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A fintech kapcsolatának feltárása a Google kereső segítségével és a banki
stabilitás: bizonyítékok Vietnamból

Exploring the relationship between fintech by Google search and bank stability:
Evidence from Vietnam

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Abstract

Due to the ongoing global debate regarding the relationship between fintech and banks, including developing countries, this study aims to investigate this relationship in the case of Vietnam, an emerging nation. Using a sample of 27 Vietnamese commercial banks from 2012 to 2023, we construct a fintech index tailored to the Vietnamese banking industry based on data from Google Trends. This index reveals substantial growth in fintech adoption within the Vietnamese banking sector over the study period. Our empirical analysis demonstrates a significant inverted U-shaped relationship between fintech development and bank stability. At moderate levels, fintech adoption positively contributes to bank stability; however, when fintech adoption becomes extensive, it introduces risks that may offset these stability benefits. This study provides important insights for bank managers, investors, and policymakers seeking to optimize fintech integration for sustainable banking stability.

Keywords: Bank stability, Fintech, Vietnam

JEL classification: G15, G21, G28, O30

Chapter 1. Introduction

In today's digital era, technology has become an indispensable aspect of socioeconomic transformation, profoundly reshaping Vietnam's economy and society. This transformation is driven by a wave of technological advancements, primarily in information technology. Since its shift from a centrally planned economy to a market-based system in the late 1980s and early 1990s, Vietnam has followed the liberalization paths of other Asian and European nations. This gradual economic liberalization has maintained state-owned banks as dominant players and key policy facilitators, providing them with unique advantages, such as implicit government guarantees, reduced risk exposure, and access to low-cost funding. This cautious liberalization approach mirrors the experiences of countries like China and Russia, where banking systems have similarly evolved through incremental reforms (Le et al., 2019; Sekuła, 2023).

In the era of global economic integration, where finance and technology intersect, financial technology (fintech) has revolutionized the financial services industry. Fintech, defined as the application of technology to create new financial products and business models, has significantly impacted financial markets, institutions, and service delivery (Financial Stability Board, 2017). It spans a wide range of areas, including retail finance, wholesale payments, investment management, insurance, credit provision, and crowdfunding. By competing with and transforming traditional financial services, fintech drives innovation across the financial sector. For banks, especially commercial banks, the rise of fintech has introduced both opportunities and challenges, affecting their operations and potentially influencing their stability.

As core institutions within the financial system, banks are critical in channeling resources between borrowers and lenders. The stability of the banking sector is widely recognized as a foundational element for economic growth, particularly in developing economies. For commercial banks, stability enhances operational efficiency and strengthens their financial intermediation role, ultimately boosting profitability and competitive positioning. However, as fintech reshapes the financial landscape, commercial banks face new risks alongside technological advancements. While fintech has modernized financial intermediation, it has not fundamentally altered the risks inherent in banking. Consequently, adapting to fintech involves balancing opportunities for innovation with the potential risks to stability and customer trust.

In Vietnam, a predominantly bank-based economy, banks are the central sources of funding, and their stability has profound implications for the country's financial system. Vietnam's fintech market is expanding rapidly, with innovations in mobile payments, peer-to-

peer lending, personal financial management, and insurtech. Recognized as one of the emerging fintech hubs in the Asia-Pacific region, Vietnam's fintech development is likely to have a significant impact on the broader financial landscape. This study examines the influence of fintech development on the financial stability of 27 commercial banks operating in Vietnam from 2012 to 2023.

The existing literature presents varied perspectives on the relationship between fintech and bank stability. Some studies highlight fintech's positive impact on stability through risk diversification and efficiency gains, while others caution that increased competition and new risks may undermine stability. Additionally, some findings suggest an inverted U-shaped relationship, where moderate fintech adoption promotes stability, but excessive adoption could lead to instability. These diverse perspectives illustrate the complex role of fintech in modern banking.

The contributions of this study are threefold. First, it extends the existing literature on the relationship between fintech development and bank stability within Vietnam's banking sector, addressing a gap in the research. Second, it introduces a novel methodology for constructing a Fintech Index using Google Trends data, offering a new approach to measuring fintech adoption. Third, it explores the relationship between fintech adoption and bank stability, with a specific focus on how bank size influences this dynamic.

This paper is structured as follows: Chapter 2 reviews relevant literature and formulates the hypotheses. Chapter 3 describes the dataset, primary variables, and econometric model used. Chapter 4 presents the baseline model results and heterogeneity analysis. Chapter 5 conducts robustness tests, Chapter 6 concludes the study with a discussion of findings and implications, and Chapter 7 is the conclusion of the thesis.

Chapter 2. Literature review and hypothesis development

2.1 Background of banking in Vietnam

When compared to more established banking systems in the US or European countries, as well as emerging markets, the Vietnamese banking market possesses a greater number of distinguishing traits. The dominance of a few large government-owned banks results in other banks having much smaller market share, which illuminates the fact that government projects may rely on funding from state-owned banks rather than private banks (Vuong et al., 2023).

Within the context of the Vietnamese economy, the banking sector is regarded as the financial backbone of the economy, which is highly regulated by the State Bank of Vietnam (SBV). By 1990, Vietnam banking system operated as a one-tier system that performed both functions of management and commercial. As a result, the SBV must undertake responsibilities of the central bank as well as the commercial bank. After the 1990 revolution of bank transformation in Vietnam, authorities decided to adapt the two-tier banking system, which separated the business activities from the state management functions, to eliminate the monopoly of State bank and enhance the diversification of banking activities. Following the 2007–2009 financial crisis, the economy in Vietnam suffers from many distresses such as high inflation and economic slowdown. As a result, to prevent the adverse influence of the recession, the SBV of Vietnam implemented a variety of monetary policies to facilitate macroeconomic stability and economic growth.

According to SBV data, during the period from 2007 to 2021, Vietnam economic growth reached an average rate of 5.8% per year. The commercial bank system accounts for 60% - 80% of the overall capital needs of the whole economy. The increased demand for capital for production and business has led to the rapid growth of the credit scale of the system (Nguyễn Thị Mỹ, 2023).

The year 2022 marks a crisis to the world economy after the Covid 19 pandemic, which leads to the global supply chain disruption causing many enterprises to rush to the brink of bankruptcy. This is also the year that SBV enacts various monetary policies to control inflation, real-estate market, securities, bonds, and credit crunch, which also has a high influence on the lending activities of commercial banks. The explosion of technology, coupled with the impact of the COVID-19 pandemic, motivated commercial banks to transform their operations and integrate technology to enhance profitability and value. In this context of post-pandemic recovery, transformation and digitalization became key areas of focus for both investors and researchers.

2.2 Fintech in Vietnam

After the 2008 global recession, Fintech has produced ground-breaking customer experiences by delivering solutions that are fully interactive, priced, and simple to use fully interactive by digital technology. Fintech is revitalizing the financial value chain today by collaborating with old or new banks (Neo Banks) to close gaps in offerings and increase client options.

A study by Financial Stability Board discussing about the important policies for financial stability goals from Fintech defines Fintech *as innovation in financial services with the help and support of technology, leading to business models, new applications, processes, or products that have an essential impact on the delivery of financial services* (Financial Stability Board, 2017).

Fintech activity in Vietnam has grown exponentially and has been playing an important role in transforming the financial services sector. However, there is still potential for further growth. Access to technology along with a young population structure with increasing per capita income has laid the foundation for the rapid growth of Fintech. The development of the Fintech market in Vietnam is most evident through the number of startups in this field that is always growing year by year. According to the State Bank of Vietnam (SBV), the number of domestic fintech companies has increased significantly from 2010 to 2023, rising from 10 companies at the end of 2010 to over 187 companies in 2023. There is still considerable room for growth in the coming years and even in the next decade. In particular, payment services (payments) are still the largest segment, accounting for 22.6% of the number of Fintech companies, followed by personal lending and blockchain/crypto segment. In addition, segments with significant growth in the number of startups compared to 2021 can be mentioned in wealth management, technology insurance and buy now pay later.

Along with the rise in the number of Fintech companies, the Fintech industry in Vietnam is also a potential market that has received the amount of funding value reaching a significant number year by year. The prolonged pandemic in 2021 has resulted in record investment volume in Fintech in Vietnam, along with increasing adoption of Fintech solutions such as e-wallets, cryptocurrencies and online investment platforms. According to the SBV's data, Vietnam ranked 3rd (after Singapore and Indonesia) when it attracted more than \$1.4 billion from investors in the Fintech market, which marked the record funding amount since Fintech appeared in Vietnam. The total investment value in Vietnam Fintech market in 2023 reached \$211 millions (only equivalent to 14% of the value in 2022) with the number of investment deals only accounting for 4% of the total number of deals in the ASEAN region in 2023.

It can be seen that FinTech is rapidly developing in Vietnam with a wide range of functions, offering diverse services related to payments, lending, blockchain/crypto, digital banking, wealth management, insurtech, and more. With functions similar to those of banks, FinTech activities have a strong impact on the operations of traditional banks, thereby affecting the financial stability of banks in Vietnam.

Due to its rapid and prominent development, FinTech has become a popular topic for researchers. There have been numbers of papers worldwide, in the context of the industrial revolution 4.0 taking place strongly and creating a trend of digital transformation in the banking system, choose Fintech-related indicators to analyze banks' performance. However, existing studies in Vietnam mostly measure FinTech's impact on bank performance, such as the studies by Pham et al. (2024), Vu et al. (2024), L. Nguyen et al. (2022), or focus on user acceptance of FinTech, as in the research by Huong et al. (2021). Studies examining FinTech's impact on the stability or risk-taking levels of Vietnamese banks are still quite new. Utilizing this research gap, this thesis will explore the relationship between FinTech development and the stability of commercial banks in Vietnam.

2.3 Relationship between bank stability and fintech development

The adoption of fintech can have a complex impact on bank stability, influencing both risks and opportunities for traditional banks. According to the technology spillover effect theory, advancements in fintech can spread into the traditional banking sector, promoting growth and efficiency in commercial banks. Fintech provides technical spillovers in several ways, including demonstration effects, new business connections, employee movement, and increased competition. These spillovers help banks improve their operations and lower risks by sharing new skills and practices (Guo & Shen, 2016).

Schumpeter's innovation theory suggests that fintech allows banks to replace or reduce traditional resources like labor, capital, and physical infrastructure, helping to lower operating costs and close the gap between actual and expected expenses. Fintech also supports new business models that integrate banking services into digital experiences, allowing banks to reach underserved areas and open up new markets. Additionally, fintech makes it easier for banks to acquire new customers, expanding their business and revenue potential. Together, these improvements in cost and revenue efficiency enhance operational performance, ultimately lowering banks' costs and encouraging safer risk management.

The competition-fragility theory explores how fintech affects bank stability in areas beyond lending, such as payments and wealth management. The rise of fintech firms in these services has increased competition in the financial industry, pushing banks to adapt to maintain

their market position. Traditionally, banks have relied on strict risk management and regulatory compliance to ensure stability (Erdogan, 2018). However, with increased competition from fintech, banks may feel pressured to adopt more aggressive strategies, which could mean taking on higher risks, relaxing service standards, or quickly adopting new technologies to keep pace (Jiménez et al., 2013; Nguyen et al., 2022).

Recent studies have explored the diverse effects of fintech development on the banking sector, showing that its impact varies widely. Some research highlights a positive impact, where fintech innovations enhance stability by improving efficiency, risk management, and resilience. Other studies suggest a negative impact, as fintech may introduce new risks that can undermine stability, especially if technology is not managed well. A third perspective identifies an inverted U-shaped relationship, where fintech initially supports stability, but excessive reliance on it can become destabilizing.

Several studies illustrate these differing views. For example, Bilgin et al. (2021) found that economic uncertainty increases default risk for conventional banks but not for Islamic banks, indicating differences in how banks respond to financial and technological pressures. Li et al. (2022) showed that fintech's links to traditional financial institutions become stronger during downturns, which can raise systemic risk. In the European context, Pacelli et al. (2022) found that during market declines, risk spillovers from traditional banks to fintech firms are more pronounced. Chaudhry et al. (2022) observed that while technology firms face higher risk levels, they are less likely than banks to experience distress after market shocks.

In terms of stability, some scholars argue that fintech can make banks more vulnerable. Thakor (2012) suggested that financial innovations may increase banks' susceptibility to crises. Buchak et al. (2018) studied the shadow banking market in U.S. residential mortgages and concluded that fintech firms contribute to shadow banking, raising issues of moral hazard and potentially destabilizing the financial system. Based on the above discussion, we propose the following hypotheses:

H1a: Fintech development has a negative relationship with the stability of Vietnamese banks.

However, other research suggests that fintech can positively affect financial intermediation. Philippon (2015) emphasized how fintech can reduce intermediation costs, while Fuster et al. (2019) found that fintech platforms streamline lending, particularly for mortgages, allowing quicker responses to demand fluctuations. Similarly, Tang (2019) reported that peer-to-peer lending platforms offered effective alternatives to traditional banking. Thus, we propose the following hypothesis:

H1b: Fintech development has a positive relationship with the stability of Vietnamese banks.

Several studies have highlighted fintech's mixed impacts on bank performance. Lv et al. (2022) discovered a U-shaped relationship between fintech and bank profitability: fintech initially lowers profitability but eventually boosts it. Zhao et al. (2022) noted that fintech lowers profitability and asset quality for large state-owned banks, but it can improve their capital adequacy and efficiency. Nguyen et al. (2022) observed that while fintech competes with banks, it also enhances stability by improving risk performance. Yudaruddin (2022) found that fintech startups negatively impact bank lending and performance.

An optimistic view suggests that fintech can support banking and financial stability by diversifying risks and moving some credit activities to a "more market-based" system Cizel et al. (2019). This perspective is supported by the "innovation-growth" hypothesis, which proposes that financial innovation promotes economic growth and resilience, creating a more stable financial system (Beck et al., 2012; Laeven et al., 2015).

On the other hand, some studies find an inverted U-shaped relationship. Wang et al. (2021) observed that while fintech adoption initially reduces bank risk-taking, high levels of adoption can increase risks. Nguyen et al. (2022) also noted the destabilizing potential of fintech under certain conditions. International studies echo this complexity, for example, Daud et al. (2022) found that fintech promotes financial stability in a sample of 63 countries. Fung et al. (2020) reported that fintech innovation, represented by regulatory sandboxes, supports stability in emerging markets but poses risks in developed economies. Liem et al. (2022) used global fintech credit data to show fintech's positive role in financial stability across 73 countries. So, we proposed the second hypothesis:

H2: From a dynamic evolution standpoint, fintech development has a U-shaped impact on the stability of Vietnamese commercial banks.

The literature presents diverse perspectives on the impact of fintech on banks. While fintech can bring benefits such as efficiency and improved risk management, it also introduces risks that can undermine stability. The relationship can be positive, negative, or follow an inverted U-shape, depending on factors like technology level, regulatory environment, and bank characteristics.

FinTech development impacts banks of different sizes in varied ways. Large banks tend to be more risk-averse due to their substantial liquidity buffers and capital reserves. These resources shield them from acute liquidity shortages, allowing large banks to invest heavily in FinTech without significantly affecting their overall risk profile. With ample capital, these banks can leverage FinTech innovations to enhance efficiency and reduce operational and financing costs, enabling them to adopt lower-risk strategies while maintaining a competitive

edge in the FinTech space (Bertay et al., 2013). Their strong capital positions lessen the need to pursue high-risk activities for returns, allowing a focus on steady, long-term gains.

On the other hand, smaller banks often face tighter liquidity constraints and have less capital available for FinTech investments. This can compel them to take on riskier practices to stay competitive with larger banks and other financial service providers. Limited capital resources may drive smaller banks to seek higher-yield, higher-risk opportunities, such as extending credit to riskier borrowers or adopting FinTech solutions that promise high returns but carry greater risk exposure (Banna et al., 2021). For smaller banks, FinTech adoption may thus require a careful balance between using technology to spur growth and managing the associated risks.

Additionally, smaller banks may adopt FinTech as a strategy to differentiate themselves within niche markets, which often requires more aggressive approaches. In contrast, larger banks, with broader resources and established customer bases, can take a more conservative approach, using FinTech primarily to improve operational efficiencies without significantly changing their risk profile. This difference highlights the complex relationship between FinTech innovation and risk-taking across the banking sector, with bank size being a significant factor that shapes risk strategies and outcomes. Based on these discussions, we propose a third hypothesis:

H3: FinTech development has heterogeneous impacts on different size of banks.

Chapter 3. Methodology

3.1 Sample collection and data source

In this research the author uses yearly bank-level panel dataset, collected from audited financial statements as well as notes to the financial statements of 27 out of 27 joint-stock listed banks, spanning from 2012 to 2023 on three Vietnam Stock Exchanges, which are the Hanoi Stock Exchange (HNX), the Ho Chi Minh City Stock Exchange (HSX) and the Unlisted Public Company Market (UPCOM). Based on this secondary data set we calculate the dependent variables of bank stability and control variables of banks' characteristics. For the macroeconomic variables, we collect data from the World Bank database. With 27 selected banks in 12 years, we collected 324 samples.

For the glossary of fintech development, we mainly based on previous literature. To ensure the list of keyword is applicable in Vietnam, we refer to Vietnam Financial Times - a newspaper house which is under the management of Vietnamese Ministry of Finance (thoibaotaichinhvietnam.vn), Banking Magazine – a financial press under the State Bank of Vietnam (tapchinganhang.gov.vn), and a fintech dictionary in English (Alt & Huch, 2022), as well as from the reports and articles published by the investigated banks themselves. For the calculation of Fintech development index, we collect data from Google trend and then construct this index.

3.2 Variables construction

3.2.1 Measuring bank stability

There are three common methods in the literature to assess financial risks (B. Chen et al., 2022). The first is the empirical or signal method, which analyzes countries that have historically experienced financial crises, explores commonalities observed during these crises, examines the economic situation, and identifies similarities in target countries to predict future crises. The second is the modeling method, which uses models such as the GARCH model or neural networks to construct an evaluation system that calculates the probability of a financial crisis occurring. The third is the stress index method, which assesses financial risks based on the financial stress level within a selected time period.

The signal method, known for its lower data frequency requirements, is commonly applied in countries with a history of financial crises but is not well-suited to Vietnam's context. On the other hand, the modeling method examines the mechanisms behind systemic risk but relies on numerous complex parameters and a substantial amount of sample data, making it

theoretically robust but demanding in terms of data. In this study, we adopt the stress index method to assess financial risk in Vietnamese commercial banks.

Research literature shows that the indicators used in financial risk assessments vary, including capital-asset ratios, expected default rates, capital adequacy ratios, stock volatility, non-performing loan ratios, and Z-values (B. Chen et al., 2022). This study uses the ZEQT variable, which represents the Hannan & Hanweck (1988) accounting model of bank risk index. This index has been used in various studies to measure bank risk-taking, such as Lepetit & Strobel (2013), Yusgiantoro et al. (2019), Maria et al. (2022), Yudaruddin et al. (2023), and Ahmad et al. (2008). The risk index ZEQT is calculated as follows:

$$ZEQT_{i,t} = \frac{ROA_{i,t} + EQTA_{i,t}}{SD(ROA)}$$

where ROA is the return on average assets, EQTA is the equity capital-to-asset ratio, and SD(ROA) is the standard deviation of ROA. ROA is calculated as net income divided by total assets. We calculate SD(ROA) for each bank using a five-year time series approach and derive the ZEQT value.

ROA provides an overview of the bank's performance, while its standard deviation describes the volatility of bank earnings, therefore, the equity capital-to-total assets ratio shows the amount of equity capital available to absorb unexpected losses (Ahmad et al., 2008). The index captures three essential aspects of bank risk, assessing how much earnings can decrease before the bank's book value becomes negative, potentially resulting in insolvency (Nash & Sinkey, 1997). A low ZEQT score indicates a riskier bank, while a higher ZEQT score implies a safer bank. The ZEQT value has its unique characteristics, showing a tail after the peak, so the logarithm of this value must be taken during regression (Li et al., 2022). When we did the calculation, considering the fact that the Z value may be zero, we used $\log(1 + ZEQT)$ instead of $\log(ZEQT)$.

3.2.2 *Measuring fintech index*

Quantifying FinTech index presents several challenges. FinTech encompasses a wide range of technologies and business models, making it difficult to establish a clear and consistent definition. The diverse and evolving nature of FinTech innovations further complicates efforts to create a standardized measure. Additionally, data availability and quality are often inconsistent across regions and countries, limiting precise assessment. Because FinTech adoption blends traditional and new financial services, distinguishing between conventional financial services and FinTech-enabled ones can be challenging. The varying rates of FinTech adoption across sectors and institutions also hinder meaningful comparisons of progress.

Furthermore, rapidly shifting consumer behaviors and preferences complicate estimations of FinTech usage and adoption levels. Despite these challenges, we have sought to define FinTech within the banking sector and to construct a bank-year indicator of FinTech development for Vietnamese commercial banks.

In this study, we use Google Trends to collect data on the level of interest in search activity related to FinTech. In today's era of rapidly advancing information technology, things that develop more tend to attract greater public attention and information searches. Therefore, we believe that the public's interest in FinTech can serve as a proxy for the level of FinTech development in Vietnam.

Internet search data, particularly from Google, is strongly linked to socioeconomic indicators (Mellon, 2013). Google, as a leading search engine, provides cost-effective, readily available, and continually updated data (hourly, daily, weekly, monthly, and yearly), which can be segmented by time and region, offering advantages over traditional survey data. When specific keywords are queried on Google Trends, the search volume time series appears as the Google Search Volume Index (GSVI), ranging from 0 to 100, representing the frequency of keyword searches from lowest to highest. Jun et al. (2018) found that Google Trends is widely used to analyze various variables across fields such as IT, communications, medicine, health, business, and economics. Google search data has become a significant data source that is widely accepted in social science research. Mellon (2013) confirmed an essential link between the volume of keyword searches on Google and socioeconomic issues. Mellon, 2014 further demonstrated that Google search data is valuable for measuring economic variables, including fuel prices, immigration, and terrorism in the US. The utility of Google search data is also supported in other fields, such as conservation (Burivalova et al., 2018; Nghiem et al., 2016; Troumbis & Iosifidis, 2020), COVID-19 prediction (Ayyoubzadeh et al., 2020; Husnayain et al., 2020), and finance.

By following literature, the author formed a bank fintech development index using a three-step model approach: (i) Forming a bank fintech glossary, (ii) calculate Average Google Searching Value (AGSV) Index, (iii) calculate the fintech index.

Step 1: Forming a bank fintech glossary

First, the author constructed a list of functional keywords from the four dimensions of fintech, based on fintech applications in the commercial banking business, as shown in **Table 1**.

Table 1. Glossary of Fintech keywords

Dimensions	Keywords
Information transfer	financial technology (fintech), openAPI, digital banking, e-banking, digitalization
Clearing and payment	cashless payment, e-wallet, mobile banking, e-payment, internet banking
Resource allocation	online lending, crowdfunding, online disbursement, online investment, peer-to-peer lending (P2P)
Technical base	blockchain, big data, cloud computing, eKYC, artificial intelligence (AI)

Source: compiled by author.

The keyword set was compiled based on the lists of keywords used in studies by Guo & Shen (2016), Li et al. (2022), and B. Chen et al. (2022). To ensure the keywords are relevant and applicable in the Vietnamese context, we consulted the Vietnam Financial Times - a publication under the Vietnamese Ministry of Finance (thoibaotaichinhvietnam.vn) and the Banking Magazine, which is managed by the State Bank of Vietnam (tapchinganhang.gov.vn). Additionally, we referenced an English-language FinTech dictionary (Alt & Huch, 2022), as well as reports and articles published by the banks included in the study.

Step 2: Calculating Average Google Searching Value (AGSV) Index

Next step, we used Google Trends, a big data source, to construct an index for FinTech development in Vietnam. Following Bijl et al. (2016), Kim et al. (2019), and Huynh (2019) and Pham, Pavelkova, et al. (2024), we apply the $AGSV_t^k$ equation of the GSVI at week t of keyword k with $SD_{GSVI_t^k}$ of the standard deviation of GSVI for the past 52 weeks to measure the components of fintech variables.

$$AGSV_t^k = \frac{GSVI_t^k - \frac{1}{52} \sum_1^{52} GSVI_{t-1}^k}{SD_{GSVI_t^k}}$$

Step 3: Calculate the fintech index

After computing the AGSV index weekly for each keyword, we derive the annual score of each keyword by taking its arithmetic average. The next step is to calculate the score for each dimension based on the average annual score of the keywords. Finally, the overall FinTech index is created from the average of these four dimension scores.

3.2.3 Control variables

To better analyze changes in the dependent variables and reduce multicollinearity more effectively, the author incorporated several control variables at both the macro and micro levels.

In line with the existing literature on bank stability and according to the theory of economies of scale and scope, expanding bank scale can reduce credit risk. Therefore, bank asset size is included as a control variable, with the asset size transformed by taking its logarithm.

According to the theory of economy of scale and scope, the expansion of scale can reduce the credit risk faced by banks. We have taken the bank's asset size as one of the control variables and taken the logarithm of the asset size.

Well-capitalized banks have more resources and expertise to effectively manage and mitigate the risks associated with FinTech adoption (Khan et al., 2023). Their substantial capital reserves also provide a cushion against potential losses or disruptions caused by new technologies. Therefore, we included capital structure (equity-to-total assets) as a control variable.

In addition, liquidity plays a crucial role in bank stability (Haq et al., 2022; Papanikolaou & Wolff, 2014; Qi, 1994; Wagner, 2007). A lack of liquidity can lead to insolvency, erode market confidence, and even trigger bank runs (Khan et al., 2023). This can cause reluctance in the interbank market to lend, force asset sales at distressed prices, prompt regulatory intervention, and exacerbate the maturity mismatch between assets and liabilities. Thus, the loan-to-deposit ratio, an important indicator of a bank's liquidity level, is included in this thesis as a control variable.

The higher the GDP growth rate, the better the economic development, which affects the business and operations of commercial banks. Generally, there is an inverse relationship between the GDP growth rate and the risk-taking of commercial banks.

There are three possibilities for the impact of inflation (INF) on bank risk. First, inflation will increase bank costs, which is adverse for banks. Second, the central bank's currency is over issued, and inflation is beneficial for the bank, which is the debtors. Third, when the economy is prosperous, inflation will make the country use tight monetary policy to curb inflation, which is adverse for the banking system.

In summary, our variables are illustrated in the **Table 2** below:

Table 2. Main variable description

	Symbol	Description	Existing literature
<i>Dependent variables</i>			
Bank risk	ZEQTA	The natural logarithm of: $ZEQTA_{i,t} = \frac{ROA_{i,t} + EQTA_{i,t}}{SD(ROA)}$	Ozili (2018), Yudaruddin et al. (2023)
Loan loss coverage ratio	LLC	Loan loss provisions to non-performing loans	
<i>Independent variable</i>			
Fintech index	FTI	The author calculated this index based on the data collected from Google Trend	Pham, Pavelkova, et al. (2024)
<i>Control variables</i>			
Operating Scale	SIZE	The natural logarithm of total assets	Li et al. (2022), Khan et al. (2023)
Liquidity	LDR	Loan-to-deposit ratio = total loans / total deposits	Li et al. (2022), B. Chen et al. (2022)
Capital Structure	CAP	Bank capital shows a bank's sufficient capital status and safety and health. CAP = equity capital / total assets	Li et al. (2022), Khan et al. (2023)
Economic Development	GDP	Growth rate of Gross Domestic Product of Vietnam	Li et al. (2022), Guo & Shen (2016), Ozili (2018), B. Chen et al. (2022), Khan et al. (2023)
Inflation	INF	Consumer Price Index of Vietnam	Li et al. (2022), Khan et al. (2023)

Source: compiled by author.

3.3 Econometric models

Our econometric model is specified as follows:

$$\text{ZEQTA}_{it} = \alpha + \beta \text{FTI}_{it} + \gamma \text{Controls}_{it} + \text{Firm FE} + \text{Year FE} + \varepsilon_{it}$$

where the dependent variable ZEQTA_{it} is the indicator of banks stability. FTI_{it} represents the index measuring the development of fintech in Vietnam. Controls_{it} denotes the vectors of bank characteristics and macroeconomic variables. Year FE and Firm FE are year fixed effect and the time-invariance bank-specific effect respectively, and ε_{it} is the error term. α , β , and γ are the coefficients to be estimated.

To examine how FinTech development changes over time, the squared independent variable for FinTech is included in the baseline regression to capture this nonlinear effect:

$$\text{ZEQTA}_{it} = \alpha + \beta_1 \text{FTI}_{it} + \beta_2 \text{FTI}_{it}^2 + \gamma \text{Controls}_{it} + \text{Firm FE} + \text{Year FE} + \varepsilon_{it}$$

Furthermore, we include bank fixed-effects and year fixed-effects to control for time-invariant unobserved heterogeneity and biases related to potentially omitted explanatory variables as well as time fixed-effects to account for time-specific unobservable factors which may systematically influence the level of bank stability. Throughout the regressions, we use Newey–West standard errors to control for potential serial correlation matters and heteroskedasticity which may lead to biased standard error estimate.

Chapter 4. Empirical Results

4.1 Descriptive statistics

Table 3. Descriptive statistics for main variables

	Mean	Median	St.dev.	Min	Max	Obs
ZEQTA	3.52	3.46	0.73	1.18	7.08	324
FTI	26.41	23.74	13.96	10.85	49.18	324
SIZE	32.59	32.56	1.17	30.28	35.37	324
CAP	8.97	8.18	3.46	4.06	23.84	324
LDR	88.26	88.43	16.59	36.33	142.82	324
GDP	5.95	6.53	1.69	2.65	8.24	324
INF	3.72	3.25	2.15	0.63	9.27	324

Source: compiled by author.

Table 3 reports the descriptive statistics of the main variables in this study, including those associated with bank stability, fintech development, and other bank-specific characteristics. The stability measure, ZEQTA, has a mean of 3.52, with a median of 3.46, indicating slight positive skewness, and ranges from 1.18 to 7.08.

Regarding fintech development, the Fintech Index (FTI) shows an average of 26.41 with considerable variability (standard deviation of 13.96), reflecting diverse levels of fintech adoption across institutions.

Among bank characteristics, SIZE, measured as the natural logarithm of total assets, averages 32.59, suggesting substantial operational scale among banks. The capital structure indicator, CAP, shows a mean of 8.97%, with a median close to 8.18%, reflecting the general capital adequacy in the sector. The liquidity metric, Loan-to-Deposit Ratio (LDR), averages 88.26%, ranging from 36.33 to 142.82, which highlights varying liquidity positions.

Macroeconomic conditions, represented by GDP growth rate and inflation (INF), show means of 5.95% and 3.72%, respectively, with moderate variability, indicating stable but varied economic environments within the sample period.

Overall, the statistics in **Table 3** illustrate a comprehensive view of the banking environment, highlighting diverse fintech adoption levels, capital and liquidity positions, and macroeconomic conditions that may influence bank stability.

Table 4. Correlation matrix

	ZEQTA	FTI	SIZE	CAP	LDR	GDP	INF
ZEQTA	1.0000						
FTI	0.2785	1.0000					
SIZE	0.1094	0.4135	1.0000				
CAP	-0.1036	-0.1119	-0.4173	1.0000			
LDR	0.0971	0.4505	0.3124	0.1441	1.0000		
GDP	-0.0135	-0.2332	-0.0797	-0.0259	-0.0508	1.0000	
INF	-0.1769	-0.3921	-0.2443	0.2434	-0.1801	-0.0533	1.0000

Source: compiled by author.

Table 4. presents the correlation matrix, illustrating the relationships between bank stability (ZEQTA), fintech development (FTI), bank-specific characteristics (SIZE, CAP, LDR), and macroeconomic indicators (GDP, INF). The results reveal a positive correlation between bank stability (ZEQTA) and fintech development (FTI) with correlation equal 0.2785, suggesting that greater fintech adoption is modestly associated with enhanced bank stability. This finding aligns with the notion that fintech innovations may support stability through improved operational efficiencies and customer engagement. Additionally, a strong positive correlation between SIZE and FTI (coefficient is 0.4135) indicates that larger banks are more likely to invest in fintech, potentially due to their greater resources and scalability for technology adoption.

The capital structure (CAP) shows a negative association with both SIZE (coefficient is 0.4173) and FTI (coefficient is 0.1119), implying that larger, fintech-oriented banks may maintain lower capital ratios, possibly reflecting different risk preferences or funding strategies. Moreover, liquidity (LDR) is positively correlated with FTI (coefficient is 0.4505), suggesting that fintech adoption could enhance liquidity management by streamlining lending and deposit processes.

Macroeconomic variables exhibit notable correlations with fintech adoption and bank stability. Inflation (INF) negatively correlates with ZEQTA (coefficient is 0.1769) and FTI (coefficient is -0.3921), indicating that inflationary pressures may pose challenges to bank stability and reduce fintech investments. Meanwhile, GDP shows limited correlation with other variables, suggesting that bank stability and fintech development may be somewhat insulated from economic growth fluctuations.

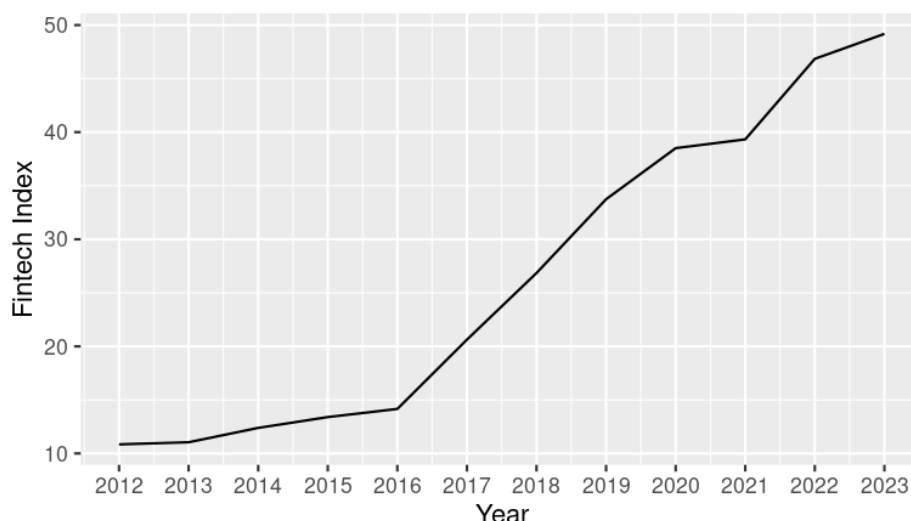
These findings provide preliminary insights into the complex interplay between fintech development, bank stability, and control variables, underscoring the relevance of fintech in

shaping the stability and liquidity dynamics of banks. Further analysis is warranted to determine the causality and strength of these relationships in a regression context.

4.2 Fintech development in in Vietnam

Based on the Fintech Index for Vietnam that we calculated, it reveals a steady upward trend from 2012 to 2023, highlighting the country's increasing adoption and development of financial technologies (see **Figure 1**).

Figure 1. Time series of FinTech Index



Source: compiled by author.

Between 2012 and 2016, the Fintech Index in Vietnam remained relatively low and stable, around a value of 10. This slow growth suggests that fintech development was limited, possibly due to it was the beginning of fintech application in Vietnam with regulatory barriers, low technology adoption, and a lack of digital infrastructure. During this period, the financial sector in Vietnam may not have fully recognized the potential of fintech, resulting in a slow uptake of digital financial solutions.

A significant shift began in 2017, with the Fintech Index showing rapid growth through to 2021. This surge likely reflects increased support from regulations, technological advancements, and changing consumer preferences. Around this time, the Vietnamese government introduced fintech-friendly policies, particularly for digital payments, which spurred innovation and investment in the sector. Additionally, the rise in smartphone use and better internet access created a strong base for digital banking, mobile payments, and other fintech services. This period also saw a boost in venture capital, helping local fintech startups expand the range of digital financial services available. With ongoing urbanization and a growing young, tech-savvy population, consumers increasingly turned to digital options for financial services, further accelerating fintech adoption.

From 2021 to 2023, the Fintech Index continued to grow but at a slower pace, suggesting a period of consolidation and sustained but slower growth. This phase may reflect a maturing fintech market, where established companies solidify their positions and new technologies are integrated more gradually. The COVID-19 pandemic likely contributed to this steady demand, as it shifted consumer preferences toward digital and contactless services. During this time, the government also adjusted its policies to support steady growth in the sector. Fintech in Vietnam diversified beyond just payments and banking, expanding into areas like insurance technology, wealth management, and blockchain, which contributed to the continued, though slower, growth of the Fintech Index.

Overall, this trend underscores Vietnam's journey towards a digital economy, with fintech driving improvements in financial inclusion, accessibility, and efficiency. The rapid adoption of fintech in Vietnam aligns with the country's broader economic and technological growth, supported by consumer demand and forward-looking regulatory support.

4.3 Results of baseline model

Table 5. The impacts of fintech development on bank stability – linear relationship

	ZEQTA	
	(1)	(2)
FTI	0.015*** (0.003)	0.015** (0.006)
SIZE		-0.079 (0.178)
CAP		-0.01 (0.019)
LDR		0.002 (0.004)
GDP		0.017 (0.019)
INF		-0.025 (0.02)
Bank fixed effect	YES	YES
Year fixed effect	YES	YES
Observations	324	324
Adjusted R2	0.0262	0.0227

Source: compiled by author. Note: ***, ** and * represent 1%, 5% and 10% significance levels, respectively. To address the potential issue of heteroskedasticity and autocorrelation, Newey-West standard error is estimated (Newey & West, 1987).

The regression results in **Table 5** examine the linear impact of fintech development on the stability of Vietnamese banks, as measured by ZEQTa. Specifically, column (1) reports the results of the two-way fixed effect regression model without any control variables and in columns (2), we include bank characteristic variables and macroeconomic variables as control variables. The result of column (2) shows that when FTI increases by 1 standard deviation, ZEQTa will increase by $0.015 * 13.69/3.52 = 5.83\%$ points (0.015 is coefficients on FTI, 13.69 is the standard deviations of FTI, and 3.52 is the mean of ZEQTa). The result is consistent in the model with and without control variable and suggests a consistent positive relationship between fintech development and bank stability, providing support for Hypothesis H1b. In other words, based on the result of baseline model, we accept the hypothesis H1b which posits a positive association between fintech adoption and stability and reject hypothesis H1a. This finding implies that as Vietnamese banks increase their fintech adoption, they experience improvements in stability, likely driven by efficiencies gained through technological innovation, enhanced service delivery, or risk diversification. The positive relationship between FTI and ZEQTa underscores the potential of fintech to contribute to a more resilient banking sector, where the operational benefits of fintech appear to outweigh any inherent technological risks. This result aligns with the finding of Cizel et al. (2019), Fuster et al. (2019), Tang (2019), Daud et al. (2022), and Liem et al. (2022).

Among the control variables, the coefficients for Bank Size (SIZE) and Capital Ratio (CAP) are negative but not statistically significant, suggesting no clear linear impact of these characteristics on bank stability in this sample. Similarly, the Loan-to-Deposit Ratio (LDR) and GDP growth (GDP) display positive but insignificant coefficients, indicating limited influence on stability. Inflation (INF) has a negative yet insignificant effect on bank stability, which may imply that inflationary pressures could detract from stability, though the effect is not statistically strong in this model. The low adjusted R^2 values (0.0262 and 0.0227 for Models 1 and 2, respectively) indicate that while fintech development is significantly associated with bank stability, the overall explanatory power of the model is limited. This suggests that additional, unobserved factors could also play important roles in determining bank stability in Vietnam beyond the variables included in this analysis.

Table 6. The impacts of fintech development on bank stability – non-linear relationship

	ZEQTA	
	(1)	(2)
FTI	0.075***	0.081***
	(0.016)	(0.019)
FTI²	-0.001***	-0.001***
	(0.0003)	(0.0003)
SIZE		-0.063
		(0.179)
CAP		0.007
		(0.019)
LDR		-0.0002
		(0.003)
GDP		0.024
		(0.019)
INF		-0.003
		(0.021)
Bank fixed effect	YES	YES
Year fixed effect	YES	YES
Observations	324	324
Adjusted R2	0.077	0.067

Source: compiled by author. Note: ***, ** and * represent 1%, 5% and 10% significance levels, respectively. To address the potential issue of heteroskedasticity and autocorrelation, Newey-West standard error is estimated (Newey & West, 1987).

The regression results in **Table 6** examine the non-linear impact of fintech development on the stability of Vietnamese banks. The inclusion of both the Fintech Index (FTI) and its squared term (FTI²) allows for the exploration of a potential U-shaped relationship, as hypothesized in H2. In both models, the coefficient for FTI is positive and statistically significant at the 1% level, with values of 0.075 in column (1) and 0.081 in column (2). That mean, at the lower levels of fintech development, when FTI increases by 1 standard deviation, stability of bank will increase by 29,16% (0.075* 13.69/3.52) points. This positive coefficient suggests that at lower levels of fintech adoption, an increase in fintech development is associated with improved bank stability, likely due to efficiency gains, enhanced risk management, and increased financial accessibility enabled by technological innovations.

Conversely, the coefficient for FTI² is negative and also highly significant at the 1% level in both models (-0.001), indicating that, with high level of fintech development, when FTI increases by 1 standard deviation, stability of bank will decrease by 0.39% (-0.001* 13.69/3.52) points. In other words, it indicates a diminishing and eventually negative effect of high levels

of fintech development on bank stability. This finding supports Hypothesis H2, which posits a inverted U-shaped impact of fintech on bank stability. Specifically, while moderate levels of fintech adoption appear to enhance stability, excessive fintech development could introduce destabilizing effects, possibly due to increased operational complexity, heightened competition, or emerging technological risks that may undermine traditional risk management practices. The findings align with research of Lv et al. (2022), Wang et al. (2021), and Nguyen et al. (2022). In the early stages of FinTech development, FinTech companies have yet to establish a strong position in the financial market, allowing banks to benefit from reduced operational costs and improved service quality through the adoption of digital services. As the FinTech sector grows and takes on more intermediary services traditionally reserved for commercial banks, these banks may start losing customers to the competition and may need to increase their risk-taking to maintain their revenue. The growth in the number of FinTech companies and FinTech transactions reveals an inverted U-shaped relationship with the level of bank stability or risk-taking. This means that in the initial stages, FinTech development enhances operational efficiency, thereby reducing banks' incentives to take on high risks to sustain profits.

Among the control variables, none are statistically significant, indicating that other bank-specific factors, such as size, capital ratio, loan-to-deposit ratio, GDP growth, and inflation, do not exhibit a strong linear or non-linear relationship with bank stability in this model. The adjusted R² values for models 1 and 2 (0.077 and 0.067, respectively) show moderate improvement compared to the linear models in Table 6, suggesting that the inclusion of a non-linear specification provides a better fit for understanding the impact of fintech on stability.

4.4 Heterogeneity analysis

According to previous studies, the application of financial technologies by banks may have different effects on liquidity creation for banks with various characteristics. To further investigate this heterogeneity, we create a dummy variable based on bank asset size (*S_dummy*) and conduct a comprehensive heterogeneity analysis.

$$LC_{it} = \alpha + \beta_1 FTI_{it} + \beta_2 FTI_{it} * S_dummy_{it} + S_dummy_{it} + \gamma Controls_t + FirmFE + Year FE + \varepsilon_{it}$$

The size dummy variable is set to one for banks whose total asset is greater than or equal to the mean, and zero for the rest. As shown in the equation below, these three sets of dummy variables were introduced into the model as interaction terms with bank fintech. The corresponding regression results are displayed in **Table 7**.

Table 7. Heterogeneity analysis

	ZEQTA
FTI	0.112*** (0.026)
FTI²	-0.002*** (0.000)
S_dummy	0.819** (0.396)
FTI*S_dummy	-0.080** (0.033)
FTI²*S_dummy	0.001** (0.001)
Control variables	YES
Bank fixed effect	YES
Year fixed effect	YES
Observations	324
Adjusted R2	0.078

Source: compiled by author. Note: ***, ** and * represent 1%, 5% and 10% significance levels, respectively. To address the potential issue of heteroskedasticity and autocorrelation, Newey-West standard error is estimated (Newey & West, 1987).

The heterogeneity analysis in **Table 7** investigates how the impact of fintech development on bank stability varies with bank size. The results show a significant positive coefficient for FTI (0.112), indicating that fintech development generally has a positive effect on bank stability. This suggests that, in general, fintech adoption supports stability in Vietnamese banks by improving their operational efficiency and potentially enhancing risk management. However, the squared term for FTI (FTI²) has a negative coefficient (-0.002), which is also significant. This finding aligns with the results of baseline model, suggests a nonlinear, inverted U-shaped relationship, where moderate levels of fintech adoption boost stability, but excessive fintech development introduces risks that could destabilize banks. In other words, while fintech offers initial benefits, too much reliance on it might expose banks to new vulnerabilities.

The size dummy variable, S_dummy, is positive and significant (0.819), indicating that larger banks experience greater stability benefits from fintech compared to smaller banks. However, the interaction term FTI*S_dummy is negative (-0.080) and significant, suggesting that as fintech adoption increases, the positive impact on stability becomes less pronounced for larger banks. This could mean that while larger banks benefit from fintech at moderate levels, they might face diminishing returns at higher levels of adoption.

Additionally, the interaction between the squared fintech term and the size dummy ($FTI^2 \times S_dummy$) is positive (0.001) and significant. This result reinforces the inverted U-shaped relationship, showing that for larger banks, excessive fintech adoption may initially reduce stability but eventually leads to a stabilizing effect. This pattern may reflect larger banks' ability to manage and adapt to high levels of fintech adoption more effectively than smaller banks.

Overall, these findings highlight the complexity of fintech's impact on bank stability. Moderate fintech adoption generally supports stability, particularly for larger banks, but extensive fintech adoption can introduce new challenges that require careful management, especially for banks with greater resources and market presence.

Chapter 5. Robustness test

In this part, we employ GMM model to address endogeneity concerns and use the alternative measure of bank stability and to conduct robustness tests. Additional models will be implemented in this stage to enhance the validity and reliability of the baseline regression results by undertaking robustness tests from several different perspectives.

5.1 Addressing endogeneity concerns

To reduce potential endogeneity problems, a system GMM approach (Blundell and Bond, 1998) is used in the thesis (see **Table 8**). On the one hand, the system GMM approach can eliminate the strict exogenous assumptions of the regressions, unobserved bank-specific effects, and path-dependence in the sequence of control-dependent variables. On the other hand, since bank risk may persist overtime, the system GMM allows for the dynamic modeling of bank risk. Considering that bank risk has dynamic continuation effects, the current risk-taking level maybe influenced by the risk level from the previous period. Therefore, one-period lagged explanatory variables, $ZEQTA_{t-1}$, are introduced in the paper to construct a dynamic panel model, and the GMM estimation method is used to test the baseline results.

Table 8. Addressing endogeneity concerns - GMM estimator

	ZEQTA	
	(1)	(2)
ZEQTA_{t-1}	0.388*** (0.100)	0.492*** (0.066)
FTI	0.006* (0.004)	0.045** (0.022)
FTI²		-0.001* (0.0004)
SIZE	0.069*** (0.012)	0.045*** (0.010)
CAP	0.008 (0.015)	0.008 (0.009)
LDR	-0.003 (0.003)	-0.003 (0.003)
GDP	0.016 (0.017)	0.019 (0.019)
INF	-0.048 (0.031)	-0.038 (0.025)
Bank fixed effect	YES	YES
Year fixed effect	YES	YES
Observations	324	324
Sargan test	0.831	0.989
AR(2)	0.031	0.057

Source: compiled by author. Note: ***, ** and * represent 1%, 5% and 10% significance levels, respectively. Column (1) is the GMM model result for the linear relationship and column (2) is the GMM model result for the non-linear relationship.

The results in **Table 8** show that the lagged dependent variable $ZEQTA_{t-1}$ is positive and highly significant in both models, with coefficients of 0.388 and 0.492, respectively. This suggests that bank stability shows a strong persistence over time, meaning that a bank's stability in the current period is influenced by its stability in the previous period. This finding highlights the dynamic nature of bank stability, where past conditions continue to play an important role in the present.

The fintech index (FTI) shows a positive and statistically significant impact on stability in both models, with a positive coefficient at the 10% significance level in one column and at the 5% significance level in the other. This suggests that fintech adoption generally supports bank stability, enhancing the resilience of Vietnamese banks as they integrate more technology into their operations. However, the squared fintech term (FTI²) in Model 2 is negative and

significant (-0.001), indicating a nonlinear, inverted U-shaped relationship. This implies that while moderate levels of fintech adoption strengthen stability, high levels may introduce risks that could eventually reduce it. These findings align with the baseline model's results, affirming its robustness.

Among the control variables, SIZE (bank size) shows a positive and significant impact on stability in both models, indicating that larger banks tend to be more stable. This may reflect the advantages larger banks have in terms of resources and economies of scale, which can support their overall resilience. Other control variables, including CAP (capital ratio), LDR (loan-to-deposit ratio), GDP (economic growth), and INF (inflation), are not statistically significant, suggesting that these factors have less of a direct influence on bank stability within this particular model.

The diagnostic tests validate the model's reliability. The Sargan test p-values of 0.831 and 0.989 confirm that the instruments used in the GMM estimation are valid, with no overidentification problems. Additionally, the AR(2) p-values (0.031 and 0.057) indicate no evidence of second-order autocorrelation, further supporting the model's accuracy.

In summary, the GMM analysis reinforces the idea that fintech development has a complex relationship with bank stability. While moderate fintech adoption improves stability, excessive reliance on fintech may introduce risks. The findings also suggest that larger banks are generally more stable, benefiting more from moderate fintech adoption. These insights are essential for bank managers and policymakers, highlighting the need for a balanced approach to fintech integration in the banking sector.

5.2 Alternative measure of bank stability

In this section, an alternative measure of bank stability is also employed in this study. The loan loss coverage ratio (LLC) is calculated as the ratio of loan loss provisions to non-performing loans (Caporale et al., 2015; Ozili & Outa, 2017). A higher LLC provides greater protection against loan losses, contributing to improved banking stability, whereas a lower LLC may indicate insufficient protection (Ozili & Outa, 2017). It should be noted that a low coverage ratio does not necessarily imply under-provisioning risk, as it may also reflect rigorous lending practices or a strong insolvency framework that facilitates easy collateral repossession for creditors (Mesnard et al., 2016).

$$LLC = \frac{\text{Loan loss provisions}}{\text{Non - performing loans}}$$

In **Table 9**, the results align with the results obtained from the baseline regression. FTI shows a positive and significant effect across all models (the result of two-way fixed effect models are in columns (1) and (2), and column is GMM model's result). This suggests that increased fintech adoption generally enhances stability in Vietnamese banks. However, the squared term, FTI², is negative and significant in all models, indicating an inverted U-shaped relationship. This implies that while moderate fintech adoption strengthens stability, excessive fintech integration may introduce risks that reduce stability. In essence, fintech's impact on bank stability is positive up to a certain point, beyond which further adoption could potentially weaken stability.

Table 9. Robustness tests – Alternative measures of bank stability

	LLC		
	(1)	(2)	(3)
LLC t_{-1}			0.888*** (0.028)
FTI	0.030*** (0.008)	0.022** (0.009)	0.017** (0.008)
FTI²	-0.0003** (0.0001)	-0.0003** (0.0001)	-0.0004** (0.0001)
SIZE		0.186** (0.088)	0.011*** (0.004)
CAP		0.026*** (0.008)	-0.003 (0.003)
LDR		-0.003 (0.002)	-0.001 (0.001)
GDP		-0.013 (0.013)	-0.035*** (0.012)
INF		-0.021** (0.011)	-0.029*** (0.011)
Bank fixed effect	YES	YES	YES
Year fixed effect	YES	YES	YES
Observations	324	324	324
Adjusted R²	0.095	0.126	
Sargan test			0.910
AR(2)			0.585

Source: compiled by author. Note: ***, ** and * represent 1%, 5% and 10% significance levels, respectively. To address the potential issue of heteroskedasticity and autocorrelation, Newey-West standard error is estimated (Newey & West, 1987).

Chapter 6. Discussion

The findings of this study reveal that fintech development has a generally positive impact on the stability of commercial banks in Vietnam. However, the results also highlight a nonlinear, inverted U-shaped relationship between fintech development and bank stability. This suggests that while moderate levels of fintech adoption enhance stability, excessive adoption can introduce risks that potentially undermine stability. Additionally, the heterogeneity analysis shows that this relationship varies among banks of different sizes, though the variation is not strong or consistent across regression models, indicating only a subtle difference based on bank size.

The positive impact of fintech on bank stability aligns with previous studies that suggest fintech can enhance operational efficiency and risk management. Fintech can help banks expand their customer base by providing convenient and accessible online financial applications and services. From the perspective of lending activities – the primary source of revenue for Vietnamese banks, the application of fintech in their operations has helped commercial banks expand customers and increase credit (Wu et al., 2024). Moreover, the growth of digital payments, online lending and mobile internet have improved financial inclusion in the community by enabling firms to provide highly accessible services to their customers (L. Chen, 2016; Maskara et al., 2021). This helps banks attract more customers, including small and medium-sized businesses that were previously overlooked due to lack of cash flow and collateral. Fuster et al. (2019) found that fintech platforms improve the efficiency of lending processes, allowing banks to process loans faster and adapt more flexibly to shifts in demand. In Vietnam, the rapid adoption of digital payment solutions, mobile banking, and automated lending processes has enabled banks to improve their service delivery and manage operations more effectively. By reducing costs and increasing accessibility, these fintech-driven efficiencies have likely contributed to the overall stability observed in Vietnamese banks. In addition, with the use of modern financial technologies, banks can minimize information asymmetry (Wu et al., 2024), or in other words, narrow the information and knowledge gap between banks and customers. By using technology such as artificial intelligence and big data, banks can analyze customer data more accurately and make credit decisions more effectively (Hung et al., 2020). This helps banks better meet customer needs, create new products, and attract more users to their services. From the perspective of payment services, the development of fintech not only enables banks to adopt new technologies to develop new payment products and upgrade existing ones, but also creates opportunities to collaborate with fintech companies

that provide e-wallet services. This collaboration expands the customer base, increases profits, and enhances stability.

However, the inverted U-shaped relationship, where fintech's positive impact on stability decreases at high levels of adoption, aligns with findings from Lv et al. (2022) and Wang et al. (2021). These studies show that while moderate fintech adoption can strengthen stability, too much reliance on fintech can bring added complexities and risks. In the early stages of fintech development, fintech firms do not yet dominate the financial market, allowing banks to enjoy lower costs and better service quality through digital solutions. However, as fintech companies grow and start providing services traditionally handled by banks, banks may lose customers to this new competition and feel pressured to take on more risks to maintain their income. In other words, in Vietnam, as fintech use expands, banks are exposed to new challenges like operational and cybersecurity risks, as well as increased competition from fintech companies offering similar services at lower prices. Integrating too much fintech without strong risk controls can lead to problems such as data breaches or system failures, which could weaken stability. This rapid adoption can also stretch banks' risk management systems, especially for smaller banks that might not have the resources to manage these risks effectively.

The study's heterogeneity analysis indicates that the impact of fintech on stability is not uniform across banks of different sizes. Larger banks, with more substantial resources, may be better positioned to implement fintech solutions safely and efficiently, benefiting more from moderate levels of fintech integration. This finding is supported by (Nguyen et al., 2022), who argue that competitive pressures from fintech firms push banks to adopt new technologies and strategies to maintain market share. In Vietnam, larger banks have the infrastructure and capital to adopt fintech innovations effectively, which likely contributes to their stability. Conversely, smaller banks may find it challenging to manage the risks associated with high levels of fintech integration, leading to a more volatile impact on their stability.

In conclusion, the positive impact of fintech on bank stability in Vietnam is clear at moderate levels of adoption. However, an inverted U-shaped relationship suggests that caution is needed with high levels of fintech integration to avoid stability risks. The findings indicate that banks, especially smaller ones, should be mindful of the risks that come with extensive fintech adoption and prioritize building robust risk management frameworks. The relatively minor heterogeneity based on bank size suggests that fintech's role in enhancing stability may be a broad trend across the sector, reflecting both consumer demand for digital services and Vietnam's policy support for fintech-driven banking.

Chapter 7. Conclusion

In the past decade, the rise of the FinTech industry and increasing use of its applications in the banking sector have played a prominent role in financial markets and drawn academic attention to this area. Nevertheless, the recent literature has focused on the external impact of the FinTech industry on the banking sector or the relationship between banks' FinTech development and their performance (credit risk and failure risk) and, specifically, on banks in Vietnam. Thus, the effect of FinTech development on stability of the Vietnamese banking sector are unexplored in the existing empirical literature.

To address this gap in the literature, we use data on a sample of the 27 commercial banks in Vietnam using a yearly frequency period from 2012 to 2023. Further, we utilize the data from Google Trends to construct a new fintech index specifically tailored for the Vietnamese banking industry. Our index indicates a notable increase in fintech development within the Vietnamese banking sector during the sample period.

Our empirical findings consistently support our hypotheses, providing convincing evidence that there is a significant U-shaped relationship between fintech development and bank stability within the Vietnamese banking sector. At moderate levels, fintech adoption appears to support bank stability, but excessive fintech expansion may introduce risks that counteract these benefits.

The findings of this study provide valuable insights for bank managers, investors, and regulators as they navigate the growing influence of fintech on the banking sector. For bank managers, the results underscore the importance of adopting fintech not only as a tool to stay competitive but also as a strategic response to the evolving financial landscape. Managers should consider expanding technology investments, focusing on robust information security measures, and enhancing risk management frameworks when integrating technology into their operations. Developing collaboration plans with fintech companies can also help banks broaden their product and service offerings. Additionally, investing in a tech-savvy workforce is crucial, as skilled employees are essential for effectively adopting advanced technologies, boosting productivity, and supporting bank stability. For regulators, the study highlights the need to strengthen the legal and regulatory framework to support the sustainable growth of fintech. The current regulatory environment in Vietnam still faces challenges that could hinder the development of a robust fintech ecosystem. Policies should be directed toward building a strong foundation for fintech investments, ensuring a secure and reliable infrastructure, and promoting data sharing among key stakeholders. Additionally, regulatory initiatives should include

programs focused on financial education, with diverse approaches tailored for different groups, including schools and families, to raise awareness and promote responsible use of digital financial services. For investors, this study suggests that fintech development generally signals greater bank stability, up to a certain level of adoption. Fintech investments can enhance a bank's competitive edge and market position; however, investors should remain cautious about the risks associated with excessive reliance on technology. By monitoring banks' levels of fintech adoption and their risk management practices, investors can make more informed decisions regarding a bank's long-term stability and growth potential.

Nevertheless, our study acknowledges several limitations. One limitation of this study is the construction of the fintech index, which is based on Google Trends data. Although this approach is creative, it may not capture all aspects of fintech adoption. Important details, such as the depth of fintech integration, the level of customer engagement, or the sophistication of fintech solutions within each bank, might not be fully reflected in this index. Another limitation is the study's timeframe, as fintech is a rapidly changing field. This timeframe may not capture the long-term effects of fintech on bank stability, and recent advancements in fintech since 2023 could change or expand the relationships observed. While the study addresses potential endogeneity by using the GMM model, there may still be factors affecting both fintech adoption and bank stability that are not fully accounted for. Additionally, the observed inverted U-shaped relationship could be shaped by other external influences, such as changes in regulations or competition from non-bank financial services, that are not included in the model. Finally, the study's heterogeneity analysis is limited to bank size and does not consider other possible differences, such as whether a bank is state-owned or private, or its main focus (retail vs. corporate banking). These factors could also play a role in how fintech affects stability.

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