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Distribution of Deposit Intermediation: Do Investments in Technology and Intellectual Capital Matter?

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Abstract

Purpose: In the landscape of global challenges, the adoption of new technologies and the implementation of intellectual capital are seen as the main vehicles to enhance banking operations. Inspired by this issue, our study is to discover the effect of technological investments and intellectual capital on one of the most important dimensions of banking operations, namely deposit intermediation. **Research design, data and methodology:** To tackle this concern, we utilize the data of 12 banks from 2011 to 2020 in Vietnam, and perform the multivariate regression analysis as well as provide different robustness tests. **Results:** Our empirical analysis demonstrates that a surge in technological expenditures would foster distribution of deposit intermediation of banks. Also, the blend of technology spending and intellectual capital plays a key role in boosting this function of banks. **Conclusions:** The study would bring one of new evidence for bank managers and national authorities in Vietnam, where has undergone the completely reform period in banking system. Accordingly, technological innovation and intellectual capital should be taken into consideration when managers and regulators build business strategies and related policies. The findings are also useful for nations bearing a close resemblance to Vietnamese financial system.

Keywords: Technology Development; Intellectual Capital; Distribution; Deposit Intermediation; Banking Business Strategy.

JEL Classification Codes: G21, G28, O31

1. Introduction

It is true that living in the advanced digital era, any organization has to gain a deep insight into the influences of technology development on their own operations, and banking industry has been not an exception. In this scenario, to reach the top of new accomplishments in a fiercely competitive environment, along with harnessing advantages of technologies, the intellectual capital naturally becomes one of the most important factors that each bank has to pay special attention. Additionally, the emergence of the information society means that the adoption of information technologies in tandem with the implementation of intellectual capital would have played a key role in opening up the new way for most of financial institutions in the today's world (Ozkan et al., 2017; Yalama, 2013). Furthermore, while the consequence of the globalization has led banking market to be more competitive and dynamic, the use of new technologies and digitalization would help banks to building sustainable business models and the resource of intellectual capital is seen as a crucial engine of growth for all of banks in current time as well as coming future (Alvino et al., 2020). Therefore, it is not surprising that the role of both technological development and intellectual capital in banking system has received much attention from not only academics, managers, but also policy-makers in recent years.

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However, the effects of these factors on banking operations seem to remain an open question.

For the technological revolution, on the one hand, regardless of advantages coming from this progress, many concerns have appeared in prior studies. The first concern is to focus on the emergence of newcomers, namely Fintech firms, who have certain abilities in providing financial products and services at the lower costs in comparison with traditional banks. As a result, banks have to face the stronger competition leading to higher risks of instability and draining market share (Lee et al., 2021; Vives, 2019). Moreover, to survive in a competitive environment, banks seem to confront the dilemma situation in which they must increasingly invest in technology development to combat with new potential rivals regardless of these investments may not bring benefits (Uddin, Mollah, et al., 2020). For the implementation of intellectual capital, on the other hand, although a variety of studies emphasizes the bright side deriving from this factor, some show mixed results. For instance, while the finding of Meles et al. (2016) indicates a positive relationship between the intellectual capital and profitability of banks, that of Tran and Vo (2018) does not find a similar result. The reason behind this mixture may come from the certain differences between the measures of profitability, the periods, and the characteristics of banking system in different nations that authors choose as the claim of Poh et al. (2018).

With that in mind, this study carried out is to revisit this issue by investigating the influences of investing in technological development on one of the most important roles of banking sphere, known as deposit intermediation. The paper also answers the straightforward question of whether these investments fuel by intellectual capital factor would help banks to make a difference in achieving financial intermediation through deposit activities. The authors opt for deposit intermediation as the main subject to examine the impact of technology investments as well as the interaction between these expenditures and intellectual capital due to some main reasons as follows. First, commercial banks function as producers and servicers for deposit demand in an economy, thus they have to attempt to bring the good quality of products and services for their customers to increasing market shares, gaining competitive advantages and ensuring sustainable capital resources (Greenbaum et al., 2019). In this sense, such the capacity of technological innovation and intellectual capital may play an essential role in boosting these operations. In addition, the expansion of deposit intermediation is considered a crucial indicator reflecting the economic growth in a country, especially in a bank-based place (Obradović & Grbić, 2015). In this vein, Vietnam would provide an appropriate environment to seek clear answers since various reasons as follows.

Vietnam is seen as the country having the fasted economic growth in the ASEAN region and is expected to become the next dragon in the Asia area. However, as developing countries, the economy in this nation likely depends on effective operations of baking system to fund other economic activities and to foster the growing economy due to underdeveloped equity market (Le & Nguyen, 2020; Tran, 2022). Hence, the financial health and growth of banks would ensure the economic resources to sustain the stability and development in Vietnam. Such this dimension would also highlight the fundamental roles of expanding the distribution of deposit intermediation, innovative technologies and intellectual capital as some studies mentioned have stated. Furthermore, the recent reports of some international organizations such as the economic outlook of World Bank in 2011 and 2022 suggest that Vietnam is considered at a good position on the digital path, and implementing digitalized progress as well as investing in intellectual capital become a backbone of sustainability and wealth in coming time. Although this prospect has led national authorities to support and encouragement to local banks to expand more technological and intellectual investments, it is astonishing that an absence of empirical studies in this research field (Phan et al., 2022). Therefore, our study conducted is to bridge this important gap through exploring the effects of technology and intellectual investments on deposit intermediation.

In relation with prior studies, our paper would contribute to the existence of relevant literature in various ways as follows. First of all, whist previous studies in financial and technological area seem to focus on profitability of banks (Beccalli, 2007; Phan et al., 2022), or bank risks (Uddin, Mollah, et al., 2020; Uddin, Ali, et al., 2020), we draw a distinction when discovering the nexus between financial intermediation and technological spending. Our finding demonstrates that these investments have advanced the distribution of deposit intermediation of commercial banks. The next contribution is that by taking a blend of technology and intellectual capital, the paper would provide the unique analysis on this issue instead of emphasis on intellectual capital alone as recent studies have employed such as Le and Nguyen (2020); Poh et al. (2018). Our empirical evidence confirms some assertions about the use of new technologies and the implementation of intellectual capital in helping banks to gain competitive advantages (Singh et al., 2019; Vătămănescu et al., 2019). Moreover, as Poh et al. (2018) indicate, different results in each study on the influences of intellectual capital may come from features and chosen periods in each country, our finding would give a deep insight into these impacts by examining the banking system in one of the most important nations among Asia Pacific countries. Eventually, we believe that our results would be useful for local authorities in Vietnam, where has undergone

the complete reform period in banking sphere.

The remainder of the paper is constructed as follows. The next section highlights various studies related to our main concern in recent years. Afterwards, we explain the data and relevant variables in our analysis model in the section 3, and the influence of technology investments would be stated in the section 4. The role of intellectual capital would be analyzed in the section 5 before we conclude the findings and suggest some implications in the final section.

2. Relevant Literature

In the backdrop of rapid changes in technological innovations, unprecedented events, and global challenges, the adoption of new technologies, digitalization, and continuous improvement in capability of intellectual capital have become a main vehicle of banks to survive in a fiercely competitive environment. With that in mind, various studies on the influences of these factors have emerged in financial literature in previous years regardless of certain constraints on available data in banking industry as the claim of Frame and White (2004).

Under the impact of technological innovations, many studies have validated the positive dimension of this factor. For instance, Phan et al. (2022a) find that expenditures on technologies and digital facilities would help banks to gain higher net interest margin and non-interest income. At the same time, the empirical results of the authors do not support the view suggesting technological investments have a positive association with bank instability. Thus, these findings advocate the bright side of technological development as many prior studies have indicated. Indeed, the finding of Alzyadat and Almuslamani (2021) suggests that the use of technologies would boost the growth of distribution sector, besides strengthening the productivity of a company (Lakhwani et al., 2020). Berger (2003) also considers that utilizing new technologies would play a vital role in building diversification strategies of traditional banks and possessing competitive advantages in financial market. Similarly, Alvino et al. (2020) argue that while the creation of sustainable business models becomes an essential strategy of banks, the implementation of up-to-date technological applications has been the key to open the door of successfulness, and to significant improvement in competitiveness. By contrast, in tandem with these benefits, some concerns about the adverse effect of technology development on banking operations have also appeared. The typical example is that the empirical evidence of Uddin, Mollah, et al. (2020) shows that technological spending would have a negative impact on the stability of banks if this spending surpasses a certain threshold. Furthermore, due to the appearance of new potential competitors, namely Fintech firms, traditional banks have few choices but to making an endeavor to increasingly invest in IT infrastructure to ensure their market share (Uddin, Ali, et al., 2020; Vives, 2019). Hence, banks may face the hazard of draining competitive advantages and market shares deriving from stronger competition.

Taken together, for the relationship between technology investments and deposit intermediation, we create the hypotheses as follows.

H1: An increase in technology investments would help banks to enhance deposit intermediation.

H2: An increase in technology investments would lead banks to weaken deposit intermediation.

On the other hand, in the landscape of fast development of technologies and innovations, it is clear that the capacity of intellectual capital has been the heart of sustainability and growth of most banks because banking sector is considered one of the most knowledge-intensive spheres (Le & Nguyen, 2020; Mavridis & Kyrmizoglou, 2005). Singh et al. (2019) consider that the intellectual capital is a creator in the long term, which would ensure the productivity, competitiveness and stability of each organization. In this scenario, the role of using new technologies would help to remain a close association between profitability, environment and society as well as between knowledge and chance development (Cillo et al., 2019). Furthermore, utilizing technologies also allows to maximize the available information and stimulate information exchange between individual sectors, which in turn sustain the dissemination of knowledge (Del Giudice et al., 2019; Natalicchio et al., 2019). The blend technologies with knowledge management in business model of banks has played a key tool in exploiting existing skills and providing profitable mixture for customers' demands (Rossi et al., 2017). Therefore, there is an appropriate expectation that technology investments fueled by intellectual capital would strengthen the deposit intermediation of banks. We build the related hypothesis as follows:

H3: A combination between technology spending and intellectual capital would help banks to enhance deposit intermediation.

The related literature would be summarized in the table 1 below.

Table 1: The Brief Summary of some Related Studies

Year	Author(s)	Journal	Main Findings	Methodology
2000	Pulic, A.	International Journal of Technology Management	The author proposes the accounting-based tool to measure and monitor the value creation efficiency in a company, namely VAIC model.	Theoretical paper

2004	Pulic, A.	Measuring Business Excellence	The author demonstrates the vital role of intellectual capital index, VAIC model, in providing the whole picture of economic efficiency of organizations and nations.	Theoretical paper
2013	Yalama, A.	International Journal of Learning and Intellectual Capital	The empirical evidence of the author shows that intellectual capital factor has a positive association with profitability, market value, and productivity of Turkish banks, specifically in the long term.	Empirical study
2017	Ozkan, N., Cakan, S., and Kayacan, M.	Borsa Istanbul Review	The findings of the paper show that human capital efficiency plays the most important role in affecting banking performance in comparison with other components.	Empirical study
2018	Poh, L. T., Kilicman, A., and Ibrahim, S. N. I.	Cogent Economics & Finance	By employing VAIC model, the authors prove that intellectual capital has remarkable influences on financial indicators including ROA, ROE, and Leverage in Malaysian banks. The authors also indicate that the findings may be different due to various measures of bank profitability, the chosen periods and nations.	Empirical study
2020	Le, T. D. Q and Nguyen, D. T	Cogent Business & Management	The results of the authors indicate that both VAIC and different components of intellectual capital have a positive relationship with bank profitability in Vietnam. However, the authors warn that the inverted U-shaped relationship might be in cases of human capital efficiency and capital employed efficiency.	Empirical study
2020	Alvino, F., Di Vaio, A., Hassan, R., and Palladino, R.	Journal of Intellectual Capital	The authors provide a general picture of related studies on the effects of intellectual capital on sustainable and innovative development of companies.	Conceptual study
2020	Uddin, Md. H., Ali, Md. H., and Hassan, M. K.	Risk Management	The main purposes of the study are to focus on providing the general literature review on the relationship between cyber insecurity and operations of financial system, besides suggesting five future directions that other authors could try to find out in coming time.	Conceptual study
2020	Uddin, M. H., Mollah, S., and Ali, M. H.	International Review of Financial Analysis	The empirical analysis demonstrates that technological spending would have an adverse effect on bank stability if it surpasses a certain threshold.	Empirical study
2022	Phan, A., Lu, C. H., Hoang, L. X., and Nguyen, P. M.	Journal of Distribution Science	The authors' findings indicate the significant effect of technological investments on net interest margin and non-interest incomes of Vietnamese banks.	Empirical study

3. Data, Variables and Methodology

To address our main concerns, we first collect the financial data from audited financial statements of Vietnamese banks on websites of each bank. Because the data related to technology investments is relatively scarcity, we have to manually gather this information from the notes to the financial statements. However, we totally gain the relevant data of 12 commercial banks from 2011 to 2020. At the same time, we gather macro variables from World Bank database during the same period. This period is chosen because it witnessed many changes in regulation, the structure of banking system with the appearance of foreign banks, and orientation towards technological innovation. Moreover, total number of collected banks is also representative sample of our investigation (Phan et al., 2022).

Afterwards, following Phan et al. (2022a,b) and Uddin, Mollah, et al. (2020), we utilize the (natural logarithm) total expenditures on technologies (Tech) as the main independent variable in our analysis model. This indicator is calculated from the total annual expenses of software, hardware, data processing, outsourced technical support in the notes to the financial statements. To estimate the deposit intermediation of banks, we create the ratio of total deposits over total assets (DEPOA) as the dependent variable. At the same time, we employ the (natural logarithm) total deposits (TODEPO) as the alternative method for this variable. For control variables, we first control bank-specific conditions consisting of: the (natural logarithm) total assets (SIZE), the ratio of capital over total assets (CAPITAL), the ratio of total income before taxes, provisions recognized in income over gross total assets (EBLTA) and the loan loss reserve ratio (LLR). We then control country-level variables that include: the annual GDP growth (GRGDP) and the inflation rate (IFLR). These control variables are widely utilized in recently financial literature such as Le and Nguyen (2020); Lu and Luong (2022); Nguyen and Lu (2023), Phan et al.

(2022a,b).

To estimate the relationship between technological investments and deposit intermediation, we employ the following regression:

$$Y_{it} = \alpha + Tech_{it} + Control\ Bank_{it} + Control\ Macro_{it} + \theta_t + \varepsilon_{it} \quad (1)$$

Where, Y_{it} is the DEPOA of bank *i* at time *t* and Tech is used as the key explanatory proxy in our model. $Control\ Bank_{it}$ is the vector of control variables consisting of SIZE, CAPITAL, EBLTA and LLR. $Control\ Macro_{it}$ is the vector of control variables including GRGDP and IFLR. We obtain time-fixed effects ,θ_t, to control for the macroeconomic conditions, common across banks. ε_{it} is the error term.

Because our study does not try to discuss the definition of intellectual capital, we use the value added intellectual coefficient model (VAIC) to measure the intellectual capital of banks. This method is created and developed by Pulic (2000, 2004), and is used in a huge studies on the effect of intellectual capital in financial industry such as Le and Nguyen (2020); Ozkan et al. (2017); Poh et al. (2018); Yalama (2013). Accordingly, VAIC is calculated as follows:

$$VAIC_{it} = CEE_{it} + HCE_{it} + SCE_{it} \quad (2)$$

Where, $VAIC_{it}$ is the measure of intellectual capital of bank *i* at time *t*, CEE_{it} represents the measure of capital employed efficiency of bank *i* at time *t*, HCE_{it} is the measure of human capital efficiency of bank *i* at time *t*, and SCE_{it} is the measure of structure capital efficiency of bank *i* at time *t*. To calculate these components, we first estimate the total value added (VA).

$$VA_{it} = OP_{it} + PC_{it} + A_{it} \quad (3)$$

Where, OP_{it} is operating profit of bank *i* at time *t*, PC_{it} is personnel costs of bank *i* at time *t,* and A_{it} represents the amortization and depreciation of bank *i* at time *t*. After that, three components mentioned above is estimated as follows:

$$CEE_{it} = VA_{it}/CE_{it} \quad (4)$$

$$HCE_{it} = VA_{it}/HC_{it} \quad (5)$$

$$SCE_{it} = SC_{it}/VA_{it} \quad (6)$$

$$SC_{it} = VA_{it} - HC_{it} \quad (7)$$

Where, CE_{it} is book value of equity of bank *i* at time *t*, and HC_{it} represents the personnel expenses of bank *i* at time *t*.

To investigate the impact of technological investments fueled by intellectual capital, we re-perform the equation (1) as the following regression:

$$Y_{it} = \alpha + Tech_{it} * VAIC_{it} + Control\ Bank_{it} + Control\ Macro_{it} + \theta_t + \varepsilon_{it} \quad (8)$$

Where, $Tech_{it} * VAIC_{it}$ is our main independent variable and we would call this variable as INTERIC in the rest of the paper.

Our sample includes about 120 observations for 12 commercial banks. All variables are winsorized at 1% level on the top and bottom of their distribution to eliminate the possible impact of outliers. The table 2 illustrates the definition of employed variables, and the table 3 depicts the descriptive statistics (Panel A) as well as the correlation matrix (Panel B).

Table 2: Variables Definitions
This table presents definitions of all main variables used in the analysis.

Variables	Definitions
TECH	The natural logarithm of total technology investments
DEPOA	The ratio of total deposits to total assets
TODEPO	The natural logarithm of total deposits
SIZE	The natural logarithm of gross total assets
CAPITAL	Book value of equity over gross total assets
LLR	The loan loss reserve ratio
EBLTA	The ratio of total income before taxes, provisions recognized in income over gross total assets
STATE	A dummy variable equal one if the commercial bank is owned by the state and equal 0 otherwise
GRGDP	The annual GDP growth of Vietnam
INFLR	The annual inflation rate in Vietnam
INTERIC	The interaction between technological spending and VAIC

Table 3: Summary Statistics
The tables below describe the summary statistics and the correlation matrix for the sample employed in the analysis. All variables are winsorized at the 1% and 99% levels of their distribution to eliminate the possible impact of outliers. The period spans from 2011 to 2020.

Panel A: Variables Descriptive Statistics

	(1)	(2)	(3)	(4)	(5)
Variables	N	mean	sd	min	max
DEPOA	120	0.696	0.106	0.414	0.886
TODEPO	120	32.65	1.129	30.00	34.65
TECH	119	24.23	1.548	20.01	27.45
CAPITAL	120	0.0818	0.0299	0.0415	0.185
SIZE	120	33.02	1.085	30.55	34.94
LLR	120	-0.0259	0.0691	-0.323	0.0220
EBLTA	120	0.0171	0.00889	0.00166	0.0419
GRGDP	120	0.0596	0.0118	0.0291	0.0708
IFLR	120	0.0532	0.0510	0.00187	0.187
INTERIC	120	76.82	22.99	16.96	111.9

Panel B: Correlation Matrix (pairwise)

Variables	(DEPOA)	(TECH)	(SIZE)	(CAPITAL)	(EBLTA)	(LLR)	(GRGDP)	(IFLR)
DEPOA	1.000							
TECH	0.187*	1.000						
	(0.041)							
SIZE	0.217*	0.688*	1.000					
	(0.017)	(0.000)						
CAPITAL	-0.227*	-0.206*	-0.529*	1.000				
	(0.013)	(0.025)	(0.000)					
EBLTA	-0.210*	0.429*	0.377*	0.324*	1.000			
	(0.021)	(0.000)	(0.000)	(0.000)				
LLR	-0.175	0.292*	0.295*	0.063	0.445*	1.000		
	(0.056)	(0.001)	(0.001)	(0.497)	(0.000)			
GRGDP	-0.004	-0.096	-0.027	-0.094	-0.082	0.013	1.000	
	(0.963)	(0.297)	(0.771)	(0.310)	(0.375)	(0.890)		
IFLR	-0.606*	-0.086	-0.264*	0.161	0.120	0.276*	0.102	1.000
	(0.000)	(0.354)	(0.004)	(0.079)	(0.191)	(0.002)	(0.267)	

*** p<0.01, ** p<0.05, * p<0.1

4. The Relationship Between Technological Spending and Deposit Intermediation

4.1. Main Finding

Our main finding is illustrated in table 4. We first apply the ordinary least squares regression in Model (1)-(5). At the beginning stage, we perform the reduced model, which only includes our main explanatory variable, in Model (1). The result indicates the positive relationship between TECH and DEPOA at the 5% level of statistical significance. Afterwards, we respectively control bank-specific variables in Model (2), macro conditions in Model (3), and both bank characteristics and country-level features in Model (4). The evidence demonstrates the positive association between technology investment and deposit intermediation in which the coefficient of TECH in Model (4), namely baseline model, has a statistical significance at the 1% level. Accordingly, an increase in one standard deviation of TECH and holding all other equals would result a rise of DEPOA of 2.9 bps (i.e., the coefficient of TECH, 0.0191, times the standard deviation of TECH, 1.548). In the next step, due to having some state-owned banks in our sample, we add a dummy variable (STATE), which equals one if a bank is state-owned bank and equals 0 otherwise, into our baseline model in Model (5). Again, our finding remains unchanged.

In general, the empirical result advocates the role of technological development in boosting banking operations, especially deposit activities. In other words, the main

function of banks, known as producers and servicers for depositors, would be enhanced by expanding technological expenditures. Therefore, our finding complements a clear understanding to the influences of creative innovation in technologies on banking system, and confirms some assertions about the bright side of this revolution (for example: Alvino et al., 2020; Phan et al., 2022a).

Table 4: Baseline Multivariate Analysis
The table depicts regression estimations of the relationship between technological investments and deposit intermediation. The asterisks ***, **, * denote significance at the 1%, 5%, and 10% level respectively.

	(1)	(2)	(3)	(4)	(5)
	Y=DEPOA				
VARIABLES	Reduced model	Control bank-specific	Control macro-specific	Baseline model	Addition Dummy variable
TECH	0.0128**	0.0144*	0.00977**	0.0191***	0.0168**
	(0.00554)	(0.00738)	(0.00390)	(0.00603)	(0.00642)
SIZE		0.0341**		-0.00552	0.0126
		(0.0157)		(0.0139)	(0.0201)
CAPITAL		0.553		-0.0525	0.0925
		(0.479)		(0.415)	(0.451)
EBLTA		-4.995***		-3.002**	-3.435**
		(1.595)		(1.375)	(1.423)
LLR		-0.265**		0.0335	0.00704
		(0.127)		(0.131)	(0.125)
GRGDP			0.619	0.482	0.467
			(0.716)	(0.635)	(0.648)
IFLR			-1.246***	-1.192***	-1.091***
			(0.142)	(0.164)	(0.189)
STATE					-0.0378
					(0.0254)
Constant	0.386***	-0.746	0.489***	0.507	-0.0340
	(0.135)	(0.465)	(0.101)	(0.421)	(0.589)
Observations	119	119	119	119	119
Number of BANK	12	12	12	12	12
R-squared	0.035	0.201	0.390	0.443	0.453

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.2. Robustness Tests

In this sub-section, we would provide some robust tests to ensure the previous finding. The result is shown in the table 5. We first re-perform Model (2)-(4) in table 4 in which the independent variable (TECH) would be lagged one year. This method is really necessary because banks have to need a certain period to adopt new technologies and digital facilities in business operations (Beccalli, 2007; Phan et al., 2022). As the table 5 illustrates in Model (1)-(3), all coefficients of TECH have the positive association with the dependent variable, DEPOA, and possess a statistical significance at 5% level or 1% level. The evidence in the baseline model seems to maintain unaltered in comparison with our previous result.

From Model (4) to Model (5), we use the (natural logarithm) total deposits (TODEPO) as the alternative method for the dependent variable. This approach would help us to capture the absolute aspect of deposit intermediation. The results show that except for the Model (4), where we only control bank-specific variables, other models indicate the positive relationship between TECH and TODEPO, and have a statistical significance at 1% level or 5% level. Specifically, in the baseline model, although the coefficient of TECH only obtains 5% level of statistical significance, the magnitude seems to be larger compared to our previous finding.

In short, our empirical evidence continues to prove the linear relationship between expanding more investments into technologies and enhancing the capability of deposit intermediation in banks. Therefore, this result re-affirms our main finding mentioned above.

Table 5: Robustness Tests
The table below illustrates regression estimations of our main concern in which from Model (1) to Model (4) the key explanatory variable is lagged one year, and we utilize the alternative measure for the dependent variable in Model (5)-(8). The asterisks ***, **, * denote significance at the 1%, 5%, and 10% level respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Y=DEPOA			Y=TODEPO		
VARIABLES	Control bank-specific	Control macro-specific	Baseline model	Control bank-specific	Control macro-specific	Baseline model
L.TECH	0.0149**	0.00938**	0.0179***			
	(0.00642)	(0.00452)	(0.00657)			
TECH				0.0177	0.479***	0.0258**
				(0.0110)	(0.0385)	(0.0100)
SIZE	0.00732		-0.00412	1.057***		0.991***
	(0.0120)		(0.0119)	(0.0252)		(0.0218)
CAPITAL	-0.207		-0.0659	1.099		0.0947
	(0.439)		(0.434)	(0.758)		(0.661)
EBLTA	-2.107		-2.687*	-7.541***		-4.196**
	(1.540)		(1.489)	(2.607)		(2.111)
LLR	-0.205		-0.0188	-0.424**		0.0744
	(0.137)		(0.145)	(0.188)		(0.190)
GRGDP		0.647	0.551		5.897	1.022
		(0.713)	(0.639)		(5.752)	(0.916)
IFLR		-1.341***	-1.387***		-6.491***	-2.000***
		(0.319)	(0.349)		(1.353)	(0.395)
STATE						
Constant	0.160	0.501***	0.488	-2.658***	21.04***	-0.579
	(0.383)	(0.127)	(0.407)	(0.762)	(1.023)	(0.642)
Observations	107	107	107	119	119	119
R-squared	0.117	0.174	0.242	0.980	0.556	0.987

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.3. GMM Approach

This sub-section would depict other econometric approach, namely GMM estimator, which is seen as one of the best tools to tackle some biased estimation when using OLS method. Indeed, as noted by Arellano and Bond (1991); Blundell and Bond (1998), GMM method could eliminate some vital issues such as potentially correct endogeneity, heteroscedasticity, autocorrelation and correlation between all independent variables. The results are illustrated in the table 6.

At the beginning step, we re-run our baseline model by employing GMM approach in Model (1) in which DEPOA is used as the dependent variable. We find that the coefficient of TECH continues to have positive association with DEPOA, and stand at the 5% level of statistical significance. Again, the result is certainly similar to our previous finding. We then re-perform our baseline model with the alternative measure for DEPOA, namely TODEPO, in Model (2). It is clear that the main evidence likely remains unchanged. Particularly, the magnitude of TECH coefficient is bigger, however, the statistical significance only stands at 10% level.

In brief, the empirical result continues to reflect the positive relationship between the expansion in technological investments and strengthening the role of deposit intermediation.

Table 6: GMM Approach
The table below shows our result in which we approach the dynamic panel of system GMM method to test further our previous finding. The asterisks ***, **, * denote significance at the 1%, 5%, and 10% level respectively.

	(1)	(2)
	Y=DEPOA	Y=TODEPO
VARIABLES	Baseline model	Baseline model
L.DEPOA	0.331***	
	(0.0817)	
L.TODEPO		0.415***
		(0.138)
TECH	0.0110**	0.0218*
	(0.00546)	(0.0114)
SIZE	0.0497*	0.651***
	(0.0266)	(0.140)
CAPITAL	1.863**	1.634
	(0.923)	(1.735)
EBLTA	-12.52**	-23.46***
	(5.688)	(8.051)
LLR	0.0929	0.387*
	(0.119)	(0.207)
GRGDP	-0.389	-0.816*
	(0.308)	(0.481)
IFLR	-0.694***	-1.017***
	(0.224)	(0.362)
Constant	-1.317	-2.496
	(0.862)	(1.581)
AR(2)	0.256	0.319
Wald chi2	48181.90	7.34e+07
Prob > chi2	0.000	0.000
Observations	107	107
Number of BANK	12	12

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5. The Role of Integrating Technological spending with Intellectual Capital

As we mentioned in the previous sections, the straightforward question appearing in the knowledge-based and IT-based society is that whether the combination between technology investments and intellectual capital has drawn a distinction in banks. This sub-section would clear this crucial issue by performing the equation (8), and the results are shown in the table 7.

We start with employing our baseline model based on OLS method in which we utilize DEPOA and TODEPO as the dependent variable in Model (1) and Model (2), respectively. The empirical evidence indicates that the coefficient of INTERIC is positive and only statistically significant at 5% level when using DEPOA as the dependent variable. However, when we perform our baseline model relying on fixed-effect estimation in the next two models, all coefficients of INTERIC have the positive association with both DEPOA and TODEPO variables, and stand at 1% level of statistical significance. Therefore, the empirical evidence advocates that integrating technological innovations with intellectual capital would play a vital role in amplifying and scaling deposit intermediation of banks, at least in Vietnamese context.

To ensure this argument, from Model (5) to Model (8), we continue to re-perform the equation (8) based on the GMM approach as we explain in the previous section. We first utilize the TODEPO as the independent variable in the first two models, and control bank-specific conditions as well as both bank-specific and macro variables in Model (5) and Model (6), respectively. In similar way, we use DEPOA as the independent variable in the final two models. The results show that all coefficients of INTERIC have positive relationship with both independent variables, and stand at 1% level of statistical significance except for the last model. Thus, to some extent, the blend of technology spending and intellectual capital would help banks to make a remarkable difference in achieving higher market shares, especially deposit activities.

Table 7: The Role of The Interaction Between Technological Investments and Intellectual Capital
The table illustrates the role of both technological spending and capability of intellectual capital in fostering deposit intermediation. The asterisks ***, **, * denote significance at the 1%, 5%, and 10% level respectively.

	(1)	(2)	(3)	(4)
	OLS		Fixed-effect	
	Y=DEPOA	Y=TODEPO	Y=DEPOA	Y=TODEPO
VARIABLES	Baseline model	Baseline model	Baseline model	Baseline model
INTERIC	0.00162**	0.00164	0.00407***	0.00475***
	(0.000735)	(0.00149)	(0.00115)	(0.00159)
SIZE	-0.00384	0.999***	-0.0669**	0.913***
	(0.0142)	(0.0233)	(0.0271)	(0.0447)
CAPITAL	0.0672	0.249	0.259	0.683
	(0.380)	(0.599)	(0.326)	(0.654)

EBLTA	-4.627***	-5.693**	-7.800***	-10.61***
	(1.577)	(2.598)	(1.899)	(2.763)
LLR	-0.0252	0.0175	-0.0189	-0.00544
	(0.128)	(0.206)	(0.0779)	(0.124)
GRGDP	0.414	0.909	0.555	1.074*
	(0.613)	(0.902)	(0.391)	(0.548)
IFLR	-1.218***	-2.013***	-1.574***	-2.484***
	(0.174)	(0.372)	(0.318)	(0.651)
Constant	0.812*	-0.340	2.754***	2.320
	(0.458)	(0.730)	(0.866)	(1.482)
Observations	120	120	120	120
Number of BANK	12	12	12	12
R-squared	0.423	0.986	0.3051	0.9853

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: (continued)

	(5)	**(6)**	**(7)**	**(8)**
	GMM			
VARIABLES	**Y=TODEPO**		**Y=DEPOA**	
L.TODEPO	0.638***	0.236*		
	(0.0888)	(0.129)		
L.DEPOA			0.377***	0.402***
			(0.0750)	(0.149)
INTERIC	0.00570***	0.00746***	0.00355***	0.00299
	(0.00154)	(0.00173)	(0.00136)	(0.00184)
SIZE	0.354***	0.768***	0.0562	0.0303
	(0.0931)	(0.135)	(0.0399)	(0.0243)
CAPITAL	1.799	2.874*	2.391**	2.681**
	(1.624)	(1.586)	(1.050)	(1.116)
EBLTA	-15.81***	-22.03***	-15.86***	-11.46**
	(5.059)	(5.797)	(5.557)	(4.610)
LLR	-0.288**	-0.254**	-0.193***	-0.200***
	(0.121)	(0.111)	(0.0660)	(0.0704)
GRGDP		0.273		0.134
		(0.206)		(0.208)
IFLR		-0.842**		-0.408*
		(0.344)		(0.240)
Constant	-0.0696	-0.747	-1.611	-0.823
	(1.404)	(1.247)	(1.308)	(0.878)
AR(2)	0.856	0.418	0.301	0.821
Wald chi2	3.47e+08	1.60e+08	35987.60	421410.67
Prob > chi2	0.000	0.000	0.000	0.000
Observations	108	108	108	108
Number of BANK	12	12	12	12

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6. Conclusions and Implications

The fast development of technological innovations has received much attention from academics and managers in banking industry in recent years. Regardless of technology advantages, some concerns about the unexpected impacts coming from this revolution have emerged in financial literature. Our study provides one of new empirical evidence to wipe out these worries. First, our result proves that an increase in investing in technologies would help banks to expanding the distribution of deposit intermediation. Second, the combination between technological spending and intellectual capital plays the fundamental role in boosting deposit intermediation. These findings likely survive when we employ a variety of battery tests. Therefore, we believe that our results are really useful for national authorities and managers in Vietnam, where has undergone the totally reform period in banking system. This paper also has some theoretical and practical implications as follows.

First of all, the deposit intermediation is seen as one of main functions of commercial banks that not only ensures the capital resource of banks, but also fosters the economic growth (Greenbaum et al., 2019; Obradović & Grbić, 2015). Thus, our empirical evidence would shed light on the vital aspect of adoption of new technologies in promoting this function in banking sphere, and support the bright side of technological development as some studies have suggested such as Alvino et al. (2020); Phan et al. (2022). In this vein, the paper likely erases some concerns on the adverse impact of technologies and innovations on banking operations as Uddin, Mollah, et al. (2020); Uddin, Ali, et al. (2020) indicated. Furthermore, the empirical evidence illuminates arguments of Singh et al. (2019); Vătămănescu et al. (2019), who consider that the use of technologies and the implementation of intellectual capital would help banks to enhancing competitive advantages, and gaining higher market shares in the digital era. With that in mind, we suggest that managers in banks, especially in Vietnam, have to invest more into adoption of new technologies and the capability of human capital in coming time. In this scenario, the first and necessary step is that building the close cooperation with foreign partners, and/or Fintech firms in business strategies is to strengthen IT infrastructure and capacity of implementation of intellectual capital.

Although having certain achievements, this paper still remains some drawbacks that future studies could bridge these gaps. For instance, to make a clear comparison, future research could separately examine foreign banks in Vietnam. This, in turn, may provide precious experiences for local banks to adjust business strategies in appropriate ways. Another compelling gap is that the investigated sample should be expanded, and estimating the influences of different components of intellectual capital on deposit intermediation. It is hoped that our study would open up new ways for future studies in this crucial field.

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