their assets more effectively, reduce costs of production and facilitate greater profits.

Vietnam is a developing country with fledgling market that is dominated by banks (Vo, 2020). There is inadequate institutional quality and information asymmetry pervades the market. This context might create incentives for banks or firms to conduct innovations to reap benefits (Mahmud et al., 2023). Technological investment is crucial and the investigation of the determinants of these activities is essential. However, there is little research about this topic, which encouraged us to perform an empirical study using a sample of Vietnamese commercial banks. Furthermore, the presence of female CEOs was still limited in this country, even though it could be advantageous for firms to appoint more female executives (Asian Development Bank, 2023). In this study, we employed a dataset of 30 commercial banks from 2010 to 2022 in Vietnam to investigate the drivers of technological investment. The research showed that bank size, capital structure and the gender of CEOs tended to have significant effects on banks' tendency to invest in technology. Furthermore, we found evidence suggesting that banks innovated to cut costs and there seemed to be a positive connection between bank profitability and bank investment. To the best of our knowledge, this was the first study to gather empirical evidence on the determinants of bank investment in technology.

After the introduction, this paper proceeds as follows. Section 2 provides a literature review on the definition, types of innovations and drivers of technological investment. Based on this, the authorsestablish the hypotheses to be validated. Section 3 discusses the research methodology, covering research sample, empirical models, variable construction and estimation strategies together with robustness check tactics. Section 4 presents the estimation results and discussion. Section 5 concludes the study with implications and avenues for future research.

LITERATURE REVIEW

Background of Financial Innovation and Technological Investment

Financial innovations are introduced due to several expected benefits. First, they can help to reduce costs (Juhakam, 2003; Mills & McCarthy, 2017). For example, banks can use the outcome of innovations to reduce costs in processing payments, or to overcome the regulatory restrictions that lead to higher costs in their operations. Second, technological investment facilitates banks to respond to changes in perceived market conditions. Businesses normally feel the urge to meet new customer demands by bringing in improved products or new ones.

In addition, market characteristics (for example, size, barriers to exit and entry, concentration, competition and similarity of the products or services) also affect banks' tendency to innovate. There could be changes in economic conditions like changes in inflation and interest rates that drive banks to invest in technology. What makes it even more complex is the possibility that market conditions and regulations could interact and lead to attractive opportunities for innovations. Another factor that could spur technological investment is the increased integration of countries into the world's system. As some innovations might lead to more volatility across markets, firms might need to put more effort into creating instruments/tools to guard against risk or take advantage of the frequent changes in the environment.

It is clear that better technology/more investment in technology permits more innovations. For the banking industry, we can mention the credit scoring algorithms that leverage data mining and machine learning have become prevalent. Also, for banking products, usually we can see that banks have been offering corporate solutions to manage the client firm's cash flow more effectively with systems that link client's cash management system directly to banks.

Determinants of Technological Investment

Size

There are a range of factors that could affect a firm's incentive to conduct technological investment. First, one can assume that bigger firms might volunteer in the innovation work as they are more equipped to enjoy economies of scale (Buzzacchi et al., 1995; Ou et al., 2009). Due to the high fixed costs of establishing, implementing and maintaining information management systems, major banks tend to have an advantage over small banks (Keeton, 2001). Except for Bughin (2003), virtually all the research on Internet banking adoption has documented favorable relationships between bank size and innovation. Consistently, Malhotra and Singh (2007) find that larger banks were more likely to adopt new technology.

According to Schumpeter (1950), large firms should be better suited to conduct innovation. Smaller organizations are unlikely to have the motivation to participate in long-term research and development projects because the rents would probably be lost to competition in the future. Due to their disadvantageous size and financial restrictions, smaller banks have significantly lower ability to invest in innovations. Understandably, many new items or enhancements simply do not pay off or provide additional value since there are fewer customers. Greater emphasis is placed on product development in larger commercial banks, which enhances competitive advantages, improves business operations, and lowers the cost of providing services while raising their quality.

However, Lerner (2002) argued that smaller firms had played an outsized role in financial innovation. Specifically, less than a doubling of innovative works produced are correlated with a doubling of firm size. These findings are in line with Silber (1975) who emphasized that small firms would generate the majority of financial innovation. In addition, young entities may be better at launching new items. In Aron and Lazear (1990) young firms used less risk-averse methods and were therefore more likely to launch novel research projects and products.

A careful review of determinants of financial innovation literature also revealed that size was an important factor (Barman et al., 2022). Therefore, we proposed the following first hypothesis:

H1: Size is associated with bank investment in technology.

Profitability and cost cutting

Performance-related rationales could motivate firms to conduct innovations, especially for banks (Le & Ngo, 2020; Chhaidar et al., 2023). Malhotra and Singh (2007) examined whether bank profitability impacted the choice of providing online banking services and argue that the direction of its impact might be unclear. It was argued that profitable banks had strong financial resources to bear the costs of investment to introduce online banking services, which will help them be more competitive. On the other hand, banks with lower profits may be more inclined to invest in technical upgrading to improve their efficiency. Lerner (2002) suggested that firms that were less profitable compared to their peers tended to be more innovative. The innovative works can be regarded as a smart response to a dire competitive situation, because such innovations allow firms enhanced profitability in the following years. Finally, there were also other studies indicating that the profitability factor was not a significant indicator in the investment decisions (Corrocher, 2002; Gourlay & Pentecost, 2005).

With regard to cost-cutting incentives, Malhotra and Singh (2007) suggested that the adoption of online technology can be seen as a method for banks with relatively high costs of real estate and fixed assets to save on brick-and-mortar branch networks. In addition, according to Furst et al. (2001, 2002), banks with high fixed costs tended to apply online banking more than banks withlow fixed costs. Mills and Carthy (2017) suggested that banks can innovate to save costs and compete against fintech start-ups.

Given the arguments above, we established two testable hypotheses as follows:

H2: Profit is positively associated with bank investment in technology.

H3: More cost is positively associated with more bank investment in technology.

Capital

On the one hand, according to Lerner (2002), more innovative firms tended to be older and more well-capitalized. New products and services were essential to the survival and thriving of any firm; however, they can be unmanageable at times. The management of banks must make sure that capital is sufficient to protect the banks from the risks associated with new products. Therefore, it is expected that banks with more equity will tend to engage in more innovation.

On the other hand, it was argued that firms that innovate prefer to use internal sources of funding. Specifically, innovative organizations prefer internal resources as their primary source of funding, followed by bank financing and supplier credit(Barona-Zuluaga & Rivera-Godoy, 2017; Rivera-Godoy, 2015). These preferences somewhat accorded with the predictions in the pecking order theory, which were based on the anticipated responses to the issue of information asymmetry in the economy (Myers & Majluf, 1984).

Due to the two potential directions of the effect of equity on investment in technology, we proposed the following testable hypothesis:

H4: More capital is negatively associated with more bank investment in technology.

CEO's gender

The impact of gender in risk preferences has drawn much attention. Hoang et al. (2019) investigated the disparities in risk preferences between male and female CEOs in Vietnam and found that female-led

businesses were less likely to operate in high-risk industries. Women were arguably more risk-averse than males (Byrnes et al., 1999; Iqbal et al., 2006; Croson and Gneezy, 2009). Summarizing the relevant literature, Croson and Gneezy (2009) offered various hypotheses for gender effect on risk preferences. First, women were more likely than males to experience powerful emotions, and this emotion might influence risk-taking behavior. Meanwhile, males tended to be overconfident, which made them more prone to taking risks. Interestingly, risks can be perceived either as challenges or threats, but males tended to consider them as challenges, thus being more willing to take on risks compared to the female counterparts. Consistently, Khan and Vieito (2013), Faccio et al. (2016) and Vo et al. (2020) documented that female CEO-led firms were less risky.

With regard to effectiveness, even though Altarawneh et al. (2023) documented no significant effect of CEO gender on investment efficiency in Malaysia, Ullah et al. (2021) found that female CEOs tended to play a significantly positive role in improving investment efficiency, as they enhanced governance and disciplinary acts in China. Female CEOs were credited with better corporate governance and financial performance (Khan & Vieito, 2013; Peni, 2014). Furthermore, previous studies extolled female leadership as it helped attenuate information asymmetry as well as agency conflicts (Chen et al., 2018; Francoeur et al., 2008), improved corporate governance and the monitoring of the firm (Frye & Pham, 2018; Adams & Ferreira, 2009), and improved innovation performance (Chen et al., 2018; Jurkus et al., 2011). Even though prior literature showed that female CEOs were generally more conservative and risk averse (Palvia et al., 2015), this risk aversion can be rational, leading to better investment decisions (Gul et al., 2011). Investment in technology was highly risky, so female CEOs might not prefer it. However, as female CEOs made great contribution to firm performance through improved governance and monitoring, they can also facilitate innovative works, as long as they saw the potential in such investment.

We proposed the following hypothesis:

H5: Female CEOs tend to engage in more investment in bank technology.

METHODOLOGY

Research Model

To test the hypotheses constructed, we proposed the following empirical model:

$$\mathbf{Techinvest_{it} = \beta_0 + \beta_1 Size_{it} + \beta_0 FCEO_{it} + \beta_0 ROA_{it} + \beta_0 CIR_{it} + \beta_0 Equity_{it} + a_i + u_{it}}$$

Where: techinvest represents the expenditure in technology investment, measured as the ratio of expenditure in technological investment to total assets. Size is the natural logarithm of total assets (Ou et al., 2009; Ullah et al., 2021). FCEO is a dummy variable, receiving the value of 1 if the CEO of the bank is female, and0 otherwise (Chen et al, 2018; Jurkus et al., 2011; Hoang et al., 2019). ROA is the return on assets, representing the profitability of a bank (Ullah et al., 2021. CIR is the proxy for the level of costs incurred by a bank, measured as the operating cost to total income ratio (Ou et al., 2009. Equity is used to measure the source of financing from equity holders, measured as the ratio of equity to total assets (Lerner, 2002). a_i is the individual effect and u_{it} is the residual.

Estimation Strategy

The study employed conventional panel data regression techniques, i.e., fixed and random regression. To ensure the robustness of our findings, we used year dummies to further control for the macro characteristics that might affect banks' incentives to conduct investment in technology. Furthermore, we also ran regression with the one-period lead value of the dependent variable to address the potential two-way causal relationship between investment and other independent variables. Finally, we employed

another proxy which was the ratio of the technological investment expenditure that has been capitalized to become assets to total assets to ensure the robustness of the findings. All the models had been tested for multicollinearity issues via the VarianceInflation Factor test, which showed satisfactory results (less than 4) (see O'Brien (2007)) for conventional values of VIF that trigger the scrutiny of researchers). In addition to fixed effects and random effects models, we employed the System Generalized Method of Moments to further control for the endogeneity linked to the potential bidirectional relationships between the dependent and independent variables. We performed the standard tests for autocorrelation of order two of the residuals in the differenced model and the overidentification conditions to ensure that the estimated results are reliable for statistical inferences (Roodman, 2009).

Research Sample

In this study, we collected both financial and nonfinancial data of 30 commercial banks in Vietnam for the period from 2010 to 2022. For financial data such as total assets, return on assets (ROA), equity and operating expenses, we collected data from financial statements of banks. For nonfinancial data like the gender of CEOs, we collected from banks' annual reports. Even though the sample did not contain all the commercial banks in Vietnam, it collectively covered over 90 percent of the total industry's size measured in terms of total assets, ensuring the generalizability of the research findings.

RESULTS AND DISCUSSION

Descriptive Statistics & Correlation Matrix

Table 1 presents the summary statistics of the variables in the model. The average value of techinvest was 0.02 percent, which was rather modest. However, there were banks that got as high as 10 times the mean value, but there were also banks that did not invest in this field. FCEO was roughly 0.15, indicating that the presence of female CEOs was quite low. ROA was on average 1 percent of the total assets. Equity accounted for about 12.7 percent of the total funding, so on average banks tended to aim to fulfill the requirement with regard to the bank capital. CIR was roughly 85 percent.

Table 1: Descriptive Statistics of the Variables in the Model

Variable	Obs	Mean	Std. Dev.	Min	Max
techinvest	386	0.0002	0.0002	0.0000	0.0025
size	386	18.6739	1.2099	15.9227	21.4557
fceo	389	0.1491	0.3566	0.0000	1.0000
roa	386	1.0491	0.9150	-4.2091	4.6882
equity	390	12.7406	5.0080	0.0000	32.9202
cir	390	84.3689	14.7193	0.0000	142.6839

Source: Author's calculation from research data

Table 2 provides the pairwise correlation coefficients of variables in the model. Size was negatively related to Techinvest, suggesting that larger banks were less likely to invest in technology improvement. FCEO was positively associated with Techinvest, indicating that female CEOs were not as risk averse as expected; on the contrary, they were ready to make investments to improve bank performance. ROA was positively linked to Techinvest, or banks that were profitable could have more funds to support the innovative activities. Equity was negatively associated with Techinvest, suggesting that banks that had

more equity tended to invest less in technology. Finally,CIR was positively linked with investment in technology, supporting the view that banks conducted innovations to cut costs to improve profitability.

However, it should be noted that the correlation coefficients just indicate the associations between pairs of variables, without controlling for the other covariates. Therefore, multiple regression was further performed to consolidate the analysis of the determinants of bank innovations.

Table 2: Correlation Matrix of the Variables

	techinvest	size	fceo	roa	equity	cir
techinvest	1.000					
size	-0.264	1.000				
fceo	0.108	-0.175	1.000			
roa	0.031	0.063	-0.090	1.000		
equity	-0.293	0.591	-0.091	-0.375	1.000	
cir	0.023	-0.286	0.056	-0.804	0.332	1.000

Source: author's calculation from research data

Regression Results and Discussion

Table 3 presents the regression results when the dependent variable is techinvest, or the ratio of technological investment to total assets. Columns with FE, RE, RE_F and RE_year and Sys GMM present the regression results using fixed effects, random effects, random effects with one-period leaded value of the dependent variable and random effects with year dummies and System GMM estimator, respectively. The Hausman test showed p-values that were higher than 5 percent, suggesting that the individual effects were not correlated with the explanatory variables, and random effects models were the best estimator. In the column of RE_F, we used one period-leaded value of techinvest ($techinvest_{t+1}$) as the dependent variable to tackle the potential two-way relationship between the dependent and independent variables. For the System GMM result, the tests for autocorrelation of order two of the residuals in the different model and overidentification condition showed satisfactory results, with p-value larger than 5 percent (Roodman, 2009). It was clear that all the variables' signs were intact, and identical to the results in the correlation matrix.

First, size was significantly and negatively related to banks' technological investment. This was in contrast with the expectation that bigger banks should take the lead in innovations, since they had advantages emanating from economies of scale and scope in R&D activities (Buzzacchi et al., 1995). There were many studies pointing to the positive relationship between bank size and bank adoption of internet banking (Malhotra and Singh, 2007). Schumpeter (1950) also argued that large firms were well suited to innovations; whereas the rents associated with innovation by smaller firms would subsequently competed away. Furthermore, smaller banks were less financially viable to fund investment activities, since this type of expenditure was quite risky and there was no guarantee that it would be worth it.

However, the result was in line with Silber (1975) and Lerner (2002) that smaller firms should have more incentives to perform financial innovation. Aron and Lazear (1990) also suggested that smalland new firms pursued less risk-averse strategies, facilitating big leaps in technology and more advanced products. The result supported hypothesis H1 on the existence of the effect of size on technological investment. Consistently, based on data provided by Ministry of Information and Communication (2021), larger banks tended to lag behind in terms of information technology investment and adoption in Vietnam.

Second, ROA was not significant in three out of five columns, which might give the impression that ROA is not a significant factor of bank innovation. Malhotra and Singh (2007) stated that the direction of the impact was quite ambiguous. On the one hand, more profitable banks could be more financially able

to support the investment. On the other hand, less profitable banks could also be willing to invest in technology to improve future profits. Due to the two contrasting predictions of the effect of profitability on the bank's technological investment, ROA could lose its significance. However, our regression using one period-leaded value of the dependent variable (Column RE_F) and System GMM, which was meant to fix the potential endogeneity issue, still lended credence to the view that banks that were profitable could have more resources for next year's innovation. Therefore, there was some evidence supporting more profitable banks tended to have more advantage in conducting investment in technology in Vietnam. This result was in line with recent studies like Le and Ngo (2020) and Chhaidar et al. (2023).

Third, CIR, cost-to-income ratio, was not significant for four specifications. One can expect that banks that had high operating costs shouldfeel the pressure to innovate. This could process innovations to provide services more efficiently and save costs. The lack of significance for this factor could be because we used an aggregate expenditure for investment in technology, rather than specific type of technology. However, the result in the last column with System GMM estimator showed a significantly positive coefficient of CIR, which was consistent with Hypothesis H3. As there was more and more competition from each other and rising fintechs in the market, banks in Vietnam had to consider innovations to stay competitive (Pham et al., 2024). Malhotra and Singh (2007) and Mills and Carthy (2017) suggested that the adoption of online technology can be regarded as a measure to save cost for banks.

Fourth, we found that the coefficient of FCEO was positive and significant in all the columns. This was interesting because previous literature tended to show that female CEOs were more risk averse, and investment in technology is highly risky. Hoang et al. (2019) provided evidence showing that female CEOs were less likely to run firms in high levels of risk in Vietnam. Khan and Vieito (2013) also found that firms led by female CEOs tended to have less risk. Nonetheless, the studies on the link between gender of CEO and firm performance tended to show that female CEOs madeless overinvestment and underinvestment and obtain higher performance indicators thanks to their ability to mitigate agency and information risks (Ullah et al., 2021; Frye & Pham, 2018; Wang et al., 2018). The higher investment efficiency attached to female CEOs suggested that they view investment in technology worth it and promoted such investment for banks to maintain competitiveness.

Finally, equity, the ratio of equity to total assets, was negatively related to innovative investments. Innovative firms were more likelyto follow pecking order theory (Barona-Zuluaga & Rivera-Godoy, 2017; Rivera-Godoy, 2015), i.e., internal resources first, then bank financing and finally equity. This was due to the issue of information asymmetry in the market, which emphasized that the cost of external financing is higher than internal financing (Myers andMajluf, 1984). The result lended support to the hypothesis H4. Vietnam was still a developing market and did not have advanced institutional quality to increase market transparency and low protection for financial providers (Vo, 2020). In this setting, information asymmetry could be devastating and firms had to resort to internal sources first, especially when it came to risky investment as technological innovation.

Table 3: Regression using Techinvest as the Dependent Variable

	FE	**RE**	**RE_F**	**RE_year**	**Sys - GMM**
	Coefficient	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
L1.techinvest					.6829029***
size	-0.0000444**	-0.0000386**	-0.0000411***	-0.0000272*	-.0000198**
fceo	0.0000664**	0.0000617**	0.0001024***	0.0000611*	.0000327**
roa	0.0000226	0.0000203	0.0000323**	-0.00000721	.0000314***
equity	-0.00000907***	-0.00000938***	-0.00000591**	-0.00000833***	-6.92e-06***
cir	0.00000119	0.00000115	0.00000169	-0.00000126	1.92e-06***

_cons	0.0010345***	0.0009369***	0.0008688***	0.00092***	.0003303**

*Source: author's calculation based on the research sample. *, ** and *** indicate significance at 10, 5 and 1 percent, respectively. FE, RE, RE_F, RE_year and Sys - GMM are the regression using fixed effects, random effects, random effects with one-period leaded value of the dependent variable and random effects with year dummies and System GMM estimator, respectively.*

CONCLUSION

In essence, investment is crucial to the economy, because it serves as a main driver for economicgrowth. The role of investment should be even more important when it refers to innovations to upgrade technology. Innovations have taken place in the field of banking industry with the advent of internet technology, improving the capability to cater to the needs of customers in a more effective and efficient manner. Innovations/technological investment should be extremely relevant for banks in a developing country, since the banking system plays an important role in financing economic activities, and innovations in this field are the key to catching up with more advanced markets. Even though there have been numerous studies that investigate the determinants of bank technological investment/innovation, there are still limitations when it comes to the Vietnamese setting, a developing market that relies heavily on the banking system.

Using a sample of 30 commercial banks from 2010 to 2022, the study investigated the drivers for banks' investment in technology. The results showed that banks that were larger tended to invest less, while banks with more equity capital also showed less interest in technological investment. Meanwhile, we did not find evidence to support the view that banks innovate to reduce costs, and just weak evidence that profitable banks tend to perform more innovation. Female CEOs, interestingly, tended to increase banks' investment in technology, which indicated their willingness to take risks for the sake of higher efficiency. There was also some evidence that banks that have better profitability could facilitate the investment in technology. Finally, banks that had a high proportion of costs also had an incentive to invest in technology with the hope to be more efficient in the operations.

The negative size effect might indicate support for the "quiet life" hypothesis; therefore, regulatory bodies should aim to spur investment from large banks. In addition, Vietnamese market should create better conditions for banks to access more external financing to facilitate investment, as equity is not a suitable source, and internal fund is not adequate. Furthermore, banks should focus more on gearing investment towards more meaningful purposes, say, reducing cost and improving profitability. Finally, females should not be regarded as those having high risk-averse preferences, at least in the banking industry. Through this behavior, it could be seen that they can act as a strong corporate governance which spurs the investment in the essential driver of bank performance and competitiveness in the future.

There were limitations in our study. We have not considered other characteristics of corporate governance or traits of the CEOs that might also affect banks' investment in technology. Furthermore, it might be of high interest to see if the determinants exert different effects on bank investment in high economic volatility times, such as the Covid-19 outbreak period. Future studies could take advantage of these avenues.

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