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The effect of competition and industrial concentration on banking stability: The case of Vietnam

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ABSTRACT

This study examines the impact of industry concentration and competition on the stability of the Vietnamese banking system, which has undergone significant restructuring in recent years. Using Bayesian regression analysis on data from 27 commercial banks between 2011 and 2021, the study measures banking stability through the Z-score and the ratio of non-performing loans (NPLs), while industry concentration and competition are assessed via the Herfindahl-Hirschman Index (HHI) and the Lerner Index, respectively. The findings reveal that industry concentration has a limited effect on banking stability, whereas competition plays a crucial role in strengthening financial resilience. Banks with higher market power, as reflected by the Lerner Index, exhibit greater stability, with a 100% probability of improving financial soundness. Additionally, a higher equity-to-assets ratio significantly enhances bank stability by reducing financial risk, while income diversification helps lower NPL ratios. The study also finds that macroeconomic factors such as credit growth, inflation, and the COVID-19 pandemic have mixed effects on banking stability. These findings emphasize the need for policymakers to prioritize enhancing banking competitiveness rather than solely focusing on industry concentration. Regulatory measures should promote non-interest income activities, facilitate digital banking development, and strengthen capital adequacy in line with Basel II and Basel III standards. Ensuring financial resilience through strategic consolidation and effective risk management is essential for the long-term stability and sustainable development of Vietnam's banking sector.

Contribution/Originality: The research paper has explored that industry concentration has a limited effect, while macroeconomic factors such as credit growth, inflation, and the COVID-19 pandemic have mixed effects on the stability of the Vietnamese banking system.

1. INTRODUCTION

Financial instability has become a top concern for policymakers and researchers worldwide in recent decades. Since the 2008 global financial crisis, developed and developing countries have implemented drastic reforms to their financial systems, focusing on the banking sector. A competitive and unpredictable environment has resulted in

significant structural and regulatory changes for banking operations. In many nations, including Vietnam, weak bank mergers and acquisitions have become commonplace; as a result, the number of banks has fallen while assets have expanded significantly to strengthen the banking sector's stability.

The idea behind this process emphasized the importance of banking centralization, which improves the financial strength of the banks, thereby making the financial system more stable. Larger credit institutions are better able to collect data, monitor and screen borrowers, and create lasting relationships between borrowers and lenders, which helps to mitigate the issues of moral hazard and adverse selection. Centralization of the banking industry could also prevent excessive competition from causing financial instability. The entry of new competitors could lead to a decrease in the market share of financial institutions and, therefore, lower profits. Coped with this situation, banks could increase risk assets to cover losses (Allen & Gale, 2004). In addition, banks with large assets could be more resilient to shocks, and thus the whole financial system would become sounder. However, many researchers opposed this idea. According to Stigler (2010) the banking industry concentration is a manifestation of oligopoly. Under these assumptions, a monopoly in the banking sector is not conducive to financial development. Guzman (2000) pointed out that banks with monopolistic power are prone to over-lending in the belief that they are "too big to fail". These behaviors could raise the issue of moral hazard and, thus, reduce the soundness of the banking system.

Despite the considerable number of studies conducted on this topic, the findings reveal inconsistencies across different research efforts. These discrepancies can often be attributed to variations in methodologies and the scope of the studies. Furthermore, at present, there exists a lack of comprehensive evaluations regarding banking concentration and stability in the context of Vietnam. Consequently, this study intends to establish a robust foundation for recommending strategies aimed at enhancing the stability of the Vietnamese banking system.

The banking system is vital in Vietnam and the driving force behind economic development. According to World Bank data, Vietnam's private sector credit in 2020 was up to 137.9% of Gross Domestic Product (GDP); this figure for countries with the same level of development as Indonesia is 38.7%; the Philippines 51.9%; and India 55.3%. This confirms that the stability of the Vietnamese banking system plays a crucial role in the growth of the Vietnamese economy. Vietnam's economy experienced a period of explosive growth, especially in 2006-2007; the wave of new bank establishments and the transformation of rural banks into urban banks resulted in the number of banks experiencing significant growth during this period. However, despite the high growth in the number and size of banks, weak financial and governance capacity caused problems in the financial market, especially in 2011-2012. To address this situation, the central bank of Vietnam has restructured the banking system, intending to reduce the number of banks and increase the competitiveness of domestic banks. This study was conducted to assess the impact of industry concentration and commercial banks' competitiveness on the stability of the banking system.

2. LITERATURE REVIEW AND RESEARCH HYPOTHESES

Many theories give different forecasts regarding the relationship between industry concentration, bank competition and bank stability, one of which is the Market Power Theory. According to the OECD (2002) market power theory refers to a firm (or group of firms) that is not subject to significant competitive pressure and thus could maintain high prices, reduce quality or output, and still make a profit. There are two opposing approaches when it comes to the theory of market power: the structure-conduct-performance (SCP) theory and the relative market power theory (RMP) (Chortareas, Garza-Garcia, & Girardone, 2011).

The SCP theory was developed by Bain (1951) which determines the correlation between industry structure and firm performance. Although organizations try to stand apart from competitors, the industry structure ultimately determines whether they would be profitable. According to this hypothesis, a market with an excessive number of enterprises would have less competition since firms would be incentivized to work together to manipulate the market (Chortareas et al., 2011). Mishkin (1999) states that banks in a highly concentrated market often receive the public's trust, which could lead to moral hazard problems because banks tend to increase risk-

taking to maximize profit. Caminal and Matutes (2002) argued that banks tend to exercise lower credit rationing and expand lending in less competitive markets, which could lead to a fall in bank failures. According to Van de Schoot (2012) a significant degree of industry concentration would enable banks to manipulate the market by enforcing low deposit rates and high lending rates. Rising interest rates would negatively affect borrowers, increasing default rates and leading to a crisis (Goodhart, Tsomocos, & Vardoulakis, 2009). Ijtsma, Spierdijk, and Shaffer (2017) with data from 1051 banks in 25 EU countries for the period 1998-2014, confirmed that banking concentration hurts the bank stability coefficient both at the bank individually and nationally.

Berger (1995) and Saif-Alyousfi, Saha, and Md-Rus (2020) used data from 70 banks listed on the stock exchanges of Gulf Cooperation Council (GCC) countries for the period 1998-2016 to assess the degree of industry concentration and competition in the risk of the GCC regional banking system. Research results show that the higher the concentration of the industry measured by the HHI, the more fragile the banking system would be, that is, less stable; (ii) The higher the market power measured through the Lerner index, the better the banking system's stability. Goetz (2018) uses data from 8412 commercial banks in the United States in the period 1978-2006 to evaluate the relationship between competition and banking stability, concluding that competition would strengthen the soundness of banks.

However, other studies refuted this hypothesis through the relative-market-power (RMP) hypothesis. This hypothesis states that the larger the bank, the more monopolistic it becomes and the more profitable it is in the market. Individual banks have seen higher returns thanks to their large market shares and diverse income (Berger, 1995). Income diversification also lowers banks' risk. Berger (1995) argued that market concentration is a highly efficient process, representing the stages in which firms expand their market share and increase in size; their ability to generate higher profits leads to higher market concentration. Larger banks could improve their ability to collect information and screen and monitor borrowers, thereby reducing bad debt. Large banks could also provide various services that establish long-term connections between borrowers and lenders, minimizing issues with moral hazard and adverse selection. Through a dynamic model of imperfect competition, Matutes and Vives (2000) find evidence that higher market power reduces the probability of bank default.

The literature review indicates significant contradictions regarding the relationship between the level of competition, industry concentration, and bank stability, both in theoretical frameworks and practical applications. At present, there is a notable lack of comprehensive studies that explore the impact of industry concentration and competition on banking stability in Vietnam. Given that Vietnam is a developing nation with a financial system that heavily depends on its banking sector, the stability of this system is vital for ensuring the overall stability of the macroeconomy. Consequently, it is imperative to conduct research on how industry concentration and competition influence the stability of commercial banks in Vietnam. This research is particularly relevant in light of the significant restructuring currently taking place within the country's banking system.

3. HYPOTHESIS AND RESEARCH MODEL

From the literature review, it can be seen that the impact of competition on stability is still controversial; Goetz (2018) showed that competition would help improve bank stability, in contrast to Leroy and Lucotte (2017) and Saif-Alyousfi et al. (2020) argued that competition would increase risks to the banking system. Therefore, to assess the impact of banking competition on financial stability, the author would test two opposing hypotheses as follows:

Hypothesis 1: Competition increases bank stability.

Hypothesis 2: Competition reduces bank stability.

Although most recent empirical studies show that banking concentration reduces the stability of the banking system (Ijtsma et al., 2017; Saif-Alyousfi et al., 2020) however Berger (1995) argued that banking concentration would create strong banks, which would create favorable conditions for information collection, loan monitoring, non-performing debt reduction, and improve the stability of these banks. Moreover, these banks also hold an

essential position in the banking system, so the stability of these banks would support the national financial system's soundness. Thus, similar to the competitive factor, to assess the impact of industry concentration on banking stability, the authors would test the following two opposing hypotheses:

Hypothesis 3: Industry concentration improves banking stability.

Hypothesis 4: Industry concentration undermines banking stability.

To measure the stability of commercial banks, according to Jiménez, Lopez, and Saurina (2013) and Ha, Nguyen, Ta, and Nguyen (2021) the authors utilized Z-scores and non-performing loans to assess bank stability. The Z-score is determined by the formula.

$$Z - score_t = \frac{ROA_t + \frac{E}{A_t}}{\sigma(ROA)_t} \quad (1)$$

Where $Z - score_t$: Z-score year t.

ROA_t: Return on assets of banks in year t.

$\sigma(ROA)_t$: The standard deviation of Return on Assets (ROA) of banks from 2011-2021.

$\frac{E}{A_t}$: The ratio of equity to total assets of the bank in year t.

This formula reflects the volatility of income relative to the average equity on total assets of the bank; it represents the bank's risk tolerance. The larger the Z-score, the more stable the bank.

To measure market concentration, the authors used the Herfindahl-Hirschman Index (HHI), a popular measure of industry concentration. This index is determined through the formula.

$$HHI = \sum_{i=1}^{n} S_i^2 \quad (2)$$

Where S_i: Market share of bank i.

n: Number of banks in the system.

To measure the level of competition among banks, the author uses the Lerner index, which is also referenced in the study of Leroy and Lucotte (2017) and Saif-Alyousfi et al. (2020). The Lerner index is calculated using the formula.

$$\text{Lener} = \frac{P - MC}{P} \quad (3)$$

Where P: Output price is estimated as total revenue over total assets.

MC: Marginal costs of banks.

The bank's marginal cost MC, is not directly measurable, so Berger (1995) and Assefa, Hermes, and Meesters (2013) proposed measuring this variable indirectly through two steps.

Step 1: Estimate the total cost equation.

$$\text{LnTC} = \beta_0 + \beta_1 \text{lnQ} + \frac{1}{2}\beta_2 \text{lnQ}^2 + \sum_{i=1}^{3} \gamma_i \text{lnW}_i + \sum_{i=1}^{3} \phi_i (\text{lnQlnW}_i) + \sum_{i=1}^{3} \text{lnW}_i \sum_{j=1}^{3} \text{lnW}_j + \frac{1}{2}\sum_{i=1}^{3} \lambda_i (\text{lnW}_i)^2 + \varepsilon \quad (4)$$

Where

TC: Total cost.

Q: Total assets.

W1: Cost of deposit (Total interest expense/total deposit).

W2: Cost of physical assets (Non-interest expenses/total fixed assets).

W3: Labor price (Wage cost/total assets).

Step 2: Marginal cost (MC) is determined by taking the first derivative of the total cost equation

$$\text{MC} = \frac{\text{TC}}{\text{Q}} (\beta_1 + \beta_2 \text{lnQ} + \sum_{i=1}^{3} \phi_i \text{lnW}_i \quad (5)$$

After estimating MC, the author will substitute this value into Equation 5 to calculate the Lerner index. The lower this value, the less market power each bank has, which indicates a higher level of competition in the market, and vice versa.

In addition to analyzing the impact of competition and concentration on the stability of the banking system, the authors also considered the influence of internal factors on bank stability, specifically.

Hypothesis 5: The equity-to-asset ratio improved the stability of the banking system.

Anginer, Demirguc-Kunt, and Zhu (2014) asserted that the increase in the equity ratio of commercial banks improves the bank's resistance to income shocks and ensures the financial capacity for banks to respond to income shocks, withdrawal needs and other agreements with customers. Mehran and Thakor (2011) and Allen and Gale (2004) also showed that the high equity ratio helps banks better withstand shocks.

Hypothesis 6: Diversification reduces the bank's risk.

Odesanmi and Wolfe (2007) stated that expanding activities that generate non-interest income, such as payment services, card services, and bancassurance through banking channels, would support banks in making the most of their infrastructure and human resources, thereby helping to reduce operating costs despite reduced revenue. Additionally, developing non-interest services would allow banks to disperse and mitigate risks associated with credit.

Hypothesis 7: Credit growth reduces the stability of banks.

Adrian and Shin (2014) commented that when commercial banks expand their credit policies, they tend to lower their borrowing standards, leading to a sharp increase in the risk of non-performing debt. In addition, banks simultaneously expand lending, which often occurs during periods of central bank easing monetary policy in response to an economic downturn; this solution could boost economic growth. However, the expansion of credit policy could accumulate potential risks, causing asset bubbles and leading to an increase in the risk of non-performing debts for banks; consequently, the stability of the banking system is eroded (Bernanke & Gertler, 1986).

Besides the internal factors of the bank, the author also considers the impact of macroeconomic factors on the bank's stability, such as the policy interest rate, economic growth, and inflation.

Hypothesis 8: Low policy interest rate increases the risk to the banking system.

Mishkin (1999) claimed that the central bank loosens the money; commercial banks would be the main transmission channel for this cash flow through credit activities. To release the absorbed capital, they may reduce credit standards, leading to a decrease in loan quality, thus increasing the risk of non-performing loans and eroding commercial banks' financial soundness.

Hypothesis 9: Economic growth improves bank stability.

Hypothesis 10: Inflation reduces bank stability.

According to Kjosevski, Petkovski, and Naumovska (2019) high economic growth would help increase the disposable income of individuals and households, improving the borrower's ability to fulfil financial obligations; moreover, rising income would encourage spending of the economy, thereby positively impacting the performance of businesses, and thus reducing non-performing loan and increase the soundness of the banking system. On the contrary, inflation would reduce the real income of entities in the economy and reduce the spending ability of subjects, this leads to stagnant goods, and as a result, profits of businesses would decrease, even at a loss, non-performing loan in the economy increases and reduces the stability of banks (Abuzayed, Al-Fayoumi, & Molyneux, 2018).

In addition to the economic growth and inflation factors affecting banking activities, the COVID-19 pandemic that emerged at the end of 2020 and escalated in 2021 caused severe impacts on the Vietnamese economy and countries worldwide. Lang (2021) stated that the impact of the COVID pandemic is much more severe than that of other epidemics such as SARS in 2001, the H1N1 flu epidemic (2009), the Middle East respiratory syndrome

(MERS) in 2012, Ebola (2013), and Zika (2015). Not only were there human losses, but the level of economic losses even exceeded those of the 2008 financial crisis. From these statements, the authors hypothesized:

Hypothesis 11: The COVID-19 pandemic erodes the stability of the banking system.

From the research hypotheses, the authors proposed the following research model.

$$\text{Model 1: } NPL_{i,t} = \alpha_1 HHI_t + \alpha_2 LERNER_{i,t} + \alpha_3 CAP_{i,t} + \alpha_4 NITA_{i,t} + \alpha_5 CRE_{i,t} + \alpha_6 ITP_{i,t} + \alpha_7 GDP_t + \alpha_8 INF_t + \alpha_9 COVID_t + \varepsilon_{i,t}$$

$$\text{Model 2: } Z - score_{i,t} = \beta_1 HHI_t + \beta_2 LERNER_{i,t} + \beta_3 CAP_{i,t} + \beta_4 NITA_{i,t} + \beta_5 CRE_{i,t} + \beta_6 ITP_{i,t} + \beta_7 GDP_t + \beta_8 INF_t + \beta_9 COVID_t + \varepsilon_{i,t}$$

Where i is the i-th bank and t is the time.

Table 1 describes the variables in the research model.

Table 1. Description of variables in the model.

Notation	Variables	Expectation	Reference	Source
Dependent variable				
$Z - score$	Natural logarithm coefficient Z-score of commercial banks		Jiménez et al. (2013) and Ha et al. (2021)	Calculation from the financial statements of commercial banks.
NPL (Non-performing loan)	NPL ratio of the banking system		Jiménez et al. (2013) and Ha et al. (2021)	
Independent variables				
HHI_TD	Banking concentration index	+/-	Leroy and Lucotte (2017); Saif-Alyousfi et al. (2020) and Goetz (2018)	Calculation from the financial statements of commercial banks.
LERNER	Lerner index	+/-	Berger (1995); Saif-Alyousfi et al. (2020) and Ijtsma et al. (2017)	
CAP	Equity/Total assets ratio	+	Anginer et al. (2014)	
NITA	Non-interest income	+	Odesanmi and Wolfe (2007)	
CRE	Credit growth rate	-	Adrian and Shin (2014)	
ITP	Policy interest rate	+	Mishkin (1999)	IMF
GDP	GDP growth	+	Kjosevski et al. (2019)	IMF
INF	Inflation	-	Abuzayed et al. (2018)	IMF
COVID	Binary variable; take the value "1" if the year of study occurred the COVID pandemic, and "0" otherwise.	-	Lang (2021)	ourworldindata.org[1]

This paper examines the influence of banking concentration and industry competition on the stability of Vietnamese banks during the period from 2011 to 2021. This timeframe is particularly critical for banking operations in Vietnam, as joint-stock commercial banks have undertaken restructuring efforts aimed at achieving greater stability. Additionally, the onset of the COVID-19 pandemic in 2019 has significantly impacted the socio-economic environment both globally and within Vietnam.

Banking stability studies frequently employ frequentist econometric methods; however, this approach has a notable limitation: its accuracy is contingent upon sample size. Securing a sufficiently large number of observations can present challenges. Muthén and Curran (1997) note that studies with small sample sizes may increase the likelihood of false positives, which could compromise the reliability of statistical inferences.

In contrast, Bayesian methods allow for the integration of observed data with prior information to estimate the probability distribution of parameters. Marielle and Sarrah (2017) assert that this methodology is effective in addressing the challenges posed by small sample sizes, providing results as probability distributions rather than

[1] https://ourworldindata.org/coronavirus

solely as point estimates. The Bayesian method presents a more flexible and practical approach to social science research compared to the frequentist approach (Bac et al., 2018; Liebschner et al., 2019). In the frequentist approach, regression coefficients are treated as fixed parameters that can only be estimated through repeated experiments, a methodology that aligns more closely with the natural sciences. In contrast, Bayesian methods regard these coefficients as random variables that can fluctuate based on context and are influenced by unobservable factors (Thach, Linh, Ngoc, & Hai, 2022). This characteristic enables Bayesian approaches to better accommodate studies involving small sample sizes.

Convincing policymakers of the efficacy of analyzing bank stability through repeated experiments under consistent conditions can be challenging. However, the Bayesian method recognizes that while the observed data are fixed, the model parameters may vary according to the unique characteristics of each research subject. Consequently, Bayesian regression yields results in the form of posterior distributions of parameters, thereby enhancing flexibility and facilitating a more realistic interpretation.

In conclusion, the Bayesian approach not only adeptly addresses research questions by providing distributions of parameters but also significantly improves the accuracy of interpretations when compared to the frequentist approach. This distinction positions Bayesian methods as a more suitable tool for research endeavors requiring both flexibility and complexity (Thach et al., 2022).

In this study, the authors utilized Bayesian simulation techniques, specifically the Metropolis-Hastings algorithm, to investigate the effects of competition and industry concentration on bank stability. The model employs a Markov Chain Monte Carlo (MCMC) approach with 10,000 iterations, supplemented by Gibbs sampling to optimize computational efficiency. While prior studies primarily relied on frequentist methodologies without incorporating prior information, our analysis indicates that the impact of prior distribution on posterior distribution is minimal, based on a dataset collected from 27 commercial banks between 2011 and 2021. Based on Block, Jaskiewicz, and Miller (2011) we implemented a Gaussian distribution with varying parameters to align with the research model. Bayesian factor analysis was applied to identify the prior distribution that best fits the data.

The simulations outlined in Table 2 demonstrate a decreasing level of prior information across the following scenarios: Simulation 1.1 (for model 1) and Simulation 2.1 (for model 2) possess the strongest prior information, whereas Simulation 1.5 (for model 1) and Simulation 2.5 (for model 2) exhibit the weakest prior information. Following the establishment of simulations with varying degrees of prior information for the research model, regression analysis will be conducted on the proposed simulations. Subsequently, a Bayes Factor analysis and a Bayes Test Model will be utilized to identify simulations where the prior information is consistent with the research model data. Upon determining the appropriate prior information, the simulation of the Bayes model will be executed, and the results will be thoroughly analyzed.

Table 2. The prior information of simulations.

Model 1		**Model 2**	
Likelihood	$Z-score \sim N(\mu_1, \sigma_1)$	Likelihood	$NPL \sim N(\mu_2, \sigma_2)$
Prior distribution			
Simulation 1.1	$\alpha_i \sim N(0,1)$ $\sigma^2 \sim Invgamma(0.01, 0.01)$	Simulation 2.1	$\beta_i \sim N(0,1)$ $\sigma^2 \sim Invgamma(0.01, 0.01)$
Simulation 1.2	$\alpha_i \sim N(0,10)$ $\sigma^2 \sim Invgamma(0.01, 0.01)$	Simulation 2.2	$\beta_i \sim N(0,10)$ $\sigma^2 \sim Invgamma(0.01, 0.01)$
Simulation 1.3	$\alpha_i \sim N(0,100)$ $\sigma^2 \sim Invgamma(0.01, 0.01)$	Simulation 2.3	$\beta_i \sim N(0,100)$ $\sigma^2 \sim Invgamma(0.01, 0.01)$
Simulation 1.4	$\alpha_i \sim N(0,1000)$ $\sigma^2 \sim Invgamma(0.01, 0.01)$	Simulation 2.4	$\beta_i \sim N(0,1000)$ $\sigma^2 \sim Invgamma(0.01, 0.01)$
Simulation 1.5	$\alpha_i \sim N(0,10000)$ $\sigma^2 \sim Invgamma(0.01, 0.01)$	Simulation 2.5	$\beta_i \sim N(0,10000)$ $\sigma^2 \sim Invgamma(0.01, 0.01)$

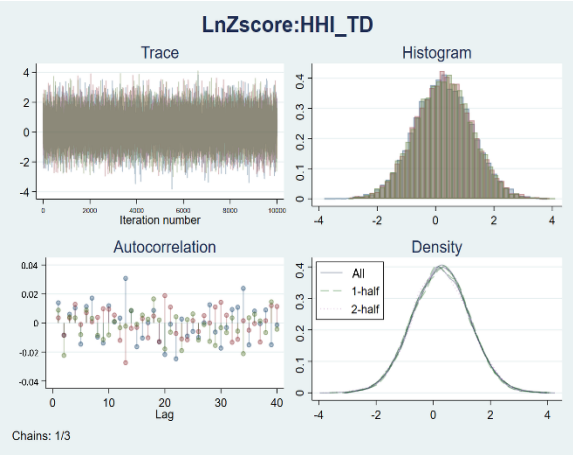
Table 3 presents the results of the Bayesian analysis. The most suitable simulation is identified by its highest average log(BF), highest log(ML), and lowest average DIC. According to the Bayesian factor analysis findings, within Model 1, Simulation 1.1 demonstrates a competitive advantage compared to other models, as indicated by its superior log (BF) and log (ML) values. However, it is important to recognize that this advantage is not absolute, as the DIC for Simulation 1.1 is less favorable than that of Simulation 1.2. In Model 2, Simulation 2.1 exhibits superiority, characterized by the highest log (BF), highest log (ML), and lowest average DIC among the evaluated models. Additionally, the Bayesian model test results in Table 3 further corroborate that Simulation 1.1 provides the most appropriate prior information for Model 1, while Simulation 2.1 is deemed best suited for Model 2.

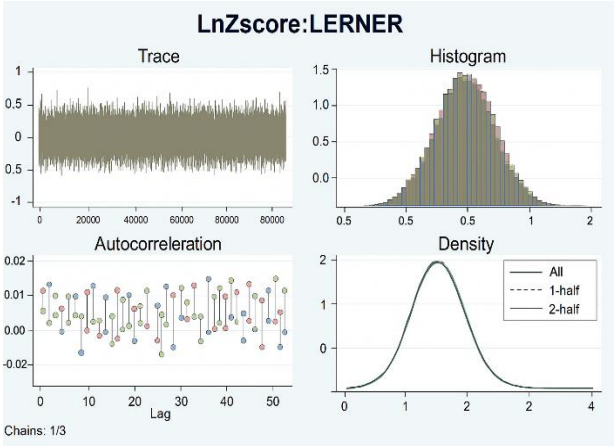
Table 3. Bayes factor analysis results.

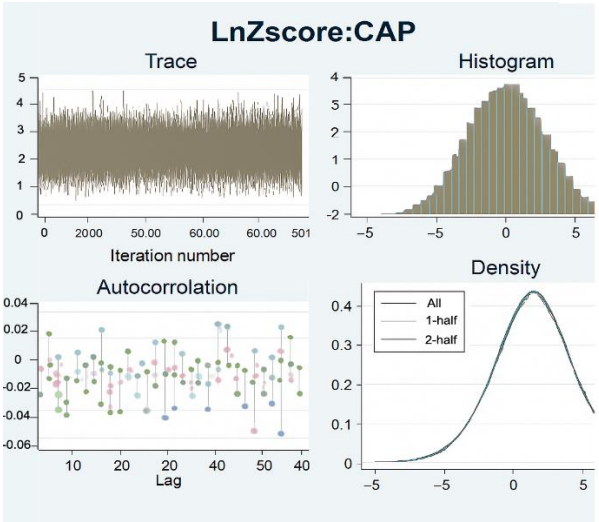
Model 1					
Simulation	**Chains**	**Avg DIC**	**Avg log (ML)**	**Log (BF)**	**P(M|y)**
Simulation 1.1	3	472.412	-255.493	.	0.891
Simulation 1.2	3	471.409	-257.594	-2.101	0.109
Simulation 1.3	3	473.656	-267.025	-11.532	0
Simulation 1.4	3	475.028	-278.626	-23.133	0
Simulation 1.5	3	475.488	-290.896	-35.403	0
Model 2					
Simulation	**Chains**	**Avg DIC**	**Avg log (ML)**	**Log (BF)**	**P(M|y)**
Simulation 2.1	3	-479.381	214.171	.	1
Simulation 2.2	3	-477.335	203.583	-10.588	0
Simulation 2.3	3	-476.234	191.544	-22.627	0
Simulation 2.4	3	-475.984	179.010	-35.161	0
Simulation 2.5	3	-475.900	166.437	-47.734	0

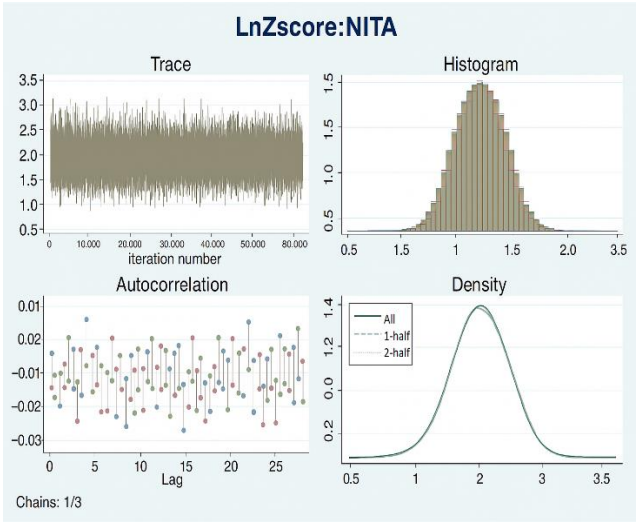
4. RESEARCH RESULTS AND DISCUSSION

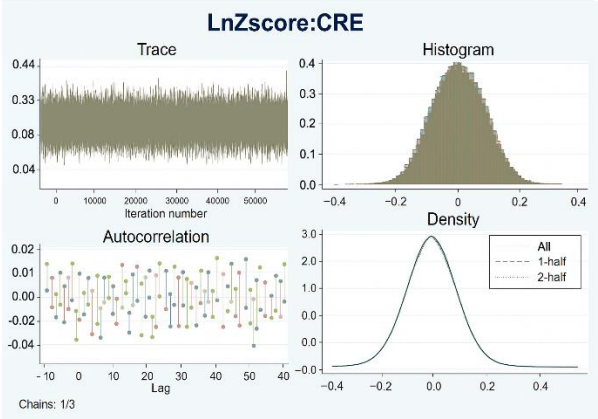
In Bayesian analysis, the most suitable simulation is the one with the largest mean log (BF), log (ML), P(M|y) coefficients and the smallest mean DIC. The Bayesian factor analysis table results show that simulations 1.1 and 2.1 have superiority over other simulations in the two models; that is, these two simulations have the most suitable prior information for the two models.

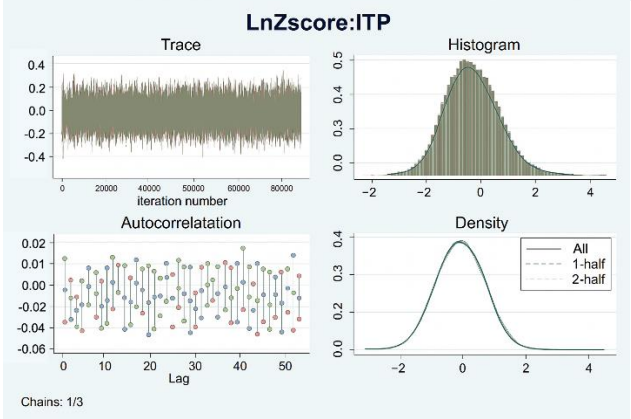


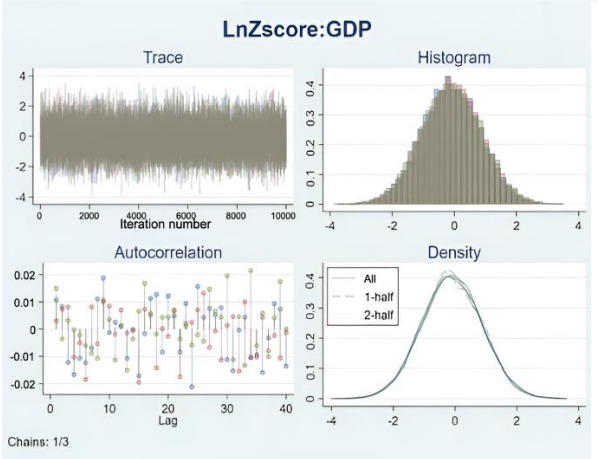


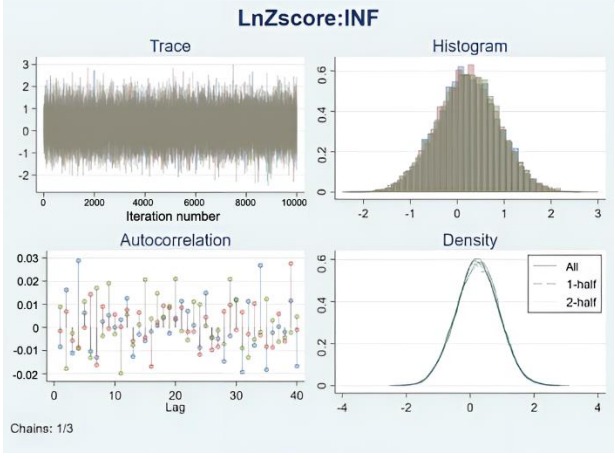


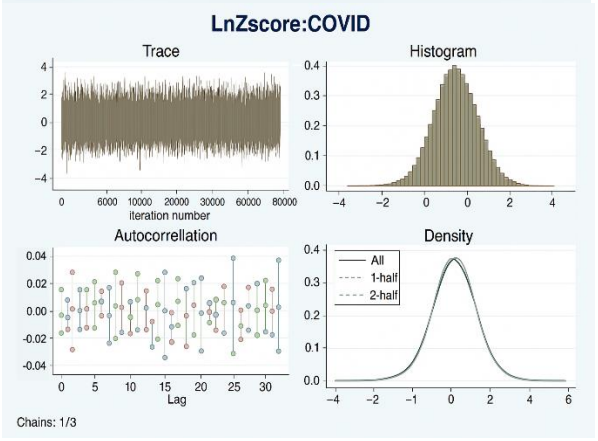


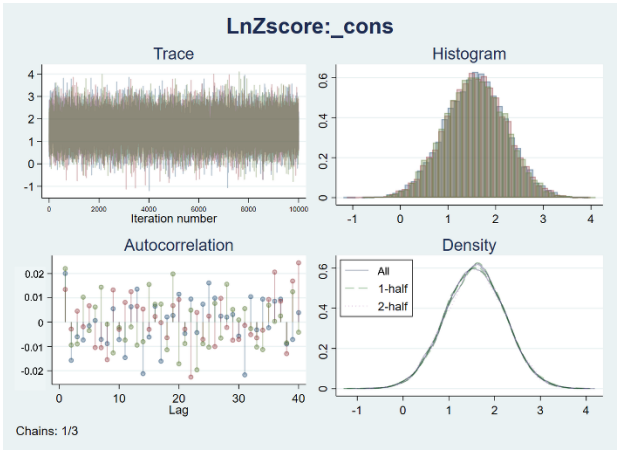












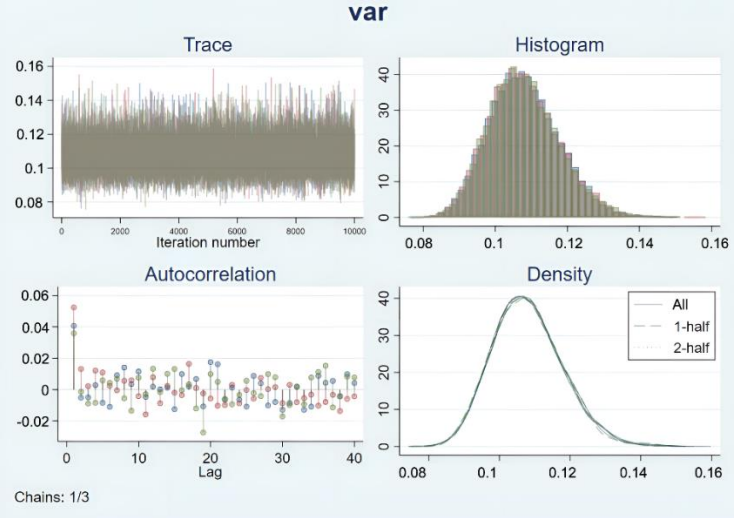


Figure 1. Convergence diagnostic chart.

The MCMC chains' convergence diagnostic chart would include (i) a trace plot, which follows the process of repeating through a parameter value of the MCMC chains. The trace plot in Figure 1 shows that it fluctuates around the mean of the histogram, which means that the MCMC chains are stationary and eligible for convergence. In addition to the trace chart, the convergence diagnostic figure also shows (ii) the autocorrelation chart; Figure 1 shows that the graphs fluctuate mainly below 0.02, which indicates a proper fit with the simulated density distribution, reflecting that the delays of MCMC chains are within the effective limit. In addition, when considering the convergence diagnostic, we also have to pay attention to (iii) the density estimate shown by the histogram and the density graph. Both of these graphs in Figure 1 show that the histogram shape has uniformity and simulates the normal distribution shape, so it can be concluded that the Bayesian inference for the model is stable.

Table 4 presents the results of the Bayesian simulation analysis. The findings indicate that the average acceptance rate for both models is 1, meeting the established minimum standard of 10%. Furthermore, the minimum efficiency observed for both models is 0.89, significantly surpassing the required threshold of 0.01. These results affirm that both models satisfy the necessary criteria for acceptability. In addition to evaluating the average acceptance rate and minimum efficiency of the Markov Chain Monte Carlo (MCMC) chain, it is essential to assess the Monte Carlo Standard Error (MCSE). According to Flegal, Haran, and Jones (2008) the stability of MCMC improves as the MCSE approaches 0. They also indicate that an MCSE below 6.5% of the standard deviation is deemed acceptable, while an MCSE below 5% is considered optimal. The findings illustrated in Table 4 demonstrate that the Bayesian simulation adheres to the established stability conditions.

Table 4. Bayes' simulation results.

Independent variables	Model 1			Model 2		
	Mean	Std. dev.	MCSE	Mean	Std. dev.	MCSE
HHI_TD	0.577	3.074	0.018	-0.118	0.412	0.002
LERNER	2.449	0.329	0.002	-0.020	0.009	0.000
CAP	3.089	0.754	0.004	-0.019	0.020	0.000
NITA	-0.187	0.309	0.002	-0.021	0.008	0.000
CRE	-0.139	0.133	0.001	0.001	0.003	0.000
ITP	0.785	1.950	0.011	0.102	0.097	0.001
GDP	-0.249	2.810	0.016	-0.071	0.182	0.001
INF	0.307	1.367	0.008	0.050	0.053	0.000
COVID	0.059	0.164	0.001	-0.002	0.007	0.000
_cons	2.287	0.387	0.002	0.034	0.039	0.000
var	0.279	0.023	0.000	0.000	0.000	0.000
Avg acceptance rate		1			1	
Avg efficiency: Min.		0.945			0.935	

Bayesian simulation results show that, in general, banking concentration tends to improve the banking system's stability as it supports the Z-score coefficient and reduces Non-Performing Loans (NPL). Besides industry concentration (HHI_TD) and competitiveness (Lerner), Equity (CAP) also has a positive impact on bank stability. Meanwhile, other factors such as credit growth (CRE), economic growth (GDP), inflation (INF), and the Covid pandemic erode the stability of banks as they lower the Z-score and increase NPL in commercial banks. Remarkably, non-interest income (NITA) has conflicting effects on bank stability as it reduces the Z-score and also reduces NPL; on the contrary, the variable policy interest rate (ITP) tends to increase the Z-score, but this factor also increases NPL. In addition, the regression coefficients of model 2 are too low to confirm the trend of the impact of these variables on NPL. Therefore, to analyze the impact of the above factors on banking stability more comprehensively, we need to conduct a posterior Bayesian analysis to determine the probability of the effect of these factors on the stability of the banking system for the dependent variable.

The assessment of the frequentist method will be conducted through the framework of null hypothesis testing. For this particular analysis, we will investigate the null hypothesis H0: Bank concentration does not enhance bank stability. This will be achieved by calculating the p-value. The p-value serves as a conditional probability, allowing us to interpret it as the likelihood of observing that bank concentration does not improve bank stability, provided that the null hypothesis H0 is true. If the calculated p-value is less than the predetermined significance levels of 1%, 5%, or 10%, we will reject the null hypothesis H0 and conclude that bank concentration positively impacts bank stability. Conversely, if the p-value exceeds these thresholds, we will retain H0. It is important to recognize that the p-value alone does not convey the probability of bank concentration improving bank stability. In contrast, the Bayesian method offers a valuable approach to address this question, thereby presenting a notable advantage over frequentist methodologies.

Table 5. Bayes posterior probabilities.

Model 1		**Model 2**	
Probability {LnZscore:HHI} > 0	0.574	Probability {NPL:HHI} < 0	0.614
Probability {LnZscore:LERNER} > 0	1.000	Probability {NPL:LERNER} < 0	0.991
Probability {LnZscore:CAP} > 0	1.000	Probability {NPL:CAP} < 0	0.825
Probability {LnZscore:NITA} < 0	0.727	Probability {NPL:NITA} < 0	0.996
Probability {LnZscore:CRE} < 0	0.851	Probability {NPL:CRE} > 0	0.602
Probability {LnZscore:ITP} > 0	0.656	Probability {NPL:ITP} > 0	0.852
Probability {LnZscore:GDP} < 0	0.534	Probability {NPL:GDP} < 0	0.652
Probability {LnZscore:INF} > 0	0.588	Probability {NPL:INF} > 0	0.826
Probability {LnZscore:COVID} > 0	0.640	Probability {NPL:COVID} < 0	0.606

Table 5 shows the probability of the impact of the independent variables on banking stability. Accordingly, the banking concentration measured through the HHI index improves financial stability when it increases the Z-score and reduces the NPL ratio. However, this level of impact is insignificant when the probability of the effect of HHI on Z-score is only 59.3% and on NPL is only 63.7%. Prior to 2011, the Vietnamese commercial banking sector experienced a significant increase in competition as banks sought to expand their operations. This period was marked by a noteworthy rise in the establishment of new banks and the conversion of rural banks into urban banks. Consequently, the level of concentration within the banking industry declined, with the number of commercial banks peaking at 35. The rapid growth of banks intensified competitive pressures, compelling institutions to focus aggressively on resource mobilization and lending activities. However, this swift expansion was accompanied by a fragile financial foundation and insufficient management capacity. In addition, a lack of accountability in operational practices led to a substantial increase in non-performing loans, particularly among smaller banks, which jeopardized the overall stability of the banking system. In light of these challenges, the State Bank undertook a comprehensive restructuring of the banking sector. This initiative included efforts to reduce the number of banks, facilitate the

merger of weaker institutions, and enhance overall industry concentration to promote a more stable financial environment. Since 2012, the State Bank has implemented a series of effective measures, including the introduction of the credit growth ceiling tool. Banks are categorized into four groups based on their operational performance and financial strength, with growth ceilings established at 17%, 15%, 8%, and 0%, respectively. These comprehensive strategies have significantly aided the commercial banking sector in addressing its challenges. Following the restructuring of weaker banks, the financial capacity of many Vietnamese commercial banks has improved. As a result, several of these institutions have received enhanced credit ratings from esteemed rating agencies. This period has also seen an influx of foreign banks entering the Vietnamese market, contributing to a reduction in industry competition. Nevertheless, through the implementation of sound policies and stringent oversight of the financial health of commercial banks, the overall stability of the banking system has been preserved. This framework elucidates why, despite a decrease in industry concentration, the stability of banks has remained robust. Consequently, the impact of industry concentration on banking stability has been relatively minimal during this time.

Meanwhile, the Lerner Index has a noticeable effect on improving the stability of commercial banks when the probability of its impact on Z-score reaches 100%, and its effects on reducing NPL are close to 95%. According to Phong and Hoang (2012) a bank with high competitiveness creates a basis for maintaining and developing its advantages, strengthening and expanding the market, and establishing a foundation for coping with economic shocks and adverse macroeconomic fluctuations. Kazarenkov, Prokop, and Kazarenkova (2015) also stated that competitiveness helps banks improve their potential to create and develop breakthrough products with high market competitiveness, helping build reputable and trustworthy brand reliability in satisfying customer needs, which not only enhances the bank's operational efficiency but also contributes to improving the bank's resistance to macroeconomic fluctuations. The research conducted by Vo and Phan (2016) provides valuable insights into the Vietnamese banking system during the period of 2006 to 2014. Their findings indicate that enhancing competitive capacity is essential for banks to improve and maintain stability in profit generation, thereby bolstering the overall stability of commercial banks. Additionally, a study by Resmi et al. (2019) which examined data from commercial banks across 12 Asian countries, reinforces this perspective. It was found that banks demonstrate greater competitive strength when they maintain high capital adequacy levels. This financial stability not only enhances banks' ability to manage risks associated with adverse selection and moral hazard but also serves to mitigate the likelihood of bankruptcy. These conclusions are consistent with the research of esteemed scholars such as Nicoletto et al. (2001); Uhde and Heimeshoff (2009); Anginer et al. (2014) and Tabak et al. (2015) further underscoring the importance of competitive strength and capital adequacy in the banking sector.

The equity to assets ratio (CAP) is an essential factor in maintaining the stability of commercial banks. Banks with a sizeable equity ratio have lower non-performing loans (NPLs), with a rate of 86.9%, while the improvement effect of this factor on the Z-score reaches 100%. This is consistent with the initial hypothesis, and this result is also similar to Anginer et al. (2014) and Oanh, Van Nguyen, Le, and Duong (2023).

The diversification factor (NITA) negatively impacted the Z-score. However, this effect is relatively vague when the probability of its impact is only 63.8%, while the probability that the NITA variable helps to reduce the bad debt ratio of the bank is as high as 99.7%. Therefore, it can be recognized that diversifying banking activities improves the stability of the banking system.

5. CONCLUSION AND POLICY IMPLICATIONS

The Vietnamese economy has experienced notable growth, particularly in 2006 and 2007, during which the financial sector underwent significant advancements. This period was characterized by a marked increase in the number of banks, including the establishment of new financial institutions and the transformation of rural banks into urban entities. However, this rapid expansion posed several challenges within the banking system. By 2011–

2012, although the number of banks was substantial, many institutions exhibited limited financial capacity and insufficient management practices, raising concerns regarding the overall stability of the banking system.

In response to these challenges, the State Bank of Vietnam initiated a restructuring process aimed at reducing the number of banks, enhancing market concentration, and improving the competitiveness of domestic institutions. As Vietnam continues to integrate more deeply into the global economy, it is imperative that its financial system, particularly the commercial banking sector, adapts and positions itself effectively in the international landscape.

This study aims to enhance understanding of the relationship between industry concentration, competition, and the stability of commercial banks. The insights presented will serve as valuable references for regulators and policymakers in their efforts to ensure the banking system's stability, thereby laying a solid foundation for sustainable economic growth.

Furthermore, this study provides a comprehensive summary of the theoretical foundations related to industry concentration and competition, examining their impact on banking stability. The authors also present appropriate methodologies for measuring banking stability, industry concentration, and competition within the banking sector. Specifically, the study utilizes the Z-score and the ratio of non-performing loans to total outstanding loans to assess bank stability. The Herfindahl-Hirschman Index (HHI) is employed to measure industry concentration, while the Lerner Index is used to evaluate the competitiveness of commercial banks.

The study analyzed data from 27 commercial banks listed on the Vietnamese stock market from 2011 to 2021. Utilizing Bayesian regression, the research aimed to assess the impact of industry concentration and competition on banking stability. The findings indicate that industry concentration does not significantly influence the stability of the commercial banking system. In contrast, the competitiveness of banks emerges as a critical factor in maintaining this stability. Furthermore, the study emphasizes the significance of various elements, including bank size, equity capital ratio, and income diversification, in enhancing the overall soundness of the banking system. It is noteworthy that policy interest rates are found to harm banking stability. In contrast, inflation appears to contribute to financial system stability, albeit with effects primarily observed in the short term (Ha et al., 2021). The analysis also suggests that other factors, such as credit growth, GDP growth, and the COVID-19 pandemic, exert relatively weak influences on financial stability.

The findings from this study highlight the critical importance of enhancing the competitiveness of banks as a fundamental factor in improving the banking system's stability. The evidence demonstrates that the Lerner variable significantly influences this enhancement, showing a complete 100% probability of positively affecting the Z-score coefficient and a nearly 95% probability of reducing the level of non-performing loans (NPLs). To foster the competitiveness of commercial banks, the State Bank needs to encourage these institutions to explore non-interest activities while emphasizing the improvement of service quality. This approach not only aims to bolster the competitive positioning of commercial banks but also plays a vital role in strengthening the banking system's stability, with the potential to decrease non-performing loans by up to 99%. In light of the increasing integration of technology across various sectors, the State Bank should establish a supportive legal framework. Such an initiative will enable banks to invest in technological advancements, adopt digital banking solutions, and enhance the customer transaction experience, thereby further improving the overall competitiveness of commercial banks. Enhancing competition among banks necessitates significant financial resources, particularly in the form of their capital. The study identified the equity-to-total-assets (CAP) ratio as a key factor in maintaining the stability of commercial banks. This variable can reduce the NPL ratio by 87%, while banks with a higher equity-to-total-assets ratio are likely to achieve a Z-score value of 100%. To facilitate these advancements, the State Bank of Vietnam should expedite the process of increasing legal capital to ensure that commercial banks can promptly meet capital safety standards outlined by Basel II while also progressing toward compliance with Basel III requirements. Furthermore, a comprehensive review and consolidation of smaller banks that may lack sufficient financial

resources to compete effectively in this challenging environment is necessary to ensure the sustainable development of the banking industry.

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