



MACROECONOMIC UNCERTAINTY AND BANK PERFORMANCE IN VIETNAM: EVIDENCE OF THE ADVERSE MODERATING EFFECT OF INFORMATION AND COMMUNICATION TECHNOLOGY

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ABSTRACT

This study examines the impact of macroeconomic uncertainty (CMUI) on the performance of Vietnamese commercial banks and investigates the moderating role of information and communication technology (ICT) in this relationship. Using panel data from 29 commercial banks over the period 2010–2022 and employing the System Generalized Method of Moments (System GMM) estimator, the study addresses potential endogeneity and the dynamic nature of bank performance. The empirical results indicate that macroeconomic uncertainty is positively associated with bank performance, while ICT exerts a positive direct effect. However, the interaction between CMUI and ICT is negative and statistically significant, suggesting that the beneficial effect of ICT on bank performance diminishes as macroeconomic uncertainty increases. These findings provide new empirical evidence from an emerging economy and imply that investments in ICT should be implemented strategically and aligned with banks' absorptive capacity to maximize their effectiveness under volatile macroeconomic conditions.

Keywords: Macroeconomic uncertainty; information and communication technology (ICT); bank performance; System GMM.

Introduction

Over the past decade, increasing levels of macroeconomic uncertainty have been observed across emerging economies, including Vietnam, as a consequence of global shocks such as the COVID 19 pandemic, oil price volatility, trade tensions, and shifts in international monetary policies. Macroeconomic uncertainty has been widely recognized as a critical factor influencing the banking and financial system because higher uncertainty is often associated with elevated credit risk, increased funding costs, and reduced predictability of business activities. Consequently, the impact of macroeconomic uncertainty on bank performance has been regarded as an important issue from both academic and policy perspectives.

Although considerable attention has been devoted to this topic in the international literature (Beck et al., 2013; Buch et al., 2013), limited evidence has been documented for emerging

economies such as Vietnam. In previous studies, the effects of uncertainty have largely been captured through individual macroeconomic indicators, including inflation, economic growth, and exchange rates. However, macroeconomic uncertainty is generally considered a multidimensional phenomenon encompassing economic, financial, and policy related dimensions. The Composite Macroeconomic Uncertainty Index (CMUI), which has been constructed from several uncertainty indicators developed for Vietnam (Ahir et al., 2022; Baker et al., 2016; Caldara & Iacoviello, 2022), has provided a more comprehensive measure of uncertainty. Nevertheless, its implications for the Vietnamese banking sector have not yet been extensively examined, despite the substantial institutional and technological transformations that have occurred in this sector.

At the same time, information and communication technology (ICT) has increasingly been recognized as a strategic resource for

enhancing competitiveness in the banking industry (Pham Thuy Tu et al., 2023; Thuy, 2021). According to the Dynamic Capabilities Theory and the Resource Based View, ICT is expected to facilitate organizational adaptability, strengthen risk management practices, and support sustainable performance under changing environmental conditions. While the effects of macroeconomic uncertainty and ICT have been investigated separately in most recent studies conducted in Vietnam, the moderating role of ICT in the relationship between macroeconomic uncertainty and bank performance has received limited attention. Therefore, an attempt is made in this study to examine this relationship by incorporating the Composite Macroeconomic Uncertainty Index and applying the System Generalized Method of Moments framework within the context of an emerging economy.

Against this background, three primary objectives are pursued. First, the impact of composite macroeconomic uncertainty on bank performance is examined. Second, the moderating role of ICT in the relationship between macroeconomic uncertainty and bank performance is investigated. Third, managerial and policy implications aimed at improving the adaptability and efficiency of the banking sector under volatile macroeconomic conditions are proposed. By employing the System Generalized Method of Moments estimator to address endogeneity concerns and the dynamic characteristics of panel data, new theoretical, empirical, and methodological contributions are expected to be generated. In addition, valuable evidence is provided for the banking and financial sectors in emerging economies.

1. Designing a Research Model

Research Design and Data

A quantitative empirical approach was adopted to examine the impact of composite macroeconomic uncertainty (CMUI) on the performance of Vietnamese commercial banks and to investigate the moderating role of information and communication technology (ICT) in this relationship. Panel data were collected from the financial statements of Vietnamese commercial banks covering the period from 2010 to 2022.

Macroeconomic data were obtained from the State Bank of Vietnam, the General Statistics Office of Vietnam, and the World Bank. The research sample consisted of 29 commercial banks that operated continuously throughout the study period, thereby ensuring adequate representation of the Vietnamese banking system.

Bank performance, measured by return on assets (ROA), was employed as the dependent variable. The main independent variables included composite macroeconomic uncertainty (CMUI), the information and communication technology index (ICT), and the interaction term between these variables (ICT_CMUI). The CMUI was constructed using Principal Component Analysis (PCA) based on four uncertainty indicators, namely the Geopolitical Risk Index (GPR), World Supply Chain Pressure Index (WSI), World Uncertainty Index (WUI), and Economic Policy Uncertainty Index (EPU), which were measured specifically for Vietnam. The suitability of the PCA model was confirmed by a Kaiser Meyer Olkin value of 0.7971 and a statistically significant Bartlett's test result ($\chi^2 = 504.32$; $p = 0.0000$).

The information and communication technology variable was measured using a composite index reflecting the level of technological investment and adoption by commercial banks. The measurement was developed with reference to the ICT Index annually published by the Ministry of Information and Communications of Vietnam. In addition, information regarding technological investment and digital application disclosed in annual reports and financial statements of Vietnamese commercial banks was incorporated to capture the internal technological capabilities of individual banks.

Furthermore, several control variables commonly employed in banking studies were included in the model (Hoque et al., 2024; Le et al., 2025; Pham Thuy Tu, 2025; Thuy, 2021). These variables included SIZE (bank size), ETA (equity to total assets ratio), LTA (loans to total assets ratio), HDV (deposits to total assets ratio), CTI (cost to income ratio), HHI (income diversification index measured by the proportion of non interest income to total income), MS (market share), GDP growth, and INF (inflation rate). The inclusion of these variables was intended to control for bank specific

characteristics and macroeconomic conditions that may influence bank performance.

Research Model

Following previous studies (Hoque et al., 2024; Le et al., 2025; Pham Thuy Tu, 2025; Thuy, 2021), the estimation model was specified as follows:

$$ROA_{it} = \alpha_0 + \alpha_1 ROA_{i,t-1} + \alpha_2 CMUL_{it} + \alpha_3 ICT_{it} + \alpha_4 (CMUL_{it} \times ICT_{it}) + \alpha_5 Controls_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

In the model, *i* denotes the bank and *t* denotes the observation year. The term μ_i represents the unobserved bank specific effect, while ε_{it} denotes the random error term. The inclusion of the lagged dependent variable, ROA, was intended to capture the dynamic nature of bank performance.

Research Methods

Since the model includes a lagged dependent variable and potential endogeneity among the explanatory variables, the System Generalized Method of Moments (System GMM) estimator was employed, following the recommendations of Arellano and Bover (1995) and Blundell and Bond (1998). This approach combines equations in first differences and levels to construct valid internal instruments, thereby reducing estimation bias and improving statistical efficiency.

The results of the Durbin Wu Hausman test indicated that CTI may be endogenous in the model. Consequently, CTI was treated as an endogenous variable and instrumented using its own lagged values within the GMM framework. The remaining control variables were assumed to be exogenous and were incorporated into the model as external instrumental variables. Estimation was performed using the two step System GMM procedure, with

Windmeijer corrected standard errors applied to address potential downward bias in the estimated variance and to ensure the consistency of statistical inference.

The validity of the model was assessed through several diagnostic tests. First, the Hansen J test was employed to evaluate the validity of the instrument set, where a *p* value greater than 0.05 indicates that the instruments are valid. Second, the Arellano Bond AR(1) and AR(2) tests were conducted to detect serial correlation in the residuals. The model was considered valid when no second order serial correlation was detected, as indicated by an AR(2) *p* value greater than 0.10. Third, the number of instruments was maintained below the number of bank groups to avoid instrument proliferation and model overfitting.

Therefore, the System GMM approach was considered the most appropriate estimation method for this study, as it effectively addresses endogeneity concerns while simultaneously capturing the dynamic characteristics of banking panel data in the Vietnamese context.

2. Results and Discussion

The research data were collected from 29 Vietnamese commercial banks over the period from 2010 to 2022, resulting in 282 observations. The sample was considered sufficiently representative of the Vietnamese banking system while ensuring data continuity throughout the study period. Prior to model estimation, descriptive statistics were examined to provide an overview of the data characteristics and to establish the foundation for subsequent empirical analyses. Table 1 presents the descriptive statistics of all variables included in the study.

Table 1. Descriptive Statistics of Variables Included in the Model

Variable	Mean	Standard Deviation	Minimum	Maximum
ROA	0.010	0.008	0.000	0.047
SIZE	18.936	1.232	15.923	21.475
ETA	0.086	0.037	0.026	0.255
LTA	0.590	0.106	0.339	0.788
HDV	0.662	0.120	0.292	0.912
CTI	0.864	0.090	0.538	0.998

HHI	0.423	0.075	0.095	0.500
MS	0.033	0.036	0.002	0.126
ICT	0.528	0.115	0.253	0.828
CMUI	0.067	1.005	-1.855	2.071
GDP	0.060	0.017	0.022	0.080
INF	0.063	0.102	-0.017	0.423

Particular attention should be given to the Composite Macroeconomic Uncertainty Index (CMUI), which exhibited a relatively high standard deviation of 1.005. This finding suggests that considerable fluctuations in the macroeconomic environment were experienced during the study period. Such fluctuations were associated with major economic shocks, including the COVID 19 pandemic, exchange rate volatility, and changes in global monetary policies. In addition, the information and communication technology index (ICT) reported an average value of 0.528 and ranged from 0.253 to 0.828. This variation indicates substantial differences in the extent of technological investment and digital adoption among Vietnamese commercial banks.

Regarding the macroeconomic control variables, average GDP growth and inflation rates

were recorded at 0.060 and 0.063, respectively. These values suggest that a relatively stable macroeconomic environment was maintained throughout most of the study period despite the occurrence of several external shocks.

Based on the descriptive evidence presented above, the estimation of the research model was subsequently conducted using the System Generalized Method of Moments (System GMM) approach. The objective was to examine the relationship between macroeconomic uncertainty (CMUI) and bank performance (ROA), while also determining whether information and communication technology (ICT) exerts a moderating effect on this relationship. The estimation results and diagnostic tests of the SGMM model are reported in Table 2.

Table 2. System GMM Estimation Results

Variable	Coefficient
lag_ROA(-1)	0,001*
SIZE	0,001*
ETA	0,042**
LTA	0,022***
HDV	-0,021***
CTI	-0,055***
HHI	-0,001
MS	-0,042*
ICT	0,011**
CMUI	0,008**
ICT_CMUI	-0,014*
GDP	0,036**
INF	-0,013
Number of observations (N)	191
Number of groups	29

Number of instruments	17
Variance Inflation Factor (VIF)	1,89
AR(1) test (p-value)	0,028
AR(2) test (p-value)	0,322
Sargan test (p-value)	0,112
Hansen test (p-value)	0,137
Wu-Hausman F(1,213) = 37.0141 (p =0.0000)	

The estimation results obtained from the two step System GMM model are reported in Table 2. The diagnostic tests indicate that the model is statistically reliable. The AR(1) test is significant at the 5 percent level, while the AR(2) test is insignificant, suggesting the absence of second order serial correlation in the residuals. Furthermore, the Hansen test (p = 0.137) and the Sargan test (p = 0.112) confirm the validity of the instrument set, indicating that the model is consistently estimated and free from instrument

specification problems. The relatively low variance inflation factor ($VIF = 1.89$) also suggests that multicollinearity is not a concern. In addition, the Durbin Wu Hausman test confirms the presence of endogeneity within the model, thereby supporting the use of the System GMM estimator.

The estimation results reveal that the Composite Macroeconomic Uncertainty Index (CMUI) exerts a positive and statistically significant effect on bank performance ($\beta = 0.008$, $p < 0.05$). This finding suggests that, under moderate levels of macroeconomic uncertainty, commercial banks tend to respond proactively through strategic adjustments and enhanced risk management practices, which subsequently improve operational performance. Higher uncertainty may encourage a more prudent allocation of credit portfolios, stronger cost control mechanisms, and greater diversification of non interest income sources. Although this result differs from much of the evidence reported for developed economies (Beck et al., 2013; Buch et al., 2013), it appears to be consistent with the Vietnamese context, where strong macroeconomic governance and flexible monetary policies are maintained. Under such conditions, uncertainty may serve as a disciplinary mechanism that promotes operational efficiency. From the perspective of Real Options Theory, uncertainty is not only associated with greater risk but may also create opportunities for well managed banks to reallocate resources efficiently and exploit profitable investment opportunities.

A positive and statistically significant coefficient is also observed for ICT ($\beta = 0.011$, $p < 0.05$), highlighting the strategic importance of digital transformation in improving bank performance. This finding is consistent with the studies of Ozili (2017) and Le et al. (2025) and provides further support for both the Resource Based View and Dynamic Capabilities Theory. Accordingly, ICT can be regarded as a critical organizational resource through which operating costs are reduced, risk management capabilities are strengthened, and adaptability to economic fluctuations is enhanced.

In contrast, the interaction term between ICT and CMUI (ICT_CMUI) is found to be negative and statistically significant ($\beta = -0.014$, $p < 0.10$),

indicating an adverse moderating effect of ICT on the relationship between macroeconomic uncertainty and bank performance. This result implies that the benefits derived from technological investment may diminish when uncertainty becomes more pronounced or when technological investment exceeds an organization's absorptive capacity. The finding is consistent with the argument of Dong and McIntyre (2014), who suggested that technology creates value only when it is effectively aligned with organizational capabilities, managerial expertise, and an innovation oriented culture.

Regarding the control variables, the coefficients of lagged ROA, SIZE, ETA, and LTA are positive and statistically significant. These findings provide additional evidence that past profitability, larger scale, stronger capitalization, and greater lending capacity contribute positively to bank performance (Athanasoglou et al., 2008; Pham Thuy Tu, 2025; Thuy, 2021). Conversely, CTI and HDV exhibit negative and significant effects, indicating that higher operating costs and greater reliance on external funding reduce profitability, which is consistent with conventional banking and financial theories.

The coefficients of HHI and INF are statistically insignificant, suggesting that income diversification and inflation did not exert a significant influence on bank performance during the sample period. Market share (MS) is found to have a negative coefficient ($\beta = -0.042$, $p < 0.10$), which is consistent with the negative association observed in the descriptive statistics. This result contrasts with the predictions of the Structure Conduct Performance hypothesis, according to which larger market shares should generate higher profitability through increased market power. However, in the Vietnamese banking sector, the result may reflect increasing marginal costs associated with expansion, greater managerial complexity, and higher systemic risk exposure among large banks. Furthermore, intense competition and declining net interest margins may have weakened the profitability advantages traditionally associated with larger market shares. Similar arguments have been advanced by Demsetz (1973) and subsequent studies conducted in emerging markets.

Overall, the findings confirm that macroeconomic

uncertainty and information and communication technology represent two important determinants of bank performance. However, the relationship between these factors appears to be nonlinear and dependent upon the absorptive capacity of individual banks. These findings extend the Dynamic Capabilities Theory by demonstrating that technology not only enhances operational performance but also shapes how banks respond strategically to macroeconomic uncertainty. Consequently, technological capability can be viewed as a key factor supporting resilience, adaptability, and sustainable development within the Vietnamese banking sector.

3. Policy Implications

From a practical standpoint, several important managerial and policy implications can be derived.

First, technological investment should be maintained at an optimal level, with greater emphasis placed on data analytics capabilities, risk management systems, and process optimization rather than on extensive and unfocused technological expansion, particularly during periods of increasing macroeconomic uncertainty.

Second, monetary policy implementation and macroprudential supervision should be directed toward maintaining a stable economic environment and minimizing unexpected policy shocks, thereby enabling banks to formulate and implement long term digital strategies more effectively.

Third, regulatory authorities should play a more active role in guiding and supervising technological investment across the banking sector to ensure that digital transformation is implemented in a sustainable and coordinated manner while remaining aligned with financial stability and risk management objectives. Such efforts would contribute to strengthening the resilience and performance of the banking system in the face of macroeconomic shocks.

Overall, the findings suggest that an appropriate combination of uncertainty management and technological development represents a critical factor for maintaining efficiency and stability within the Vietnamese banking sector. The implications of this study are not limited to Vietnam but may also provide valuable insights for other emerging economies undergoing rapid digital transformation

of their financial systems.

Despite these contributions, several limitations should be acknowledged. The moderating role of ICT was examined only within a linear framework. Consequently, the inference regarding the possibility of ICT investment exceeding its optimal level was derived indirectly from the interaction effect rather than being tested explicitly. Future research could extend the analysis by employing nonlinear specifications, such as squared ICT terms or threshold models, to identify and validate the optimal level of technological investment more directly. Such approaches may provide deeper insights into the conditions under which ICT contributes most effectively to bank performance under macroeconomic uncertainty.

Conclusion

In this study, the impact of composite macroeconomic uncertainty (CMUI) on the performance of Vietnamese commercial banks was examined, and the moderating role of information and communication technology (ICT) in this relationship was investigated. By employing the two step System Generalized Method of Moments estimator on a panel dataset of 29 Vietnamese commercial banks over the period from 2010 to 2022, endogeneity concerns and the dynamic nature of bank performance were effectively addressed, thereby enhancing the reliability of the empirical findings.

The empirical results indicate that CMUI exerts a positive, although modest, effect on bank performance. This finding suggests that under moderate levels of macroeconomic uncertainty, commercial banks tend to adapt more effectively through improved risk management practices and adjustments in lending strategies, leading to enhanced operational performance. ICT was found to have a positive and statistically significant effect, highlighting the importance of digital transformation as a strategic capability that enables banks to improve efficiency, optimize operating costs, and strengthen resilience against macroeconomic fluctuations (Le et al., 2025; Ozili, 2017; Pham Thuy Tu, 2025; Thuy, 2021). However, the interaction term between ICT and CMUI was found to be negative, indicating that excessive

technological investment or poorly aligned digital strategies may reduce performance under conditions of heightened uncertainty. This finding suggests that the effectiveness of ICT depends largely on each bank's absorptive capacity and ability to integrate technology into organizational processes, which is consistent with the concept of a technological effectiveness threshold proposed by Dong and McIntyre (2014).

From a theoretical perspective, the findings extend both the Dynamic Capabilities Theory and the Resource Based View by demonstrating that technology not only generates internal competitive advantages but also shapes strategic responses to macroeconomic uncertainty. Through this mechanism, organizational adaptability and long term sustainability can be strengthened. From a methodological perspective, the study contributes additional empirical evidence supporting the application of the System GMM estimator in dynamic banking panel data analyses conducted in emerging economies, where endogeneity issues frequently arise.

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