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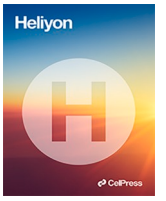

Research article

Assessing the impact of macroeconomic uncertainties on bank stability: Insights from ASEAN-8 countries

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ABSTRACT

This research examines the effect of economic uncertainties on bank stability in ASEAN-8 countries. We use estimations with fixed effects for a panel dataset of bank stability, bank characteristics, banking system characteristics, and macroeconomic uncertainties from 2010 to 2020. Geopolitical risk (GPR), economic policy uncertainty (EPU), climate policy uncertainty (CPU), world pandemic uncertainty (WPU), global supply chain pressure (GSCP), and monetary policy uncertainty (MPU) are used as proxies for economic uncertainty (MU) in this research. We find that although an increase in macroeconomic uncertainties weakens bank stability, GPR is positively related to bank stability. An alternative measurement of bank stability, endogenous tests, and quantile regression corroborate our primary findings. Further analyses focus on the heterogeneous influence of macroeconomic uncertainties on bank stability with diversified bank specifics and the country's financial openness. Our paper supplies deep insights for bank managers and macro policymakers in the ASEAN region relevant to the effect of macroeconomic uncertainties on bank stability. Most crucially, experimental results from this research enrich a wealth of knowledge about the regional banking industry's stability; they are the basis for the establishment of bank strategies and macroprudential policies geared to managing the increased macro-unpredictability.

1. Introduction

The liberalization and integration of economies have exposed them to the policy and crisis headwinds of other nations [1]. Macroeconomic uncertainties hinder economic performance, enlarge economic slowdowns, and spillover between other economies [2,3]. Recent studies indicate that global uncertainty factors directly impact bank stability in the global banking system. For example [4], find an adverse relationship between lessened risk (GPR) and bank stability in the US. Also [5,6], and [7] provide evidence of the impact of economic policy uncertainty (EPU) on bank stability in the US, China, and the Euro area [8]. show elevated risks in

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geopolitics and economic policies threaten the stability of banks in BRICS economies. Climate change, specifically climate policy uncertainty (CPU), poses a new risk source for the financial system, potentially impacting bank leverage through exacerbated defaults [9]. Financial regulations during the pandemic, such as maintaining adequate liquidity and delaying credit risk detection, have further heightened risks in the banking system [10]. The global supply chain's pressures on commodity markets have also been a significant concern [11]. The provision of bank credits plays a role in the connections between buyers and sellers, and changes in global supply chain uncertainty can increase bank instability [12]. Monetary policy uncertainty (MPU) hampers economic growth and increases credit risks [13]. As financial markets become increasingly interconnected, macroeconomic uncertainties exert more severe effects on the stability of the international banking system [14]. Consequently, an in-depth investigation into how macroeconomic uncertainties impact the stability of the regional banking industry is expected to yield numerous intriguing findings. Yet, the concern of existing studies focuses on how a single or a few factors of uncertain macroeconomic conditions modify bank stability. Plus, the majority of research executed recently has concentrated on banks in massive economies (US and China) or groups of large economies (Europe and BRICS).

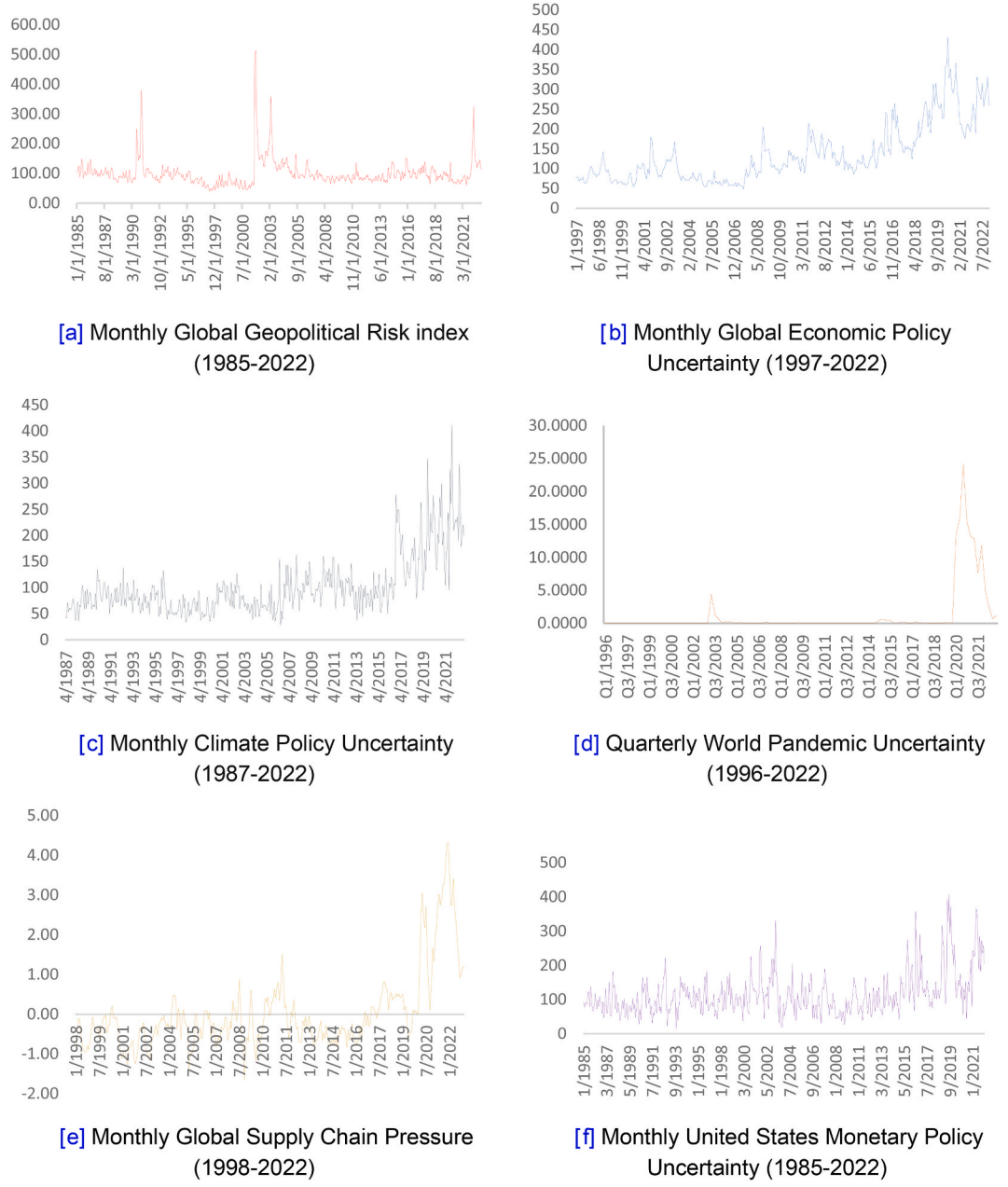

Fig. 1. [1(a–f)]: Macroeconomic uncertainty (MU) indexes.

The Association of Southeast Asian Nations (ASEAN), established in 1967, aims to enhance political, cultural, social, economic, and financial cooperation among Southeast Asian nations [15]. The region's banking system has undergone liberalization, consolidation, and restructuring since the Asian currency crisis, with a primary focus on achieving financial stability [16]. The 2011 ASEAN Financial Integration Framework (AFIF) provides a general framework for liberalization and integration measures. The AFIF has five main goals: (1) lifting restrictions on financial services that ASEAN financial institutions can offer across the region; (2) establishing the infrastructure and capacity to develop and integrate the ASEAN capital markets; (3) facilitating freedom of capital flows within the ASEAN region; (4) harmonizing payments and settlements systems; and (5) bolstering the building and development of financial capacity and regional oversight. The ASEAN Banking Integration Framework (ABIF) was approved in 2011 and aims to boost competition, efficiency, and economies of scale in the banking system [17]. The interdependence between banks in the ASEAN region conjectures that the failure of one national banking system can have immediate consequences for others, posing a risk to the entire ASEAN area. Previous works on bank stability in the ASEAN area usually revolve around financial inclusion, market structure, diversification strategy, or institutional quality issues [18–21]. Since the 1997 currency crisis, ensuring banking system stability has remained a paramount concern for all ASEAN countries. The ability to perceive and manage risks, as seen through the perspectives of both bank managers and policymakers, is crucial in mitigating the potentially severe consequences of identifiable factors [22]. Nowadays, Southeast Asian nations are in a race with the integration and globalization process, and their financial markets are not left out of this process. It is noteworthy that current papers have not comprehensively explored the effects of macroeconomic uncertainties on ASEAN bank stability, which serves as a primary motivation for our promising investigation.

Three key motivations underpin our research, as follows: Firstly, there has been a growing trend towards globalization and increased interconnectedness in the ASEAN banking system. This trend has facilitated the transmission of macroeconomic concerns across borders, making it more likely that these concerns can impact the global financial system, including the banking sector in ASEAN. However, the majority of current research papers primarily focus on the effects of macroeconomic uncertainties on bank stability in the US, Chinese, European, or BRICS banking systems, leaving a significant gap in understanding the ASEAN banking system. Secondly, prior studies have merely looked at how macroeconomic uncertainty affects bank stability. Figures [1(a-f)] display that six macroeconomic uncertainty factors have tended to increase significantly since 2000. They are global geopolitical risk in panel Fig. [1-a], global economic policy uncertainty in panel Fig. [1-b], climate policy uncertainty in panel Fig. [1-c], world pandemic uncertainty in panel Fig. [1-d], global supply chain pressure in panel Fig. [1-e], and monetary political uncertainty in panel Fig. [1-f]. These macro risks may have an impact on the banking industry, either directly or indirectly. Thirdly, prior research has not thoroughly explored the moderating roles of a bank's inherent characteristics and a country's level of financial openness in relation to the impact of macroeconomic uncertainties on bank stability. Particularly noteworthy is the post-2007 period when ASEAN countries joined the World Trade Organization (WTO), underwent liberalization, and engaged in fierce competition between domestic and foreign banks [16]. While the bank run phenomenon and banking system collapse have received more attention, exploring global macro-risk spillovers to economic communities or groups is necessary and meaningful. The ASEAN economic community is not immune to these concerns.

To address these existing gaps, our study investigates the impact of macroeconomic uncertainties on bank stability in the ASEAN-8 economies, spanning from 2010 to 2020. We specifically examine six macroeconomic uncertainties, namely geopolitical risk (GPR), economic policy uncertainty (EPU), climate policy uncertainty (CPU), world pandemic uncertainty (WPU), global supply chain pressure (GSCP), and monetary policy uncertainty (MPU). Our experimental evidence reveals that increased economic uncertainties have heightened bank instability. However, it's noteworthy that geopolitical risk shows a positive effect on bank stability in the ASEAN region. Furthermore, our primary findings remain robust when using an alternative measure of bank stability and different estimations for a panel sample. Additionally, we find that the effects of macroeconomic uncertainties on bank stability vary across different bank characteristics, including bank scale, loan ratios, competitiveness, and income diversification, as well as the level of national financial openness. In other words, the link between macroeconomic uncertainties and bank stability displays heterogeneity among banks with distinct characteristics and those operating in financial markets with varying degrees of openness. Our research significantly contributes to a comprehensive understanding of the impact of diverse macroeconomic uncertainties on the stability of ASEAN banks. It also highlights the mediating roles played by bank characteristics and the level of financial system openness in relation to this impact. Collectively, the empirical analyses of this paper expand the scope of existing studies and provide novel insights into the effect of six macro-risk factors on the stability of the ASEAN banking system at the bank level. ASEAN banks can refer to the evidence in this work as a basis for developing risk-hedging strategies as the global macroeconomic situation becomes more uncertain.

The remaining sections of this paper are structured as follows: Section 2 presents a literature review focusing on the relationship between uncertain factors and bank stability. In Section 3, a detailed description of the data employed in the study is provided. Section 4 is dedicated to outlining the empirical models used for the analysis and the subsequent interpretation of the empirical results. Finally, Section 5 offers concluding remarks and policy suggestions stemming from the research findings.

2. Literature review

In recent years, numerous studies have examined the effects of economic uncertainty on various aspects of the economy, including output, investments, consumption, and global trade [23,24]. It is widely observed that uncertainty reduces corporate investment, prolongs decision-making processes, increases cash holdings, affects household savings, and disrupts trade volume [25,26]. Economic instability has been identified as a major contributor to recessions. Earlier research primarily focused on the impact of uncertainty on real economic activities. The important role of financial intermediaries, particularly banks, in transferring and intensifying the effects of uncertainty in the financial system has been recognized in more recent studies [27].

The uncertain effects of macro factors on the riskiness of financial institutions, particularly banks, are theoretically ambiguous due to conflicting viewpoints [28]. In times of heightened uncertainty, banks may be able to preserve their financial stability, according to Ref. [29]'s "real options" theory. Banks face irreversible investment and lending problems and may adopt a "wait and see" strategy in uncertain times. As the option value of waiting aggravates, banks are more likely to make better-informed decisions, reducing the risk of making wrong decisions due to incomplete information. The theory also implies that higher uncertainty can lead to increased bank safety, as it discourages activities associated with over-optimism during periods of low optimism, which can result in credit expansion and excessive indebtedness, leading to insolvency risks. Thus, the uncertainty intensity of the economy can be negatively correlated with bank insolvency risk [27].

There are driving forces relevant to uncertainty that are more likely to pose higher insolvency risks for banks. Firstly, uncertainty's recessionary effect on aggregate demand exacerbates the probability of borrower defaults, banks' asset quality, and, subsequently, their risk of insolvency. Secondly, uncertainty can encourage banks to take on higher risks through its impact on interest rates. Uncertainty-related contingency savings depress the risk-free rate, putting downward pressure on the lending rates banks can charge borrowers. During times of uncertainty, companies tend to cut investments and employ fewer workers, leading to a decline in credit demand and lower bank lending rates. Obviously, given the characteristics of financial institutions [30], banks' capital structures change significantly amidst unstable periods. In such cases, banks with higher loan ratios face more bankruptcy pressure.

Uncertainty raises the likelihood of banks experiencing huge adverse shocks, which prompts investors to demand a higher funding premium, thereby increasing banks' funding costs [31]. These factors collectively narrow the interest rate differentials for banks, eroding their primary source of profit. The profit target of shareholders may not immediately adjust as bank profitability declines, leading banks to allocate their assets to "high-risk, high-return" projects, potentially decreasing stability. These dynamics suggest that banks may boost their holdings of risky assets in a less profitable environment, further compromising stability [32,33].

2.1. Geopolitical risk (GPR) and bank stability

Geopolitical risk (GPR) refers to the risks associated with wars, acts of terrorism, and relations between states, which can create disruption in the entire economy and social life. Many prior studies have found that GPR reduces the size of loans, profitability, and performance of banks [4]. It is possible that the flow of capital inflows decreases in the context of surging geopolitical risk, negatively affecting the domestic credit supply [4]. point out that this uncertainty leads to a rise in information asymmetry, making it difficult for lenders to distinguish between good and bad borrowers, thereby reducing the size of lending, investment, and economic efficiency. In short, GPR introduces uncertainty, which has a direct negative effect on the financial health of the banking system [34,25,4]

From the perspective of banks' customers, geopolitical instability can lead to the cancellation or delay of domestic enterprises' investment projects, which lessens consumer confidence and the need for investment financed through consumer loans and mortgages. This has a significant effect on bank profitability, increasing earnings volatility and the risk of failure and insolvency [35,36]. Geopolitical risk is associated with investor sentiment, leading to portfolio reorganizations that shift investments from riskier assets to safer ones, reducing liquidity, particularly among banks. This sentiment-driven impact can cause significant volatility in bank credit and real investments, potentially weakening bank stability. Thus, the higher risk is expected to make banks more unstable or fragile [34,35,37]. Some recent studies document that the impact of GPR on investor sentiment, profitability, and bank stability depends on political stability [38] and governance effectiveness [39]. Findings from these studies implicate that increases in military and governance effectiveness in some countries in coping with increases in GPR help maintain greater financial stability in times of uncertainty. In short, our research predicts a strong likelihood of a negative relationship between sentiment and the financial stability of banks, considering its impact on lending, profitability, performance indicators, information asymmetry, and investors.

H1. Geopolitical risk (GPR) negatively affects bank stability in ASEAN.

2.2. Economic policy uncertainty (EPU) and bank stability

Governmental policies have considerable influence on the financial markets. Interventional (encouraging) policies can impede or promote financial markets and spill over to economic aspects [40]. Many scholars have explored the impact of economic policy uncertainty (EPU) on a variety of corporate and economic decisions. For instance, the impact of EPU on corporate investments [41]; corporate cash holdings [42]; mergers and acquisitions [43]; surveillance policy [44]; fiscal policy [45]; and regulatory policy [46]. EPU has been recognized as a significant threat, particularly in relation to regulatory and policy frameworks [40,47,48], and its impact on the banking industry has been studied [49–52].

EPU affects bank stability through several channels. Firstly, it escalates default risk and asymmetric information between borrowers and lenders [53]. The volatility of future cash flows and market returns also rises, leading to higher risk premiums and borrowing costs, which depress a company's efficiency and productivity [54]. Secondly, EPU influences bank stability and lending through demand-side effects, as higher uncertainty alleviates firms' funding needs and delays investment projects [55,56]. This results in reduced credit demand, lower lending rates, and negative effects on bank credit growth [50,57]. Lastly, the herd effect plays a role, as lending market participants may exhibit herd behavior during times of policy uncertainty, affecting bank lending decisions and potentially threatening bank stability [27,52]. Based on the above discussion, we propose the following hypothesis.

H2. Economic policy uncertainty (EPU) negatively affects bank stability in ASEAN.

2.3. Climate policy uncertainty (CPU) and bank stability

Experimental research has examined the relationship between climate disasters and financial stability, focusing on climate uncertainty policy (CPU). Two categories of studies have emerged in this area. Firstly, the studies by Refs. [58,59] indicate that climate disasters amplify risks. Specifically, studies find that climate-related disasters significantly raise the operational risk of banks in affected regions. Furthermore [60], demonstrate that a greater rise in green indexes compared to brown indexes helps minimize financial systemic risk. Secondly [61,62], show that climate disaster damage has a negative impact on financial stability. The implementation of climate policies directly affects the fossil fuel sector, resulting in stranded assets for energy-intensive companies. This leads to economic losses, credit defaults, and market value depreciation for companies. It also affects investor sentiment and can trigger crises. Theoretical modeling by Ref. [63] explains how climate policies induce financial risk using the post-Keynesian Stock-Flow Consistent (SFC) model [64]. construct a macroeconomic model that reveals a negative impact of climate policies on alternative energy infrastructure investment, causing economic recession and financial crises [65]. explore the influence of "carbon tax" and "green subsidy" policies on financial system stability, finding that investor sentiment about climate change significantly affects portfolio adjustments. Thus, the CPU can influence the stability of the financial system [66]. research suggests that climate policy encourages Chinese banks to take on higher risks and uncertainty. In the contemporary context, addressing climate change is undeniably a global imperative. It presents a multitude of challenges that transcend national boundaries, affecting every country. Governments find themselves compelled to consistently enact policies aimed at adapting to climate change. These policies, in turn, have a ripple effect, altering government expenditure, shaping economic activities, influencing corporate operations, and ultimately impacting the stability of the financial system. In light of these considerations, our research seeks to delve into the repercussions of CPU on bank stability within the ASEAN region.

H3. Climate policy uncertainty (CPU) negatively affects bank stability in ASEAN.

2.4. World pandemic uncertainty (WPU) and bank stability

During the pandemic, central banks took proactive steps by implementing monetary stimulus policies to alleviate concerns regarding the solvency and liquidity of non-financial companies. Numerous countries have introduced loan guarantee programs and credit support measures aimed at providing assistance to businesses [67,68]. These measures, particularly those related to loan guarantees and the government's acquisition of corporate bonds, infused much-needed liquidity into companies [69]. The pandemic has had various negative effects on the global economy and financial system, leading to a significant decline in countries' GDP growth rates [70,71]. The high degree of uncertainty surrounding the pandemic and the subsequent economic downturn has resulted in extreme unpredictability and volatility in the stock market [72,73]. Economic uncertainty has strengthened, elevating bank risk [27].

Recent literature has focused on the role of the COVID-19 pandemic in the banking sector [74]. observe a significant increase in systemic risk during the COVID-19 outbreak [75]. develop the bank equity stock options model and demonstrate that COVID-19 weakens banks' optimal interest rates, state injections enhance margins, and outbreaks and capital injections harm banking's performance. As a result, COVID-19 boosts banks' risk-taking propensity and affects their stability [76]. examine how COVID-19 has affected inventory profitability under different input conditions [77]. argue that COVID-19 negatively affects public and joint stock banks' asset quality in the short term and has a stronger negative impact on credit risks in the long term. The COVID-19 pandemic has had a lasting impact on the global economy, emphasizing the importance of investigating its effect on bank stability [78]. study the influence of COVID-19 on the geographic stability of banks and the effectiveness of liquidity pumping. They find a decline in bank stability due to the spread of the pandemic, with differences observed between high and low COVID-19 exposure locations. Based on the aforementioned arguments, we propose the following hypothesis.

H4. World pandemic uncertainty (WPU) negatively affects bank stability in ASEAN.

2.5. Global supply chain pressure (GSCP) and bank stability

Over the past few decades, the production of durable goods has become more fragmented, with firms outsourcing production processes to other countries to benefit from comparative advantages. Notwithstanding, this reliance on global value chains comes with risks [79]. Shocks in specific stages of the production process can propagate along the chain and disrupt firms dependent on inputs from affected regions. The pandemic has highlighted these risks through global lockdowns, low vaccination rates in emerging countries, and shipping disruptions in key ports, exerting additional pressure on supply chains [80,81]. For instance, COVID-19 has exposed vulnerabilities in the production structure of durable goods, which depends on global value chains [82]. These risks can be further aggravated when supply chains heavily depend on critical inputs from limited regions. As a result, even a minor demand shock to a vital sector can cause significant disruptions in supply and demand, leading to inflation [83,84]. demonstrate that inflation affects people's behavior, including the withdrawal of money and customers' ability to repay loans. This increase in non-performing loans turns down bank stability. Based on these arguments, our study proposes the following hypothesis under the scheme of increasing trade cooperation among ASEAN nations.

H5. Global supply chain pressure (GSCP) negatively affects bank stability in ASEAN.

2.6. Monetary policy uncertainty (MPU) and bank stability

Policy uncertainty arises due to the inherent imperfections in the information used for shaping policy decisions. This uncertainty can have a far-reaching impact, extending to institutional structures, governance strategies, and the monetary and financial systems. Consequently, factoring in policy uncertainty has the potential to enhance the effectiveness of policy decision-making as well as bolster the resilience of the financial and monetary systems [85]. While existing research on the effects of monetary policy uncertainty (MPU) has predominantly focused on its implications for financial markets and corporate decisions [86,87], it has paid relatively less attention to the stability of the banking sector. Some studies suggest a negative correlation between a bank's leverage, risk-taking, and short-term interest rates [88,89]. Given that MPU introduces significant uncertainty regarding short-term interest rate movements, its potential impact on banking stability cannot be overlooked. Interest rates play a pivotal role in guiding household consumption and firm investment, and uncertainty about future interest rates can exert influence on crucial economic variables, including investments, inflation, and overall growth [90,91]. In Asian countries, the uncertainty surrounding US interest rates can reverberate through exchange rates, market sentiment, and capital flows, thereby influencing the stability of banking institutions [87]. Furthermore, MPU, manifested through uncertain interest rates, is more likely to affect corporate investment activities, potentially diminishing stability within the banking sector [92]. Based on these arguments, our study proposes the following hypothesis.

H6. Monetary policy uncertainty (MPU) negatively affects bank stability in ASEAN.

3. Data and methodology

3.1. Sample and database

This study examines annual data from 157 banks across eight ASEAN economies (Cambodia, Laos, Singapore, the Philippines, Vietnam, Thailand, Malaysia, and Indonesia). Bank-specifics are gathered from the Focus Bank Orbis Database in order to investigate the characteristics of banks between 2010 and 2020. The following banks are excluded from our sample: (1) those with fewer than three years of continuous observations; and (2) those with outlier data, which may result in measurement mistakes and therefore affect risk measurement. To generate a strongly balanced panel data sample, we take off banks with less than 11 years of data. Financial variables are winsorized at the 1 % and 99 % levels to minimize outliers in our sample. Four macroeconomic uncertainties (MU) are downloaded from the economic policy uncertainty database, including global geopolitical risk (GPR); global economic policy uncertainty (EPU); climate policy uncertainty (CPU); and US monetary policy uncertainty (MPU) indexes.[1] Additionally, the global supply change pressure (GSCP) and world pandemic uncertainty (WPU) indexes are collected from the New York Fed data[2] and Fred economic data,[3] respectively. All macroeconomic uncertainty (MU) variables are collected and computed, covering the period 2010–2020.

3.2. Empirical models

In order to investigate the effects of macroeconomic uncertainties (MU) on bank stability in ASEAN countries, we build up the baseline Model (1) as described in a large number of reputable studies [4,7,66,93,94]:

$$ZSCORE_{i,t} = \alpha + \beta_1 * BC_{i,j,t-1} + \beta_2 * BSC_{j,t} + \beta_3 * MU_{m,t} + £_{i,t} + \mu_i \quad (1)$$

where $ZSCORE_{i,t}$ denotes the bank stability for the bank (i) in the year (t). Following [7,14,94], ZSCORE _n is used as an alternative measure of bank stability. Higher ZSCORE and ZSCORE_n show that the bank has relatively more stability (less risk) than its counterparts. Bank-characteristic ($BC_{i,j,t}$) variables consist of bank scale ($SIZE_{i,t}$), bank capital structure ($LTA_{i,t}$), loan loss provisions ($LLP_{i,t}$), credit risk ($NPL_{i,t}$) of the bank (i) for the year (t) in the country (j). $ZSCORE(Country)_{j,t}$ and $CONCEN(Country)_{j,t}$ stand for banking system stability and banking system concentration in the country (j) for the year (t), respectively. $MU_{m,t}$ denominations macroeconomic uncertainty (m) in the year (t). Six factors (MU_m) are in place of macroeconomic uncertainties: geopolitical risk (LnGPR), economic policy uncertainty (LnEPU), climate policy uncertainty (LnCPU), world pandemic uncertainty (WPU), global supply chain pressure (GSCP), and monetary policy uncertainty (LnMPU). To address the first and second gaps (posited in the Introduction section), we conduct regression Eq. (1) with six uncertain variables for the entire sample, respectively. The sign of the β_3 coefficient displays the effect of macroeconomic uncertainty variables on bank stability in ASEAN nations. We lag these variables across one period in Eq. (1), which helps us to diminish endogeneity issues [95].

According to Refs. [96,97]'s studies, the fixed effects of the bank are considered in our analysis. Due to the absence of certain bank observations from different countries in our dataset, our panel is uneven. Therefore, we use the fixed-effects estimator to regress the fundamental Eq. (1). The fixed-effects estimator is suitable in our case because the unobserved bank-level variables are temporal fixed effects and are not random. We cluster the standard errors at the bank level. μ_i represents the bank-fixed effects, and $£_{i,t}$ represents the error term. Moreover, we examine the robustness of our findings by employing an alternative dependent variable (ZSCORE_n) and

[1] https://www.policyuncertainty.com.
[2] https://www.newyorkfed.org/research/policy/gscpi#/overview.
[3] https://fred.stlouisfed.org/series/WUPI.

Table 1
Variable definition and measurement.

Variables	Definition	Measurement
Dependent variable		
ZSCORE	Bank stability	ZSCORE = Ln((ROA + E/A)/σ(ROA)). ROA is the return on assets, E denotes total equity, A denotes total assets, and σ (ROA) estimates the standard deviation of ROA, calculated over a three-year rolling window.
ZSCORE_n		Normalized ZSCORE (ZSCORE_n) is calculated by the following formula. ZSCORE_n = [Z – min(Z)]/[max (Z) – min (Z)], where min and max represent the minimum and the maximum of ZSCORE in each market over the sample period, respectively.
Independent variables		
Bank characteristics		
SIZE	Bank Scale	Natural logarithm of bank assets (Unit is 1 USD($)).
LTA	Bank capital structure	Net loans to total assets.
LLP	Loan loss provisions	The loan loss provisions to total loans.
NPL	Credit risk	Non-performing loans to total loans.
LER	Competitiveness (Lener Index)	$Lerner_{i,t} = (P_{i,t} - MC_{i,t})/P_{i,t}$. $P_{i,t}$ is the price of total assets calculated as the ratio of total revenue to total assets of a bank (i) at the time (t). $MC_{i,t}$ is the marginal cost of producing one more unit of output.
DIV	Diversification	Non-interest income to total operating income.
Banking system characteristics		
ZSCORE (Country)	Banking system stability	Banking system Z-scores captures the probability of default of a country's banking system. Z-score compares the buffer of a country's banking system (capitalization and returns) with the volatility of those returns. It is estimated as (ROA+(E/A))/sd(ROA); sd(ROA) is the standard deviation of ROA. ROA, E (total equity), and A (total assets) are country-level aggregate figures.
CONCEN (Country)	Banking system concentration	Percent of bank assets held by the top three banks.
Macroeconomic uncertainties (MU)		
LnGPR	Global Geopolitical Risk (GPR)	Annual GPR is measured by the logarithm of an average of twelve-monthly global GPR indexes. where: global GPR index is proposed by Caldara & Iacoviello (2022). The global GPR index uses ten newspapers and it started in 1985.
LnEPU	Global Economic Policy Uncertainty (EPU)	Annual EPU is measured by the logarithm of an average of twelve-monthly global EPU indexes. where: global EPU index is proposed by Baker et al. (2016).
LnCPU	Climate Policy Uncertainty (CPU)	Annual CPU is measured by the logarithm of an average of twelve-monthly U.S CPU indexes. where: CPU is proposed by Gavriilidis (2021).
WPU	World Pandemic Uncertainty (WPU)	Annual WPU is measured by an average of four-quarterly WPU indexes. where: WPU is proposed by Ahir, Bloom, & Furrerci (2018). The WPU Index is constructed by counting the number of times uncertainty is mentioned within proximity to a word related to pandemics in the Economist Intelligence Unit country reports.
GSCP	Global Supply Chain Pressure (GSCP)	Annual GSCP is calculated by an average of twelve-monthly GSCP indexes. where: GSCP Index is a product of the Applied Macroeconomics and Econometrics Center (AMEC).
LnMPU	Monetary Policy Uncertainty (MPU)	Annual MPU is measured by the logarithm of an average of twelve-monthly U.S MPU indexes. where: MPU index for the US is proposed by Baker et al. (2016).

Table 1 shows the definition and measurement of all used variables in this study.

Table 2
Summary statistics.

Variables		Obs.	Mean	Std. dev.	Min	Max
Bank stability	ZSCORE	1727	0.7943	0.5429	−2.9666	3.0506
	ZSCORE_n	1727	0.5916	0.1767	0.0000	1.0000
Bank characteristics	SIZE	1727	6.7592	0.8057	4.6090	8.6916
	LTA	1727	0.6108	0.1316	0.1487	0.9162
	LLP	1727	0.9389	1.2659	−1.9634	13.1294
	NPL	1727	0.0347	0.1233	0.0001	1.4712
Banking system characteristics	ZSCORE(Country)	1727	0.1210	0.0927	0.0041	0.3693
	CONCEN(Country)	1727	0.4318	0.1807	0.0053	0.9526
Macroeconomic uncertainty	LnGPR	1727	4.5219	0.1066	4.3476	4.6763
	LnEPU	1727	5.0952	0.3193	4.6632	5.7685
	LnCPU	1727	4.8096	0.3246	4.3509	5.3872
	WPU	1727	1.6432	4.9313	0.0000	17.2288
	GSCP	1727	0.0373	0.5911	−0.6436	1.5043
	LnMPU	1727	4.2853	0.3936	3.6761	4.9575

Table 2 shows summary statistics of all variables, used in the baseline Model (1). All financial variables are winsorized at the 1 % and 99 % levels.

conducting additional econometric estimations, such as the System-Generalized Method of Moments (SGMM) estimation and Quantile regression (QR). SGMM estimation allows the solving of endogenous matters [14]. QR provides a deep insight into the nexus between MU and bank stability at various deciles [7,91]. Refer to Table 1 for detailed definitions and measurements of all variables.

3.3. Descriptive statistics

Summary statistics regarding the variables used are displayed in Table 2. ZSCORE and ZSCORE_n averages for eight ASEAN nations are 0.7943 and 0.5916. ZSCORE reaches a minimum of −2.9666, a maximum of 3.0506, and has a standard deviation of 0.5429. These figures suggest that the bank stability of ASEAN countries varies across countries and is not great [98]. Singaporean and Laos banks have higher ZSCORE values compared to those of banks in other ASEAN markets. Geopolitical risk (LnGPR), climate policy uncertainty (LnCPU), economic policy uncertainty (LnEPU), world pandemic uncertainty (WPU), global supply chain pressure (GSCP), and monetary policy uncertainty (LnMPU) have an average value of 4.5219, 4.8096, 5.0952, 1.6432, 0.0373, and 4.2853, respectively. The basic statistics of other control variables display relevance.

4. Empirical analysis

4.1. Baseline analysis

Table 3 presents the empirical results from the baseline model (1) for the entire sample, focusing on the ZSCORE-dependent variable. In Column 1, the estimated results demonstrate the influence of bank characteristics (SIZE, LTA, LLP, and NPL) on bank stability in the ASEAN region. Column 2 includes the impacts of both bank and banking system characteristics on bank stability. All estimated coefficients for the six macroeconomic uncertainty (MU) variables are respectively shown in Columns 3–8.

Negative and significant coefficients of NPL and LLP variables implicate that increased credit risk impairs bank stability in the ASEAN area. These results are robust to the findings in the papers of [94,99] that banks with higher credit risk tend to have poorer stability than banks with lower credit risk. Positive and significant coefficients of SIZE and LTA variables imply that larger banks and banks with high loan ratios are more stable [94]. Large banks are better able to diversify their funding sources and loan portfolios, thereby worsening their risk of insolvency compared to small banks [16]. The negative coefficients of CONCEN(Country) variables are significant, showing that more concentrated banking systems have higher risks [45]. This finding is consistent with the "concentration-fragility" hypothesis that banks can raise lending rates because they have more market power, which raises the credit risk they

Table 3
The impact of macroeconomic uncertainty (MU) on bank stability (ZSCORE).

Variables	ZSCORE is the dependent variable							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag.SIZE	0.2405**	0.2320**	0.2375**	0.3331***	0.3329***	0.4035***	0.3771***	0.2651**
	(0.1024)	(0.1031)	(0.1020)	(0.1177)	(0.1148)	(0.1078)	(0.1057)	(0.1021)
Lag.LTA	0.6620***	0.6958***	0.6226***	0.6863***	0.6961***	0.6393***	0.6157**	0.5932**
	(0.2342)	(0.2372)	(0.2369)	(0.2389)	(0.2405)	(0.2403)	(0.2399)	(0.2363)
Lag.LLP	-0.0497***	-0.0489***	-0.0532***	-0.0477***	-0.0462***	-0.0509***	-0.0463***	-0.0542***
	(0.0119)	(0.0120)	(0.0121)	(0.0119)	(0.0118)	(0.0123)	(0.0119)	(0.0120)
Lag.NPL	-1.1560**	-1.1245**	-1.0602**	-1.0637**	-1.0660**	-1.0061**	-0.9677**	-0.9915**
	(0.4646)	(0.4649)	(0.4516)	(0.4439)	(0.4461)	(0.4268)	(0.4295)	(0.4374)
ZSCORE(Country)		0.1483	0.2732	0.1027	0.0447	0.0876	-0.0269	0.2482
		(0.1817)	(0.1782)	(0.1780)	(0.1795)	(0.1794)	(0.1805)	(0.1791)
CONCEN(Country)		-0.2425***	-0.2145***	-0.2133***	-0.2204***	-0.1701**	-0.1764***	-0.1965***
		(0.0661)	(0.0681)	(0.0666)	(0.0657)	(0.0654)	(0.0650)	(0.0678)
LnGPR			0.3163**					
			(0.1309)					
LnEPU				-0.1105**				
				(0.0549)				
LnCPU					-0.1056**			
					(0.0521)			
WPU						-0.0162***		
						(0.0028)		
GSCP							-0.1102***	
							(0.0240)	
LnMPU								-0.1235***
								(0.0336)
Constant	-1.1258*	-1.0079	-2.4585***	-1.1266*	-1.1797*	-2.1245***	-1.9488***	-0.6728
	(0.6498)	(0.6585)	(0.9425)	(0.6569)	(0.6595)	(0.6878)	(0.6774)	(0.6419)
Obs.	1,570	1,570	1,570	1,570	1,570	1,570	1,570	1,570
R squared	0.0506	0.0569	0.0625	0.0620	0.0619	0.0892	0.0775	0.0693
Banks	157	157	157	157	157	157	157	157
BFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 3 reports estimated results from the baseline model (1). The dependent variable of ZSCORE is bank stability. Column (1) shows the impact of bank characteristics on bank stability. Column (2) displays the effect of bank characteristics and banking system characteristics on bank stability. Columns (3-8) report the influences of bank characteristics, banking system characteristics, and macroeconomic uncertainty (MU) variables on bank stability. MU variables include LnGPR, LnEPU, LnCPU, WPU, GSPC, and LnMPU, they are key explanatory variables. Robust standard errors are in parentheses. ***denotes significance at a 1% level. **denotes significance at a 5%. *denotes significance at a 10% level.

Table 4
Heterogeneity effects of bank characteristics.

Panel A: Small banks – Large banks												
Variables	Zscore is the dependent variable											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
Lag.SIZE	0.2619*	0.3107	0.3652**	0.4598*	0.4112**	0.3964*	0.3659**	0.7347***	0.3604**	0.6161***	0.2655*	0.3547*
	(0.1370)	(0.1998)	(0.1702)	(0.2392)	(0.1659)	(0.2346)	(0.1476)	(0.2199)	(0.1447)	(0.2281)	(0.1371)	(0.2022)
Lag.LTA	0.5658	1.0048***	0.4593	1.2970***	0.4366	1.2877***	0.4295	1.2386***	0.3944	1.2319***	0.4949	1.0738***
	(0.3739)	(0.2891)	(0.3620)	(0.3182)	(0.3605)	(0.3228)	(0.3671)	(0.2975)	(0.3646)	(0.3113)	(0.3712)	(0.2919)
Lag.LLP	−0.0282**	−0.0954***	−0.0282**	−0.0777***	−0.0260**	−0.0762***	−0.0314**	−0.0848***	−0.0273**	−0.0724***	−0.0310**	−0.0922***
	(0.0131)	(0.0196)	(0.0126)	(0.0202)	(0.0121)	(0.0203)	(0.0132)	(0.0202)	(0.0127)	(0.0208)	(0.0133)	(0.0199)
Lag.NPL	−1.4083*	−0.2693	−1.2744*	−0.4269	−1.2295*	−0.4419	−1.2695*	−0.2620	−1.2427*	−0.2583	−1.3677*	−0.1970
	(0.8054)	(0.3227)	(0.7454)	(0.3650)	(0.7249)	(0.3720)	(0.7269)	(0.3386)	(0.7286)	(0.3666)	(0.7897)	(0.3286)
ZSCORE(Country)	0.2038	0.2370	0.2289	−0.0122	0.0680	−0.0367	0.3764	−0.1807	0.2131	−0.2929	0.2918	0.1997
	(0.3246)	(0.2172)	(0.3246)	(0.2204)	(0.3259)	(0.2244)	(0.3360)	(0.2180)	(0.3237)	(0.2193)	(0.3193)	(0.2253)
CONCEN(Country)	−0.1977	−0.2080**	−0.1942	−0.2397***	−0.1737	−0.2706***	−0.1453	−0.1929**	−0.1679	−0.1826**	−0.1931	−0.2068**
	(0.1333)	(0.0812)	(0.1327)	(0.0788)	(0.1325)	(0.0766)	(0.1340)	(0.0756)	(0.1318)	(0.0765)	(0.1356)	(0.0789)
LnGPR	−0.0361	0.5962***										
	(0.2215)	(0.1778)										
LnEPU			−0.1446	−0.1537**								
			(0.1105)	(0.0670)								
LnCPU					−0.1894*	−0.1141*						
					(0.1013)	(0.0609)						
WPU							−0.0141***	−0.0228***				
							(0.0053)	(0.0036)				
GSCP									−0.1012**	−0.1591***		
									(0.0428)	(0.0308)		
LnMPU											−0.0552	−0.1811***
											(0.0636)	(0.0416)
Constant	−1.0006	−4.4861***	−0.9898	−2.2323	−1.0720	−1.9855	−1.7268**	−4.9537***	−1.6722**	−4.1220**	−0.9203	−1.3796
	(1.3010)	(1.6838)	(0.7514)	(1.5761)	(0.7631)	(1.5678)	(0.8429)	(1.5688)	(0.8300)	(1.6305)	(0.7936)	(1.4365)
Obs.	651	862	651	862	651	862	651	862	651	862	651	862
R squared	0.0523	0.0880	0.0592	0.0756	0.0649	0.0718	0.0702	0.1372	0.0663	0.1104	0.0543	0.0957
Banks	81	104	81	104	81	104	81	104	81	104	81	104
BFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: Low loan ratios – High loan ratios												
Variables	Zscore is the dependent variable											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Lag.SIZE	0.3857**	0.2739*	0.3916**	0.3908**	0.3745**	0.3996**	0.5399***	0.5131***	0.4702***	0.4668***	0.3987***	0.3277**
	(0.1476)	(0.1570)	(0.1810)	(0.1758)	(0.1736)	(0.1689)	(0.1575)	(0.1703)	(0.1591)	(0.1620)	(0.1503)	(0.1549)
Lag.LTA	0.3173	−0.7770**	0.3642	−0.7440*	0.3586	−0.7380*	0.3788	−0.6785*	0.3565	−0.8034**	0.3425	−0.8050**
	(0.3482)	(0.3906)	(0.3581)	(0.3919)	(0.3602)	(0.3910)	(0.3477)	(0.3826)	(0.3562)	(0.3835)	(0.3537)	(0.3905)
Lag.LLP	−0.0006	−0.1205***	0.0023	−0.1092***	0.0025	−0.1059***	−0.0036	−0.1141***	0.0005	−0.1046***	0.0001	−0.1231***
	(0.0198)	(0.0305)	(0.0201)	(0.0295)	(0.0198)	(0.0292)	(0.0200)	(0.0288)	(0.0197)	(0.0295)	(0.0203)	(0.0298)
Lag.NPL	−1.3148	−0.9627*	−1.3432	−0.9523*	−1.3276	−0.9521*	−1.0913	−0.8543	−1.3131	−0.8117	−1.3378	−0.8463*
	(1.3316)	(0.5177)	(1.3444)	(0.5213)	(1.3361)	(0.5280)	(1.2735)	(0.5199)	(1.3656)	(0.5129)	(1.3485)	(0.4974)

(*continued on next page*)

Table 4 (*continued*)

Panel B: Low loan ratios – High loan ratios												
Variables	Zscore is the dependent variable											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
ZSCORE(Country)	0.4596	−0.1834	0.2876	−0.3506	0.2997	−0.4132*	0.3827	−0.4296*	0.2692	−0.5580**	0.3376	−0.1674
	(0.3379)	(0.2240)	(0.3410)	(0.2313)	(0.3448)	(0.2354)	(0.3336)	(0.2277)	(0.3412)	(0.2452)	(0.3319)	(0.2312)
CONCEN(Country)	−0.0378	−0.1809**	−0.0581	−0.1808**	−0.0608	−0.1917**	−0.0185	−0.1403*	−0.0303	−0.1458*	−0.0470	−0.1581*
	(0.1428)	(0.0807)	(0.1383)	(0.0798)	(0.1378)	(0.0786)	(0.1373)	(0.0783)	(0.1387)	(0.0774)	(0.1408)	(0.0801)
LnGPR	0.3030	0.3007*										
	(0.2362)	(0.1725)										
LnEPU			0.0081	−0.1144*								
			(0.1009)	(0.0689)								
LnCPU					0.0261	−0.1225*						
					(0.0926)	(0.0648)						
WPU							−0.0142***	−0.0193***				
							(0.0048)	(0.0036)				
GSCP									−0.0655	−0.1317***		
									(0.0415)	(0.0318)		
LnMPU											−0.0480	−0.1440***
											(0.0592)	(0.0423)
Constant	−3.3483**	−1.5702	−2.0488**	−0.4363	−2.0186**	−0.4875	−2.9980***	−1.8865	−2.5287**	−1.5065	−1.8479*	0.0404
	(1.5459)	(1.4438)	(0.9835)	(1.1416)	(0.9870)	(1.1304)	(1.0137)	(1.2190)	(1.0350)	(1.1610)	(0.9707)	(1.1124)
Obs.	547	818	547	818	547	818	547	818	547	818	547	818
R squared	0.0466	0.0636	0.0416	0.0634	0.0419	0.0647	0.0643	0.0984	0.0489	0.0843	0.0435	0.0760
Banks	103	121	103	121	103	121	103	121	103	121	103	121
BFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel C: Less income diversification – More income diversification												
Variables	ZSCORE is the dependent variable											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Less	More	Less	More	Less	More	Less	More	Less	More	Less	More
Lag.SIZE	0.3973***	0.0895	0.3665*	0.3472*	0.3458*	0.3945**	0.5150***	0.3752*	0.4434***	0.4220**	0.4050***	0.1417
	(0.1495)	(0.1901)	(0.1885)	(0.1912)	(0.1874)	(0.1802)	(0.1591)	(0.2114)	(0.1631)	(0.1848)	(0.1504)	(0.1874)
Lag.LTA	0.7792**	0.4452	0.8174***	0.5072	0.8135***	0.5186	0.7954**	0.4550	0.7983***	0.2750	0.7863***	0.3295
	(0.3003)	(0.3868)	(0.3002)	(0.3879)	(0.2995)	(0.3828)	(0.3067)	(0.3864)	(0.3037)	(0.3573)	(0.3003)	(0.3790)
Lag.LLP	−0.0276*	−0.1171***	−0.0254*	−0.1018***	−0.0262*	−0.0918***	−0.0257*	−0.1095***	−0.0243	−0.0910***	−0.0272*	−0.1197***
	(0.0149)	(0.0181)	(0.0153)	(0.0149)	(0.0155)	(0.0147)	(0.0146)	(0.0154)	(0.0149)	(0.0133)	(0.0149)	(0.0162)
Lag.NPL	−1.3335*	−2.7831*	−1.4032*	−2.6567*	−1.4063*	−2.7081*	−1.3169*	−2.4618	−1.3484*	−2.3241	−1.3396*	−2.4279
	(0.7251)	(1.5953)	(0.7395)	(1.5448)	(0.7511)	(1.5696)	(0.6872)	(1.6176)	(0.7012)	(1.5983)	(0.7175)	(1.5047)
ZSCORE(Country)	0.4261	−0.2365	0.3487	−0.4876*	0.3776	−0.7167***	0.3396	−0.4637*	0.3120	−0.8035***	0.3755	−0.1917
	(0.2648)	(0.2827)	(0.2613)	(0.2647)	(0.2560)	(0.2643)	(0.2653)	(0.2707)	(0.2611)	(0.2631)	(0.2640)	(0.2775)
CONCEN(Country)	−0.2169**	−0.2031*	−0.2416**	−0.2312**	−0.2457***	−0.2496**	−0.1865**	−0.1595	−0.2100**	−0.1707	−0.2140**	−0.1928*
	(0.0977)	(0.1120)	(0.0948)	(0.1115)	(0.0935)	(0.1115)	(0.0935)	(0.1120)	(0.0941)	(0.1085)	(0.0963)	(0.1120)
LnGPR	0.2097	0.4181*										
	(0.1818)	(0.2375)										
LnEPU			0.0333	−0.2802***								
			(0.0861)	(0.0799)								
LnCPU					0.0536	−0.3215***						

(*continued on next page*)

Table 4 (*continued*)

Panel C: Less income diversification – More income diversification												
Variables	ZSCORE is the dependent variable											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Less	More	Less	More	Less	More	Less	More	Less	More	Less	More
					(0.0805)	(0.0814)						
WPU							−0.0118***	−0.0255***				
							(0.0039)	(0.0059)				
GSCP									−0.0365	−0.2463***		
									(0.0339)	(0.0396)		
LnMPU											−0.0483	−0.2124***
											(0.0471)	(0.0518)
Constant	−3.1977**	−1.5259	−2.2165**	−0.0087	−2.1658**	−0.2011	−3.0221***	−1.5929	−2.5559**	−1.8207	−2.0920**	0.9583
	(1.3020)	(1.9285)	(0.9903)	(1.2318)	(1.0103)	(1.2050)	(1.0069)	(1.4503)	(1.0416)	(1.2670)	(0.9429)	(1.2449)
Obs.	942	462	942	462	942	462	942	462	942	462	942	462
R squared	0.0646	0.1277	0.0626	0.1477	0.0633	0.1590	0.0786	0.1839	0.0643	0.2101	0.0640	0.1554
Banks	123	85	123	85	123	85	123	85	123	85	123	85
BFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel D: Low competitiveness – High competitiveness												
Variables	ZSCORE is the dependent variable											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Lag.SIZE	0.0697	0.3204	0.1374	0.3446	0.1255	0.3226	0.2928*	0.5291**	0.2280	0.4516**	0.1048	0.3419*
	(0.1555)	(0.2033)	(0.1760)	(0.2124)	(0.1697)	(0.2060)	(0.1705)	(0.2078)	(0.1656)	(0.2026)	(0.1547)	(0.2022)
Lag.LTA	0.8128***	0.3763	0.8872***	0.4566	0.8972***	0.4624	0.7976***	0.4052	0.8014***	0.3792	0.7942***	0.3752
	(0.2732)	(0.4487)	(0.2778)	(0.4378)	(0.2780)	(0.4353)	(0.2837)	(0.4585)	(0.2858)	(0.4499)	(0.2763)	(0.4455)
Lag.LLP	−0.0536***	−0.0284	−0.0480***	−0.0200	−0.0469***	−0.0195	−0.0520***	−0.0263	−0.0448***	−0.0232	−0.0545***	−0.0268
	(0.0152)	(0.0330)	(0.0152)	(0.0305)	(0.0150)	(0.0308)	(0.0156)	(0.0316)	(0.0155)	(0.0297)	(0.0153)	(0.0318)
Lag.NPL	−1.1228*	−0.8865	−1.1604*	−0.8610	−1.1682*	−0.8926	−1.0668*	−0.6137	−1.0941*	−0.5278	−1.0780*	−0.7711
	(0.6496)	(1.3649)	(0.6580)	(1.3799)	(0.6614)	(1.3651)	(0.6138)	(1.3956)	(0.6395)	(1.3590)	(0.6335)	(1.3825)
ZSCORE(Country)	0.0629	0.3507	−0.0969	0.1593	−0.1309	0.1511	−0.1780	0.2418	−0.2793	0.1741	0.0503	0.2505
	(0.2324)	(0.4160)	(0.2344)	(0.4310)	(0.2413)	(0.4326)	(0.2284)	(0.4190)	(0.2387)	(0.4172)	(0.2322)	(0.4211)
CONCEN(Country)	−0.1862**	−0.3812***	−0.1984**	−0.3948***	−0.2065**	−0.3990***	−0.1474*	−0.3298***	−0.1659**	−0.3406***	−0.1744**	−0.3657***
	(0.0832)	(0.1223)	(0.0815)	(0.1190)	(0.0809)	(0.1180)	(0.0798)	(0.1183)	(0.0800)	(0.1214)	(0.0815)	(0.1254)
LnGPR	0.3197*	0.3864										
	(0.1687)	(0.2590)										
LnEPU			−0.0806	−0.0212								
			(0.0668)	(0.0858)								
LnCPU					−0.0705	−0.0005						
					(0.0629)	(0.0808)						
WPU							−0.0168***	−0.0146**				
							(0.0034)	(0.0058)				
GSCP									−0.1027***	−0.0844*		
									(0.0297)	(0.0455)		
LnMPU											−0.1213***	−0.0938
											(0.0411)	(0.0628)
Constant	−1.4344	−3.0756*	−0.0630	−1.4065	−0.0529	−1.3699	−1.4746	−2.6947**	−1.0434	−2.1928*	0.2954	−1.0648
	(1.3781)	(1.6713)	(1.0398)	(1.2286)	(1.0289)	(1.2223)	(1.1174)	(1.2624)	(1.0834)	(1.2378)	(1.0089)	(1.2314)

(*continued on next page*)

Table 4 (*continued*)

Panel D: Low competitiveness – High competitiveness												
Variables	ZSCORE is the dependent variable											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Obs.	1017	429	1017	429	1017	429	1017	429	1017	429	1017	429
R squared	0.0515	0.0544	0.0481	0.0461	0.0476	0.0460	0.0824	0.0700	0.0630	0.0580	0.0580	0.0533
Banks	129	71	129	71	129	71	129	71	129	71	129	71
BFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4 shows the impact of macroeconomic uncertainty (MU) on bank stability for heterogeneous bank types. The dependent variable of ZSCORE is bank stability. MU variables include LnGPR, LnEPU, LnCPU, WPU, GSCP, and LnMPU, they are key explanatory variables. In Panel A, we split the banks for every country each year. A bank with a value greater than the bank median is classified as large-size. A bank with a value equal to or less than the country median is classified as small size. Robust standard errors in parentheses. *** denotes significance at a 1 % level, ** denotes significance at a 5 %, * denotes significance at a 10 % level.

Table 4 shows the impact of macroeconomic uncertainty (MU) on bank stability for heterogeneous bank types. The dependent variable of ZSCORE is bank stability. MU variables include LnGPR, LnEPU, LnCPU, WPU, GSCP, and LnMPU, they are key explanatory variables. In Panel B, we split the banks for every country each year. A bank with a value greater than the bank median is classified as having high loan ratios. A bank with a value equal to or less than the country median is classified as having low loan ratios. Robust standard errors in parentheses. *** denotes significance at a 1 % level, ** denotes significance at a 5 %, * denotes significance at a 10 % level.

Table 4 shows the impact of macroeconomic uncertainty (MU) on bank stability for heterogeneous bank types. The dependent variable of ZSCORE is bank stability. MU variables include LnGPR, LnEPU, LnCPU, WPU, GSCP, and LnMPU, they are key explanatory variables. In Panel C, the income diversification index (DIV) is computed as the ratio of non-interest incomes to total operating incomes. We split the banks for every country each year. A bank with a value greater than the bank median is classified as more diversified. A bank with a value equal to or less than the country median is classified as less diversified. Robust standard errors in parentheses. *** denotes significance at a 1 % level, ** denotes significance at a 5 %, * denotes significance at a 10 % level.

Table 4 shows the impact of macroeconomic uncertainty (MU) on bank stability for heterogeneous bank types. The dependent variable of ZSCORE is bank stability. MU variables include LnGPR, LnEPU, LnCPU, WPU, GSCP, and LnMPU, they are key explanatory variables. In Panel D, the Lerner index is used for measuring the bank's competitiveness. $Lerner_{it} = (P_{it} - MC_{it})/P_{it}$. The P_{it} variable is the price of total assets calculated as the ratio of total revenue to total assets of a bank (i) at the time (t). MC_{it} is the marginal cost of producing one more unit of output. We split the banks for every country each year. A bank with a value greater than the bank median is classified as high competitiveness. A bank with a value equal to or less than the country median is classified as low competitiveness. Robust standard errors in parentheses. *** denotes significance at a 1 % level, ** denotes significance at a 5 %, * denotes significance at a 10 % level.

incur as well as the overall risk profile of the financial system.

Notably, the positive coefficient of LnGPR variable in Column 3 is significant, implying that a surge in GPR may spike the stability of ASEAN banks. This finding diverges from prior results on US banks [4], which showed that GPR intensifies loan costs and banks' instability in the US. Conversely, the effect of GPR on bank stability can be positive when the pressure on GPR is relatively low [100]. As the world's greatest economy, the US economy is incredibly influential. The reality is that the world's most significant financial crises—like the Great Depression (1929), the Global Financial Crisis (2008), the COVID-19 pandemic (2020), and others—all started in the US financial system and then spilled over to other economies. Other political conflicts that involved the US and had an impact on the global economy included the US-China trade war, the Iraq war, and most recently, the Russia-Ukraine dispute. Our evidence suggests that the ASEAN region may experience less pressure from increasing global GPR, allowing ASEAN banks to seize opportunities presented by this risk to improve their efficiency while banks in other areas struggle to cope with GPR.

The negative coefficients of LnEPU, LnCPU, WPU, GSCP, and LnMPU are significant in Columns 4–8. In Column 4, the adverse relationship between LnEPU and ZSCORE indicates that global economic policy uncertainty (EPU) distorts bank stability in ASEAN. This aligns with previous findings by Refs. [7,101] that EPU alters sectoral stability by reducing credit quantity, increasing non-performing loans, and increasing loan loss provisions in banks. Besides that [14], admit that either low demand or supply sides occur during extreme uncertainty. They are key reasons that explain why geopolitical and economic uncertainty influence bank efficiency through poorer profitability and value. The negative coefficients of LnCPU in Column 5 suggest that climate policy uncertainty (CPU) plummets the instability of ASEAN banks. This finding is consistent with the results of [66] on Chinese banks. The CPU prompts nations to establish appropriate climate policies and resolutions to lead the sector and mitigate risk. Uncertainty in setting policies can impact a country's financial stability and economic conditions [102]. Banks, being integrated into the finance sector, bear the brunt of such risk, and the regression results confirm that CPU intensifies the instability of ASEAN banks.

In Column 6, the negative coefficients of WPU indicate that the surrounding uncertainty policies contribute to higher instability in ASEAN economies. The COVID-19 pandemic has caused economic downturns, making the equity market extremely difficult and volatile. Governments often require banks to loosen credit to rescue economies from severe effects of the epidemic, which leads to increased risk-taking by banks and heightened instability in the banking system. In Column 7, negative coefficients of GSCP imply that enhanced pressure on the global supply chain amplifies bank instability in ASEAN. Globalization and integration have facilitated free trade among countries, resulting in tightly linked supply and demand chain borders. The COVID-19 pandemic amplifies the pressure on global supply chains owing to lockdowns, high shipping costs, and transportation disruptions. Reduced customer demand and scarce supply sources significantly alleviate trade activities and place banks and the banking system at greater risk from global supply chains. The empirical evidence sheds light on the effect of GSCP on bank stability, an interesting theme that has not been thoroughly explored in previous studies.

Finally, in Column 8, the adverse relationship between monetary policy (MPU) and bank stability is observed. United States MPU is not only significantly influenced by the uncertainty of interest rates in the US market but also by other factors. Interest rate instability affects the volatility of deposits and loans in banks. Given that most banks in the ASEAN region rely heavily on interest income, MPU significantly raises bank stability by directly affecting earnings volatility. To summarize, global GPR is positively correlated with bank stability, while global EPU, CPU, WPU, GSCP, and MPU amplify bank instability in the ASEAN region. In short, most global macroeconomic shocks have a high potential to amplify bank risk and result in the banking system collapsing. A contagion through banks in the economic community is a catalyst for this issue. The estimated results in Table 3 provide a comprehensive understanding of the impact of macroeconomic uncertainties on ASEAN bank stability, effectively addressing the current research gaps.

4.2. Further analyses

In order to fill the third gap posed in the Introduction part, we implement further analyses in this section. The "too big to fail" doctrine proposes that sizable, interconnected financial institutions may cause systemic risk if permitted to fail, particularly if they do so "disorderly" [103]. Therefore, we expect that the impact of macroeconomic uncertainties on bank stability is more pronounced in large banks than in small banks. Secondly, when facing higher uncertainties, banks tend to hold higher equity ratios as conservative actions [104]. Precautionary motives push bank managers to store equity ratios and shorten loan supply to avoid high credit risks. Thirdly, competition motivates banks to strengthen their effectiveness, which leads to improved stabilization in the long term [7,105]. Banks with highly competitive abilities are easier to survive in market-oriented economies than ones with lowly competitive abilities. Put differently, banks with high competitiveness are most likely to easily cope with increased risks from the macroeconomic environment, which is concordant with the "competition-stability" hypothesis [106]. Fourthly, the relationship between income diversification and bank stability is a trade-off in emerging markets [99]. Income diversification requires higher costs than benefits for banks, leading to enhanced bank instability [20].

Firstly, Table 4 presents the exercise evidence about the mediation effect of bank features (SIZE, LTA, LER, and DIV) in the link between bank stability and macroeconomic uncertainties (MU). Following [107,108], and [7], the values of SIZE, LTA, LER, and DIV variables are the bases for dividing the entire sample into two deciles (Low/Small group and Large/High group). Each panel displays results for banks at low deciles in odd columns and results for banks at high deciles in even columns. Panel A shows regression results from Eq. (1) for small and large banks. Panel B reports estimated results from Eq. (1) for banks with low and high loan ratios. Panel C synthesizes empirical results from Eq. (1) for banks with low and high competitiveness. Panel D displays practical results from Eq. (1) for banks with low- and high-income diversification. Comparing regression results between two groups in each panel (A, B, C, and D) of Table 4, we conclude that the moderating role of bank scale, loan ratios, competitive ability, and income diversification on the link between macroeconomic uncertainties (MU) and bank stability in ASEAN-8 countries.

Table 5
The moderating role of financial openness.

Variable	ZSCORE is the dependent variable					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	−1.2550	−3.2019***	−2.6844***	−2.3297***	−2.2333***	−1.3181**
	(1.1497)	(0.6815)	(0.6435)	(0.4932)	(0.4997)	(0.5706)
Lag.SIZE	0.3348***	0.4279***	0.4211***	0.4542***	0.4454***	0.3493***
	(0.0771)	(0.0840)	(0.0847)	(0.0793)	(0.0805)	(0.0774)
Lag.LTA	0.6750***	0.6816***	0.6882***	0.6651***	0.6425***	0.6445***
	(0.1791)	(0.1780)	(0.1785)	(0.1764)	(0.1777)	(0.1789)
Lag.LLP	−0.0547***	−0.0519***	−0.0500***	−0.0517***	−0.0481***	−0.0549***
	(0.0123)	(0.0123)	(0.0123)	(0.0121)	(0.0122)	(0.0123)
Lag.NPL	−1.1021***	−1.0978**	−1.0937**	−1.0385**	−1.0048**	−1.0323**
	(0.4258)	(0.4257)	(0.4267)	(0.4214)	(0.4243)	(0.4258)
ZSCORE(Country)	0.2916	0.1169	−0.0276	0.0396	−0.0798	0.2075
	(0.2163)	(0.2070)	(0.2084)	(0.2045)	(0.2067)	(0.2138)
CONCEN(Country)	−0.2600***	−0.3324***	−0.3117***	−0.2036**	−0.2311***	−0.2449***
	(0.0808)	(0.0842)	(0.0833)	(0.0806)	(0.0821)	(0.0812)
KAOPEN	4.7218**	2.8375***	1.8290**	0.2947**	0.3534**	0.1327**
	(2.0985)	(0.8727)	(0.7558)	(0.1448)	(0.1456)	(0.0582)
LnGPR	0.0480					
	(0.2350)					
LnGPR*KAOPEN	0.9324**					
	(0.4641)					
LnEPU		−0.2195**				
		(0.0914)				
LnEPU*KAOPEN		−0.6374***				
		(0.1708)				
LnCPU			−0.1345*			
			(0.0721)			
LnCPU*KAOPEN			−0.4653***			
			(0.1572)			
WPU				−0.0118**		
				(0.0056)		
WPU*KAOPEN				−0.0074		
				(0.0101)		
GSCP					−0.0425**	
					(0.0216)	
GSCP*KAOPEN					−0.1276**	
					(0.0534)	
LnMPU						−0.0608*
						(0.0360)
LnMPU*KAOPEN						−0.1329***
						(0.0301)
Obs.	1570	1570	1570	1570	1570	1570
R squared	0.0734	0.0753	0.0715	0.0923	0.0826	0.0762
Banks	157	157	157	157	157	157
BFE	Yes	Yes	Yes	Yes	Yes	Yes

Table 5 shows the impact of macroeconomic uncertainty (MU) on bank stability under the mediating effect of financial openness. The dependent variable of ZSCORE is bank stability. MU variables include LnGPR, LnEPU, LnCPU, WPU, GSCP, and LnMPU, they are key explanatory variableless. The KAOPEN index is constructed by Chinn & Ito (2008). The value of KAOPEN index for each country is collected from https://web.pdx.edu/~ito/Chinn-Ito_website.htm. The KAOPEN variable and interaction variables between KAOPEN and uncertainty factors are added to our regressions. Robust standard errors are in parentheses.*** denotes significance at a 1% level, ** denotes significance at a 5%, * denotes significance at a 10% level.

In Table 4, Panel A reveals that MU variables have more significant influences on bank stability in large banks, supporting the "too big to fail'' hypothesis [104,108]. Climate policy instability affects both small and large banks, with larger banks exhibiting lower risk-taking behavior. These findings imply that larger banks in the ASEAN region are more capable of coping with CPU than smaller banks. Panel B shows that MU variables are more significant for banks with high loan ratios, which are in line with cautious motives. Banks tend to hold more equity during uncertain macroeconomic conditions. Regression results in Panel C indicate that income diversification enhances the impact of MU variables on bank stability, while Panel D suggests that banks with low competitiveness experience a stronger impact of MU on stability. In short, the empirical findings in Table 4 highlight the role of bank characteristics in moderating the relationship between MU and bank stability. Based on the results found in Table 4, bank executives might be aware that improving competitiveness, strengthening traditional activities, and reducing loan ratios are crucial tactics for minimizing the macro-risk effects on ASEAN bank stability. On the other hand, they demonstrate that banks' attributes play a role in determining the intensity of macro-risks' effect on bank risk in the ASEAN area.

Financial openness may either escalate or diminish the financial system's risks [106]. Recently, some studies have analyzed the role of the country's financial openness on bank stability. In emerging markets, amplified competition resulting from more international

Table 6
Robust Test 1 - Using alternative variable of bank stability (ZSCORE_n).

Variables	ZSCORE_n is the dependent variable							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag.SIZE	0.0822***	0.0802**	0.0821***	0.1056***	0.1026***	0.1277***	0.1194***	0.0900***
	(0.0311)	(0.0312)	(0.0308)	(0.0378)	(0.0371)	(0.0331)	(0.0330)	(0.0309)
Lag.LTA	0.1735***	0.1819***	0.1571**	0.1795***	0.1819***	0.1662**	0.1602**	0.1514**
	(0.0640)	(0.0647)	(0.0647)	(0.0654)	(0.0656)	(0.0658)	(0.0660)	(0.0649)
Lag.LLP	−0.0109***	−0.0107***	−0.0122***	−0.0104***	−0.0101***	−0.0113***	−0.0100***	−0.0123***
	(0.0026)	(0.0027)	(0.0027)	(0.0027)	(0.0027)	(0.0027)	(0.0027)	(0.0027)
Lag.NPL	−0.2779**	−0.2703**	−0.2485**	−0.2550**	−0.2573**	−0.2375**	−0.2279**	−0.2308**
	(0.1068)	(0.1071)	(0.1031)	(0.1024)	(0.1033)	(0.0955)	(0.0978)	(0.1003)
ZSCORE(Country)		0.0383	0.0805	0.0268	0.0152	0.0215	−0.0091	0.0679
		(0.0501)	(0.0502)	(0.0484)	(0.0482)	(0.0491)	(0.0487)	(0.0503)
CONCEN(Country)		−0.0589***	−0.0494**	−0.0515***	−0.0540***	−0.0388**	−0.0410**	−0.0452**
		(0.0194)	(0.0193)	(0.0195)	(0.0194)	(0.0191)	(0.0189)	(0.0192)
LnGPR			0.1070***					
			(0.0375)					
LnEPU				−0.0278*				
				(0.0161)				
LnCPU					−0.0235*			
					(0.0132)			
WPU						−0.0045***		
						(0.0008)		
GSCP							−0.0298***	
							(0.0070)	
LnMPU								−0.0367***
								(0.0096)
Constant	−0.0433	−0.0154	−0.5061*	−0.0452	−0.0535	−0.3248	−0.2699	0.0841
	(0.1989)	(0.2004)	(0.2836)	(0.2027)	(0.2056)	(0.2126)	(0.2123)	(0.1921)
Obs.	1570	1570	1570	1570	1570	1570	1570	1570
R squared	0.0470	0.0518	0.0599	0.0558	0.0548	0.0831	0.0708	0.0656
Banks	157	157	157	157	157	157	157	157
BFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 6 shows the impact of macroeconomic uncertainty (MU) on bank stability with an alternative measurement of bank stability (ZSCORE_n). MU variables include LnGPR, LnEPU, LnCPU, WPU, GSCP, and LnMPU, they are key explanatory variables. Robust standard errors in parentheses.*** denotes significance at a 1% level, ** denotes significance at a 5%, * denotes significance at a 10% level.

financial openness induces banks to take excessive risks [106,109]. Thus, it is expected that the presence of financial openness can amplify the effects of macroeconomic uncertainties on bank stability in the ASEAN area. Using the Chinn-Ito index (KAOPEN[4]) and [106]'s methodology, we add an interaction variable between KAOPEN and each MU variable in Eq. (1). Regression results are shown in Table 5.

The estimated coefficients of interaction variables (LnEPU*KAOPEN, LnCPU*KAOPEN, WPU*KAOPEN, GSCP*KAOPEN, and LnMPU*KAOPEN) are negative, while the LnGPR*KAOPEN coefficient is positive in Table 5. Practical results in Table 5 indicate that increased uncertainty factors impair the stability of banks in the country's high financial openness, except for the GPR factor. These findings are consistent with [106] 's results that the greater competition pressure, along with external shocks, makes banks operating in highly open financial systems face higher risks. Banks operating in highly open economies are compelled to take on greater risks in the context of growing macroeconomic uncertainty. This result gives economic policymakers and banking managers in highly open markets an empirical foundation on which to act proactively in response to risks brought on by heightened macroeconomic volatility. In other words, they support the "competition-fragility" doctrine. More interestingly, ASEAN banks located in highly open markets may seize the opportunity to surge GPR in the global market to stabilize.

4.3. Robust tests

4.3.1. Robust test 1: Alternative bank stability variable

A bank in one nation having a higher ZSCORE than another bank in another nation does not definitely indicate that one is riskier than the other. We follow [94] in normalizing the ZSCORE of banks for each nation to resolve this issue. A higher ZSCORE normalization (ZSCORE_n) rate indicates that the bank is more stable than its competitors in other nations. Table 6 reports the estimated results from Eq. (1) with the ZSCORE_n dependent variable. Overall, the regression results in Table 6 are significantly similar to the ones in Table 3. Particularly, the estimated coefficients of MU variables in Table 6 corroborate the substantial impact of unstable factors on bank insolvency risk (ZSCORE_n). The coefficients of the other explanatory variables are all negative and significant, with only one exception of the GPR variable's positive and significant coefficient. Speaking differently, our main findings are robust to an

[4] Chinn & Ito (2008) developed this index.

Table 7
Robust test 2 – Using System-Generalized Method of Moments (SGMM) estimation.

Variable	ZSCORE is the dependent variable					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	−2.0404***	−0.4219*	−0.3028	−1.1303***	−0.8075***	−0.6408***
	(0.3684)	(0.2407)	(0.2521)	(0.2167)	(0.2224)	(0.2322)
Lag.ZSCORE	0.4446***	0.4862***	0.5052***	0.4951***	0.5023***	0.4039***
	(0.0446)	(0.0398)	(0.0389)	(0.0390)	(0.0386)	(0.0446)
Lag.SIZE	0.1366***	0.1359***	0.1220***	0.1617***	0.1400***	0.1638***
	(0.0340)	(0.0347)	(0.0356)	(0.0338)	(0.0352)	(0.0338)
Lag.LTA	0.8109***	0.8960***	0.8627***	0.9533***	0.7260***	0.8339***
	(0.1379)	(0.1324)	(0.1272)	(0.1284)	(0.1240)	(0.1418)
Lag.LLP	−0.0481***	−0.0442***	−0.0431***	−0.0483***	−0.0450***	−0.0512***
	(0.0057)	(0.0055)	(0.0054)	(0.0060)	(0.0056)	(0.0061)
Lag.NPL	−0.1536***	−0.1587***	−0.1320***	−0.2386***	−0.1748***	−0.2004***
	(0.0478)	(0.0472)	(0.0464)	(0.0486)	(0.0448)	(0.0478)
ZSCORE(Country)	1.4370***	1.0187***	0.8193***	0.8025***	0.3654*	1.3466***
	(0.2044)	(0.2008)	(0.2200)	(0.1932)	(0.2134)	(0.2016)
CONCEN(Country)	−0.6002***	−0.5939***	−0.6178***	−0.3631***	−0.3932***	−0.5455***
	(0.0713)	(0.0729)	(0.0736)	(0.0720)	(0.0759)	(0.0695)
LnGPR	0.2644***					
	(0.0607)					
LnEPU		−0.0883***				
		(0.0201)				
LnCPU			−0.0910***			
			(0.0210)			
WPU				−0.0170***		
				(0.0012)		
GSCP					−0.1101***	
					(0.0105)	
LnMPU						−0.0876***
						(0.0149)
Obs.	1570	1570	1570	1570	1570	1570
Banks	157	157	157	157	157	157
AR (1) test	0.000	0.000	0.000	0.000	0.000	0.000
AR (2) test	0.523	0.317	0.279	0.233	0.138	0.384
Hansen test	0.346	0.307	0.251	0.244	0.128	0.416

Table 7 presents robust tests of the impact of macroeconomic uncertainty on bank stability by using System-Generalized Method of Moments (SGMM) estimation. The dependent variable is bank stability (ZSCORE) in all regressions. MU variables include LnGPR, LnEPU, LnCPU, WPU, GSCP, and LnMPU, they are key explanatory variables. The first and second order serial correlation tests (AR (1) and AR (2)), and Hansen test of overidentifying restrictions verify the validity of the picked instrument variable. Standard errors in parentheses.*** denotes significance at a 1% level, ** denotes significance at a 5%, * denotes significance at a 10% level.

alternative metric of bank stability.

4.3.2. Robust test 2: The system - generalized method of moments (SGMM) estimation

[14] state that the SGMM estimation is used in our baseline model to address potential endogeneity concerns. The AR (1), AR (2), and Hansen tests are used to assess the suitability of the chosen instrumental variables to address endogenous problems. The results in Table 7 demonstrate that the coefficients of all macroeconomic uncertainty (MU) variables retain their signs and significance, in line with the fundamental results in Table 3. These outcomes show how reliable our key conclusions for the SGMM estimation are. The last three rows of Table 7 display the *P*-values for AR (1), AR (2), and Hansen tests, which corroborate the validity of the instrumental variables contained in all regressions. Through SGMM estimation, all core findings are credible regardless of existing endogeneity matters in our baseline specifications.

4.3.3. Robust test 3: quantile regression (QR)

Banks in eight ASEAN countries are different in terms of economic, financial, and political development compared to the bank stability (ZSCORE) in our sample, which has a significant deviation. When the key variable has a possibly different impact on the provisional distribution of the dependent variable, QR is popularly used in the economic, business, and financial literature [7,97,110]. To evaluate whether MU factors have varied effects on bank stability at different probability levels of bank risk, we utilize conditional QR for a panel sample [110]. The impacts of LnGPR, LnEPU, LnCPU, WPU, GSCP, and LnMPU on bank stability by using the conditional QR are separately shown in panels of Table 8. Basically, most findings in Table 8 are consistent with the ones in Tables 3 and 6 Even though we utilized plenty of econometric techniques, our conclusions are relatively robust. Empirical results in Tables 7 and 8 assert that our key findings are comparably high across various estimations.

Table 8
Robust Test 3 - Using conditional quantile regression (QR).

Panel A: The impact of geopolitical risk (GPR) on bank stability (ZSCORE)									
Variables	ZSCORE is the dependent variable								
	10th	20th	30th	40th	50th	60th	70th	80th	90th
SIZE	0.0033	0.0694	0.1160	0.1565**	0.1960***	0.2317***	0.2737***	0.3191***	0.3762***
	(0.1210)	(0.0927)	(0.0763)	(0.0664)	(0.0627)	(0.0653)	(0.0748)	(0.0901)	(0.1140)
LTA	1.2838***	1.1257***	1.0142***	0.9171***	0.8228***	0.7372***	0.6368***	0.5280**	0.3916
	(0.3234)	(0.2476)	(0.2039)	(0.1774)	(0.1676)	(0.1746)	(0.1997)	(0.2408)	(0.3048)
LLP	−0.0832***	−0.0704***	−0.0614***	−0.0536***	−0.0460***	−0.0391**	−0.0310	−0.0222	−0.0112
	(0.0310)	(0.0237)	(0.0195)	(0.0170)	(0.0161)	(0.0167)	(0.0191)	(0.0231)	(0.0292)
NPL	−1.9226**	−1.7669***	−1.6570***	−1.5613***	−1.4684***	−1.3841***	−1.2851**	−1.1779*	−1.0435
	(0.8293)	(0.6350)	(0.5223)	(0.4543)	(0.4291)	(0.4470)	(0.5116)	(0.6180)	(0.7817)
ZSCORE(Country)	0.2079	0.2020	0.1978	0.1942	0.1907	0.1875	0.1838	0.1798	0.1747
	(0.3238)	(0.2479)	(0.2039)	(0.1774)	(0.1675)	(0.1745)	(0.1997)	(0.2413)	(0.3052)
CONCEN (Country)	−0.3057**	−0.2814***	−0.2643***	−0.2494***	−0.2349***	−0.2217***	−0.2063***	−0.1896**	−0.1686
	(0.1240)	(0.0950)	(0.0781)	(0.0679)	(0.0642)	(0.0668)	(0.0765)	(0.0924)	(0.1169)
LnGPR	0.5123**	0.4294***	0.3710***	0.3201***	0.2706**	0.2258**	0.1731	0.1161	0.0445
	(0.2031)	(0.1555)	(0.1280)	(0.1113)	(0.1052)	(0.1095)	(0.1254)	(0.1513)	(0.1914)
Obs.	1727	1727	1727	1727	1727	1727	1727	1727	1727
Panel B: The impact of economic policy uncertainty (EPU) on bank stability (ZSCORE)									
Variables	ZSCORE is the dependent variable								
	10th	20th	30th	40th	50th	60th	70th	80th	90th
SIZE	0.0758	0.1278	0.1637*	0.1950**	0.2294***	0.2541***	0.2876***	0.3219***	0.3674***
	(0.1416)	(0.1084)	(0.0894)	(0.0776)	(0.0725)	(0.0750)	(0.0856)	(0.1025)	(0.1305)
LTA	1.4074***	1.2296***	1.1068***	0.9996***	0.8820***	0.7975***	0.6832***	0.5657**	0.4100
	(0.3196)	(0.2447)	(0.2019)	(0.1753)	(0.1639)	(0.1695)	(0.1934)	(0.2313)	(0.2945)
LLP	−0.0799**	−0.0676***	−0.0590***	−0.0516***	−0.0434***	−0.0375**	−0.0296	−0.0214	−0.0106
	(0.0313)	(0.0239)	(0.0197)	(0.0171)	(0.0160)	(0.0166)	(0.0189)	(0.0226)	(0.0288)
NPL	−1.9889**	−1.8173***	−1.6988***	−1.5954***	−1.4818***	−1.4003***	−1.2899***	−1.1766**	−1.0263
	(0.8262)	(0.6324)	(0.5213)	(0.4522)	(0.4227)	(0.4371)	(0.4991)	(0.5983)	(0.7614)
ZSCORE(Country)	0.0638	0.0724	0.0784	0.0836	0.0894	0.0935	0.0990	0.1048	0.1123
	(0.3221)	(0.2465)	(0.2032)	(0.1762)	(0.1647)	(0.1703)	(0.1945)	(0.2332)	(0.2968)
CONCEN (Country)	−0.3686***	−0.3311***	−0.3052***	−0.2825***	−0.2577***	−0.2398***	−0.2157***	−0.1909**	−0.1580
	(0.1221)	(0.0935)	(0.0771)	(0.0669)	(0.0625)	(0.0646)	(0.0738)	(0.0884)	(0.1125)
LnEPU	−0.0712	−0.0565	−0.0464	−0.0375	−0.0278	−0.0208	−0.0114	−0.0017	0.0112
	(0.0780)	(0.0597)	(0.0492)	(0.0427)	(0.0399)	(0.0413)	(0.0471)	(0.0565)	(0.0719)
Obs.	1727	1727	1727	1727	1727	1727	1727	1727	1727
Panel C: The impact of climate policy uncertainty (CPU) on bank stability (ZSCORE)									
Variables	ZSCORE is the dependent variable								
	10th	20th	30th	40th	50th	60th	70th	80th	90th
SIZE	0.0525	0.1186	0.1656*	0.2059***	0.2488***	0.2814***	0.3247***	0.3670***	0.4256***
	(0.1382)	(0.1060)	(0.0870)	(0.0755)	(0.0707)	(0.0732)	(0.0838)	(0.0997)	(0.1271)
LTA	1.4221***	1.2366***	1.1044***	0.9914***	0.8710***	0.7795***	0.6580***	0.5391**	0.3746
	(0.3213)	(0.2464)	(0.2023)	(0.1756)	(0.1645)	(0.1702)	(0.1948)	(0.2316)	(0.2954)
LLP	−0.0814***	−0.0685***	−0.0592***	−0.0513***	−0.0429***	−0.0366**	−0.0281	−0.0198	−0.0083
	(0.0314)	(0.0241)	(0.0198)	(0.0171)	(0.0161)	(0.0166)	(0.0190)	(0.0226)	(0.0289)
NPL	−1.9837**	−1.8094***	−1.6851***	−1.5789***	−1.4657***	−1.3797***	−1.2654**	−1.1537*	−0.9990
	(0.8270)	(0.6341)	(0.5200)	(0.4510)	(0.4222)	(0.4371)	(0.5007)	(0.5965)	(0.7606)
ZSCORE(Country)	0.0279	0.0357	0.0413	0.0460	0.0511	0.0549	0.0601	0.0651	0.0720
	(0.3272)	(0.2509)	(0.2057)	(0.1784)	(0.1670)	(0.1729)	(0.1981)	(0.2361)	(0.3010)
CONCEN (Country)	−0.3641***	−0.3264***	−0.2996***	−0.2767***	−0.2522***	−0.2337***	−0.2090***	−0.1849**	−0.1515
	(0.1232)	(0.0944)	(0.0775)	(0.0672)	(0.0629)	(0.0651)	(0.0746)	(0.0888)	(0.1133)
LnCPU	−0.0550	−0.0537	−0.0527	−0.0519	−0.0510	−0.0504	−0.0495	−0.0487	−0.0475
	(0.0740)	(0.0567)	(0.0465)	(0.0403)	(0.0377)	(0.0391)	(0.0448)	(0.0533)	(0.0680)
Obs.	1727	1727	1727	1727	1727	1727	1727	1727	1727
Panel D: The impact of world pandemic uncertainty (WPU) on bank stability (ZSCORE)									
Variables	ZSCORE is the dependent variable								
	10th	20th	30th	40th	50th	60th	70th	80th	90th
SIZE	0.1987	0.2421**	0.2728***	0.3020***	0.3295***	0.3536***	0.3819***	0.4120***	0.4505***
	(0.1278)	(0.0988)	(0.0817)	(0.0704)	(0.0665)	(0.0693)	(0.0792)	(0.0952)	(0.1202)

(*continued on next page*)

Table 8 (*continued*)

Panel D: The impact of world pandemic uncertainty (WPU) on bank stability (ZSCORE)									
Variables	ZSCORE is the dependent variable								
	10th	20th	30th	40th	50th	60th	70th	80th	90th
LTA	1.2986***	1.1253***	1.0025***	0.8860***	0.7762***	0.6799***	0.5669***	0.4467*	0.2927
	(0.3192)	(0.2466)	(0.2042)	(0.1763)	(0.1663)	(0.1733)	(0.1980)	(0.2375)	(0.3000)
LLP	−0.0773**	−0.0642***	−0.0549***	−0.0461***	−0.0378**	−0.0306*	−0.0221	−0.0130	−0.0014
	(0.0315)	(0.0244)	(0.0202)	(0.0174)	(0.0164)	(0.0171)	(0.0196)	(0.0235)	(0.0297)
NPL	−1.8223**	−1.7092***	−1.6291***	−1.5530***	−1.4813***	−1.4185***	−1.3447***	−1.2662**	−1.1657
	(0.7803)	(0.6030)	(0.4987)	(0.4297)	(0.4055)	(0.4228)	(0.4836)	(0.5811)	(0.7342)
ZSCORE(Country)	−0.0527	−0.0121	0.0166	0.0439	0.0697	0.0922	0.1187	0.1469	0.1830
	(0.3069)	(0.2372)	(0.1962)	(0.1690)	(0.1595)	(0.1663)	(0.1902)	(0.2286)	(0.2888)
CONCEN (Country)	−0.3174***	−0.2886***	−0.2682***	−0.2488***	−0.2306***	−0.2146***	−0.1958***	−0.1759**	−0.1503
	(0.1197)	(0.0925)	(0.0765)	(0.0659)	(0.0622)	(0.0649)	(0.0742)	(0.0891)	(0.1126)
WPU	−0.0166***	−0.0151***	−0.0140***	−0.0129***	−0.0120***	−0.0111***	−0.0101***	−0.0091**	−0.0077
	(0.0051)	(0.0039)	(0.0033)	(0.0028)	(0.0027)	(0.0028)	(0.0032)	(0.0038)	(0.0048)
Obs.	1727	1727	1727	1727	1727	1727	1727	1727	1727
Panel E: The impact of global supply chain pressure on bank stability (ZSCORE)									
Variables	ZSCORE is the dependent variable								
	10th	20th	30th	40th	50th	60th	70th	80th	90th
SIZE	0.1017	0.1682*	0.2174***	0.2639***	0.3020***	0.3384***	0.3863***	0.4293***	0.4890***
	(0.1248)	(0.0964)	(0.0792)	(0.0682)	(0.0648)	(0.0673)	(0.0780)	(0.0925)	(0.1172)
LTA	1.3304***	1.1427***	1.0038***	0.8727***	0.7653***	0.6625***	0.5274***	0.4062*	0.2377
	(0.3221)	(0.2489)	(0.2046)	(0.1762)	(0.1673)	(0.1739)	(0.2015)	(0.2388)	(0.3024)
LLP	−0.0829***	−0.0693***	−0.0593***	−0.0498***	−0.0421***	−0.0347**	−0.0249	−0.0161	−0.0040
	(0.0314)	(0.0243)	(0.0200)	(0.0172)	(0.0163)	(0.0170)	(0.0197)	(0.0233)	(0.0295)
NPL	−1.8366**	−1.6984***	−1.5963***	−1.4998***	−1.4207***	−1.3451***	−1.2457**	−1.1565*	−1.0325
	(0.7977)	(0.6166)	(0.5058)	(0.4347)	(0.4133)	(0.4295)	(0.4983)	(0.5916)	(0.7492)
ZSCORE (Country)	−0.1286	−0.1006	−0.0800	−0.0604	−0.0444	−0.0291	−0.0089	0.0091	0.0343
	(0.3171)	(0.2451)	(0.2010)	(0.1728)	(0.1643)	(0.1707)	(0.1981)	(0.2352)	(0.2978)
CONCEN (Country)	−0.2977**	−0.2678***	−0.2456***	−0.2247***	−0.2076***	−0.1912***	−0.1696**	−0.1503*	−0.1234
	(0.1222)	(0.0945)	(0.0775)	(0.0666)	(0.0633)	(0.0658)	(0.0764)	(0.0906)	(0.1148)
GSCP	−0.1000***	−0.0973***	−0.0954***	−0.0935***	−0.0920***	−0.0906***	−0.0887***	−0.0870***	−0.0846**
	(0.0382)	(0.0295)	(0.0242)	(0.0208)	(0.0198)	(0.0206)	(0.0239)	(0.0283)	(0.0359)
Obs.	1727	1727	1727	1727	1727	1727	1727	1727	1727
Panel F: The impact of monetary policy uncertainty (MPU) on bank stability (ZSCORE)									
Variables	ZSCORE is the dependent variable								
	10th	20th	30th	40th	50th	60th	70th	80th	90th
SIZE	0.0264	0.0889	0.1367*	0.1768***	0.2163***	0.2502***	0.2935***	0.3385***	0.3969***
	(0.1202)	(0.0931)	(0.0762)	(0.0664)	(0.0626)	(0.0650)	(0.0747)	(0.0901)	(0.1148)
LTA	1.2668***	1.1099***	0.9900***	0.8893***	0.7902***	0.7052***	0.5966***	0.4837**	0.3369
	(0.3239)	(0.2510)	(0.2053)	(0.1788)	(0.1687)	(0.1752)	(0.2014)	(0.2428)	(0.3095)
LLP	−0.0808***	−0.0689***	−0.0598***	−0.0522***	−0.0447***	−0.0382**	−0.0300	−0.0214	−0.0103
	(0.0310)	(0.0240)	(0.0197)	(0.0171)	(0.0162)	(0.0168)	(0.0193)	(0.0233)	(0.0296)
NPL	−1.8815**	−1.7360***	−1.6248***	−1.5313***	−1.4393***	−1.3606***	−1.2598**	−1.1550*	−1.0189
	(0.8216)	(0.6367)	(0.5202)	(0.4526)	(0.4272)	(0.4436)	(0.5101)	(0.6160)	(0.7850)
ZSCORE(Country)	0.1216	0.1378	0.1501	0.1605	0.1707	0.1794	0.1906	0.2022	0.2173
	(0.3143)	(0.2436)	(0.1990)	(0.1731)	(0.1633)	(0.1696)	(0.1951)	(0.2356)	(0.3003)
CONCEN (Country)	−0.2857**	−0.2649***	−0.2491***	−0.2357***	−0.2226***	−0.2113***	−0.1969***	−0.1819**	−0.1625
	(0.1227)	(0.0951)	(0.0777)	(0.0676)	(0.0638)	(0.0662)	(0.0762)	(0.0920)	(0.1172)
LnMPU	−0.1654***	−0.1448***	−0.1291***	−0.1158***	−0.1028***	−0.0917***	−0.0774**	−0.0626	−0.0433
	(0.0527)	(0.0409)	(0.0334)	(0.0291)	(0.0275)	(0.0285)	(0.0328)	(0.0395)	(0.0504)
Obs.	1727	1727	1727	1727	1727	1727	1727	1727	1727

Note: Table 8 shows the impact of macroeconomic uncertainty (MU) on bank stability using the conditional quantile regression (QR) with fixed-effects for panel models. Bank stability (ZSCORE) is the dependent variable in all specifications, macroeconomic uncertainties (MU) and control variables (bank-specific and banking system characteristic) as independent variables. The impact of LnGPR, LnEPU, LnCPU, WPU, GSPC, and LnMPU variables on bank stability are shown in Panels A, B, C, D, E, and F with nine quantile levels (10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th, and 90th). Standard errors in parentheses.*** denotes significance at a 1% level, ** denotes significance at a 5%, * denotes significance at a 10% level.

5. Concluding remarks and research limitations

The process of globalization and international economic integration has forged stronger interconnections among the financial systems of countries and regions worldwide. In the present era, the volatility and unpredictability of macroeconomic factors, such as geopolitical risk, economic policy uncertainty, climate policy uncertainty, global pandemic uncertainty, global supply chain pressure, and monetary policy uncertainty, pose significant threats to the stability of both financial and banking systems. These concerns transcend boundaries, affecting not only developed regions but also emerging economies like the ASEAN region. Heightened levels of uncertainty have the potential to trigger crises that may jeopardize the integrity of banking and financial systems. As such, this study is dedicated to investigating the effect of economic uncertainties on bank stability within the ASEAN region.

The practical analysis conducted in this study encompasses a sample of 157 banks across eight ASEAN economies, spanning the period from 2010 to 2020. The experimental findings reveal a predominant negative impact of most uncertainty factors on bank stability within ASEAN countries. This shows that economic policy uncertainty, climate policy uncertainty, global pandemics, monetary policy uncertainty, and global supply chain pressure collectively pose significant threats to the stability of the ASEAN banking system. Specifically, the study presents an intriguing discovery: geopolitical risk exhibits a positive correlation with bank stability in the ASEAN region, offering a distinctive insight. Our finding in ASEAN countries differs from the detrimental effect of GPR on bank stability in the US market. To bolster the robustness of the primary findings, a diverse array of econometric techniques is employed. Notably, this research stands as a pioneering effort in examining the effects of macroeconomic uncertainties on bank stability, with a specific focus on the ASEAN region. Furthermore, it delves deeper into this connection by investigating the moderating roles of national financial openness and bank features in the ASEAN-8 framework. Our study expands and offers extensive and comprehensive insights into the associations between unpredictable macroeconomic circumstances and bank stability in an Asian developing region. The valuable findings of this paper contribute to the body of knowledge on bank risk.

Our findings offer policy implications for bank managers and involve policymakers in the ASEAN banking system. Firstly, earlier studies demonstrate that competitiveness, financial inclusion, bank traits, and institutional quality control bank stability in the ASEAN region. With another approach, this work emphasizes that bank managers in ASEAN nations should take into account the volatility of macroeconomic factors in designing risk management strategies to effectively carry them out. Secondly, the study reveals that rising equity ratios and improving competitiveness can mitigate the effects of economic uncertainties on bank stability. Thirdly, large banks, more diversified banks, and banks operating in countries with extreme financial openness make them more vulnerable to uncertainties that contribute to instability. Therefore, bank managers and policymakers in these banks should set up proper strategies to mitigate the risks associated with enlarged macroeconomic uncertainties. Thirdly, our research reveals that ASEAN banks can harness the positive effects of favorable global risk conditions, presenting an opportunity to fortify bank stability within the region by leveraging these global dynamics. Finally, our study underscores the potential for the influence of macroeconomic uncertainties on bank stability to permeate the broader financial system. Thus, central banks within ASEAN countries should adopt proactive measures to address macroeconomic uncertainties, thereby contributing to the overall stability of the financial system.

To sum up, this research sheds valuable light on the intricate relationship between macroeconomic uncertainties and bank stability within the ASEAN region. Our findings enrich the existing banking literature, provide empirical evidence on bank stability, and offer valuable insights for policymakers and bank managers alike. Additionally, we propose that ASEAN bank instability might be mitigated when facing increased macroeconomic uncertainties by proactively creating risk management strategies, establishing macroprudential policies, acknowledging and understanding the effects of these uncertainties, and taking advantage of favorable conditions in the global landscape. No research has been without limitations, and our work is no exception. Firstly, the research period merely stretches from 2010 to 2020 and is unable to include current years owing to restricted access to data availability. Secondly, the impact of macroeconomic uncertainties on bank stability in ASEAN is observed in our paper without comparison with these effects on banks in other areas. Thirdly, we largely concentrate on bank stability in the surged uncertainty of macroeconomic settings. We did not account for other bank aspects such as performance and diversification during this highly uncertain macro time. It would be fantastic to examine bank performance or diversification under uncertain macroeconomic factors. Ultimately, despite an alternative metric of bank stability being considered in our paper, a measure of each uncertain macroeconomic factor is analyzed in a general form. Further experiments may consider diversified metrics of uncertain macro-factors to provide more interesting findings.

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Data availability statement

The data is available upon reasonable request.

Ethics and statement

This study does not involve animals or humans.

CRediT authorship contribution statement

Giang Thi Huong Vuong: Writing – original draft, Formal analysis, Conceptualization. **Yen Dang Hai Nguyen:** Formal analysis, Data curation. **Manh Huu Nguyen:** Writing – review & editing, Software, Methodology. **Wing-Keung Wong:** Validation, Investigation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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