
**Temperature Anomaly, Investor Attention, and Stock Market Returns:
Evidence from the Stock Exchange of Thailand and Ho Chi Minh Stock Exchange
Massaporn Cheuathonghua**

Department of Finance, Faculty of Business Administration, Kasetsart University, Thailand

Corresponding author: massaporn.c@ku.th

Received: 11 August 2026

Revised: 24 August 2026

Accepted: 27 August 2026

Abstract

This study aims to investigate the relation among six independent variables that include temperature anomaly, Google Search Volume Index, the CBOE Crude Oil Volatility Index (OVX), the CBOE Volatility Index (VIX), Brent crude oil price and foreign exchange rate, and two dependent variables that consist of the total return indices of SET100 in the Stock Exchange of Thailand (SET100 TRI) and VN100 in Ho Chi Minh Stock Exchange (VN100 TRI). This quantitative research collects monthly time series data from April 2018 to April 2025 with the total of 85 observations and utilizes Multiple Linear Regression for the analysis.

The findings demonstrate that temperature anomaly is significantly positively associated with VN100 TRI. Google Search Volume Index only has a significant negative correlation with SET100 TRI. Furthermore, OVX, VIX, Brent crude oil price and exchange rate between domestic currencies and U.S. dollar have inverse relations with both SET100 TRI and VN100 TRI. The empirical evidence suggests that those factors play crucial roles in determining stock market returns in Thailand and Vietnam. These insights contribute to investors who intend to diversify their portfolios in both capital markets to conduct investment strategies effectively.

Keywords: Temperature Anomaly, Investor Attention, VIX, OVX, Stock Market Return

Introduction

Investment perspectives have evolved significantly over time. The concept of sustainable investment, which incorporates Environmental, Social, and Governance (ESG) considerations alongside traditional financial factors, has become an important framework in investment decision-making as documented by Mollet and Ziegler (2014) and Peillex and

Ureche-Rangau (2016). Modern investors are increasingly inclined to allocate capital toward companies that comply with regulatory standards and operate in accordance with ESG principles, reflecting a broader evaluation approach that considers factors beyond financial returns alone. Among ESG dimensions, environmental issues have received particular attention as they represent global challenges affecting both ecosystems and human well-being. One prominent example is global warming, which has become an increasingly severe and widespread phenomenon. The continuous rise in global average temperatures has contributed to persistent climate changes and abnormal temperature variations across many regions. In addition, pollution, including air pollution, water pollution, and other forms of environmental degradation, has created substantial negative impacts on ecosystems and environmental quality. Furthermore, these environmental changes have significant implications for business operations, particularly for industries such as energy and agriculture that are highly sensitive to climate conditions.

Climate changes such as abnormal temperature and pollution which are the critical environmental challenges also influence investor behavior as well as risk assessments prior to their investment decisions and subsequently affect the stock market. Specifically, an unusually high or low temperature can affect people's mood, risk perception, and risk-taking behavior, so that changes in mood can affect investors' trading decisions and then influence stock prices. A classic study by Cao and Wei (2005) find a negative relationship between temperature and stock returns across international markets such as the United States, Britain, Germany, Canada, Sweden, Japan, Taiwan and Australia, which are all mature markets, suggesting that temperature affects investor mood and consequently risk-taking behavior. Change in trading finally influences stock returns. However, recent studies that scrutinize the impact of temperature anomaly on stock market performance in emerging markets, especially countries in Southeast Asia such as Thailand and Vietnam that are fast-growing economies in term of large GDP and FDI, remain relatively limited. Consequently, these issues lead to research gap that requires further investigation as well as they raise research questions regarding the relation between environmental factors and stock market returns in Thailand and Vietnam which recently experience higher levels of temperature and pollution due to country development driven from economic growth and industrialization.

The first environmental factor examined in this study is temperature anomaly, which differs from conventional air temperature measurements reported by meteorological agencies. Specifically, temperature anomaly represents deviations in observed surface temperatures from historical averages and serves as an indicator of climate-related phenomena. Such deviations reflect environmental changes, including deforestation, and provide important signals of global warming and greenhouse gas concentrations, which subsequently contribute to long-term climate change. This study also investigates investor attention measured by Google Search Volume Index (GSVI) for the topic of pollution, which reflects public awareness and the level of attention given to environmental pollution issues in Thailand and Vietnam. This indicator captures changes in public interest and information-seeking behavior regarding pollution-related concerns, which may influence investor perceptions and market expectations.

Furthermore, this study examines uncertainty-related factors in oil and stock markets such as the CBOE Crude Oil Volatility Index (OVX) and the CBOE Volatility Index (VIX), respectively that potentially transmit from the U.S. market to emerging countries. Since the U.S. market accounts for the largest GDP as well as market capitalization, the movements of OVX and VIX tends to negatively influence on stock market performance of Thailand and Vietnam. OVX serves as a proxy for uncertainty in the crude oil market that measures the market's expectation of crude oil price volatility over the following 30-day period which is calculated based on the option prices of the United States Oil Fund (USO). VIX, introduced by Whaley (1993) and later on applied to construct OVX, is used to measure the expected 30-day volatility of S&P 500 Index derived from option prices which widely recognized as an indicator of investor sentiment and market uncertainty in the stock market, and can be used to assess market trends and investment risks.

In this regard, this study investigates whether temperature anomaly, Google Search Volume Index, the CBOE Crude Oil Volatility Index (OVX), the CBOE Volatility Index (VIX), Brent crude oil price and foreign exchange rate influence the total return indices of SET100 in the Stock Exchange of Thailand and VN100 in Ho Chi Minh Stock Exchange. Specifically, this study aims to provide evidence on the impact of climate change, investor attention, uncertainty transmission from U.S., and macroeconomic factors on stock market returns in Thailand and Vietnam. These insights benefit investors to understand new aspects of stock market determinants that support their investment portfolio decisions

Research Objectives

The purpose of this study is to examine the influence of temperature anomaly, Google Search Volume Index, the CBOE Crude Oil Volatility Index, the CBOE Volatility Index, Brent crude oil price and foreign exchange rate between domestic currencies and U.S. Dollar on the total return indices of SET100 in the Stock Exchange of Thailand (SET100 TRI) and VN100 in Ho Chi Minh Stock Exchange (VN100 TRI).

Literature Review

Climate change refers to significant and persistent changes in average climatic conditions or variability over several decades. According to the Intergovernmental Panel on Climate Change (IPCC), such changes may result from either natural climate variability or human activities. Likewise, the United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as changes in the Earth's climate that are directly or indirectly attributable to human activities that alter the composition of the global atmosphere, in addition to natural climate variability observed over comparable time periods. Climate change gives rise to a wide range of risks, including physical risks associated with more frequent and severe natural disasters, as well as transition risks arising from changes in environmental regulations and policies, such as the implementation of carbon taxes and clean energy mandates. For investors, these risks may increase market uncertainty and require more comprehensive reassessments of investment portfolios. For example, firms that fail to adapt to the transition toward a low-carbon economy may experience substantial financial challenges. Conversely, companies that recognize opportunities arising from sustainability-related investments such as the development of renewable energy technologies may benefit from these structural changes.

Temperature anomaly refers to the difference between the observed temperature and a baseline average temperature, which is typically calculated using historical temperature records spanning at least 30 years. Temperature anomaly is computed by subtracting the baseline average temperature from the observed temperature for a given period. The value may be either positive, indicating warmer-than-average conditions, or negative, indicating cooler-than-average conditions. Temperature anomaly data are collected and disseminated by many internationally recognized climate organizations, including the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration's

Goddard Institute for Space Studies (NASA GISS), and the UK Met Office. Temperature anomaly constitutes a key indicator in climate science and environmental economics that are widely used as a proxy for climate change since it captures deviations in observed temperatures from long-term climatic norms. Persistent positive or negative temperature anomalies may significantly influence economic activity, industrial and agricultural production, energy demand, and the overall level of risk within an economy. Consequently, temperature anomaly has become an important variable in empirical studies examining the economic and financial impacts of climate change. Deviations in temperature from long-term averages can influence economic activity through multiple channels, including production, consumption, and investment, thereby affecting financial market performance. Cao and Wei (2005), Chang et al. (2006) and Kang et al. (2010) examines the effects of weather conditions, temperature variability, heatwaves, and temperature anomalies on stock market returns and find that higher-than-normal temperatures or positive temperature anomaly are associated with lower stock returns, indicating that persistent deviations from normal climatic conditions adversely affect investor sentiment, economic activity, and market performance.

Moreover, to capture investor attention, Google Search Volume Index (GSVI) is used as a measure of search activity derived from Google Trends that analyzes data generated through its search engine (Da, Engelberg, & Gao, 2011). Google Trends are developed to provide insights into users' search behavior by tracking the relative popularity of search terms over time and across geographic locations. The search results are presented as a time-series index normalized on a scale from 0 to 100, where a value of 100 represents the period with the highest relative search interest, and 0 indicates insufficient search volume. However, the index does not represent the absolute number of searches. For example, a score of 50 does not indicate that a keyword is searched 50 times, but it rather signifies that the search interest is approximately half of its peak popularity during the selected period. El Ouadghiri et al. (2021) investigate the impact of public attention using Google Search Volume Index for the topic of pollution as an indicator of environmental concern, on stock market returns and show that GSVI is significantly associated with the returns of sustainable stock indices, including the Dow Jones Sustainability Index (DJSI) U.S. and the FTSE4Good USA Index. On the contrary, GSVI exhibits a statistically significant negative relation with returns of conventional stock indices, including S&P 500 and FTSE USA Index. Heightened public concern about environmental issues encourages investors to reallocate capital toward companies with stronger sustainability practices, thereby

increasing the performance of sustainability-oriented equity indices while reducing the relative attractiveness of conventional stock markets. Furthermore, previous studies document the relation between PM 2.5 and stock returns in Thailand and Vietnam as follows. In Thailand, Khanthavit (2025) addresses the negative association between Bangkok's PM 2.5 pollution and Thai stock market return. In Vietnam, Bao and Van (2023) find that air quality which is measured by the atmospheric particulate matter PM 2.5 index, positively affects stock return from 2016 to 2019 whereas it negatively influences stock return during the period of COVID-19 pandemic, suggesting that its relation varies across the periods of study.

The CBOE Crude Oil Volatility Index (OVX) is a forward-looking measure of the market's expectations regarding future crude oil price volatility and widely used as a proxy for oil price uncertainty, which has direct implications for production costs, corporate profitability, and investor confidence in financial markets. Existing literature generally reports a negative relation between OVX and stock market returns. For example, He et al. (2020) examine the relation between OVX and stock market returns in both oil-importing and oil-exporting countries. The increases in crude oil price volatility significantly reduce stock market returns, suggesting that heightened uncertainty in the oil market adversely affects equity market performance. Similarly, Vu (2019) investigates the effects of international crude oil prices and crude oil futures volatility on stock markets in Southeast Asia and finds a statistically significant negative relation between oil price volatility and stock market returns across the region. Consistent with these findings, Dutta et al. (2017) conclude that higher levels of uncertainty in the oil market are associated with lower stock market returns. One important explanation is that increased oil price uncertainty weakens investor confidence, raises business costs, and contributes to declining equity market performance.

A substantial body of literature has examined the relation between the CBOE Volatility Index (VIX) and stock market returns and documented a significant inverse relationship. Higher VIX, which represents higher expected market volatility, generally corresponds to lower equity returns. Specifically, Cheuathonghua et al. (2019) find that VIX is negatively associated with international equity market returns in both developed and emerging markets. Meanwhile, the strong asymmetric and negative relation between return and implied volatility is documented at the tails of the distribution by Padungsaksawasdi and Daigler (2014) and Badshah et al. (2016).

Changes in crude oil prices serve as an important indicator reflecting economic conditions and market expectations, providing investors with valuable information for making more informed and effective investment decisions. Darmawan et al. (2020) examine the impact of Brent crude oil price on the performance of Indonesia Composite Index (IHSG) and reveal that an increase in crude oil price significantly reduces IHSG. This negative relation can be explained by Indonesia's position as a net oil-importing country, where higher oil prices increase production costs and create pressure on corporate profitability.

Furthermore, exchange rate movements reflect changes in macroeconomic conditions and can provide important signals regarding economic stability, international capital flows, and market expectations and thereby influencing stock market performance. Chopra (2026) investigates the relation between exchange rate and stock market performance in India and finds an inverse relationship between currency movements and equity market returns. Wong (2017) examines the relationship between real exchange rate returns and real stock price returns and finds the negative and significant associations for Malaysia, Singapore, Korea and the UK.

Conceptual Framework

This study develops conceptual framework by integrating theories, hypotheses and previous studies to explain the determinants of stock market performance. For example, literature related to temperature anomaly is from Cao and Wei (2005), Chang et al. (2006) and Kang et al. (2010), and investor attention for the topic of pollution is from El Ouadghiri et al. (2021). The framework proposes that the total return indices of large-cap listed companies in Thailand and Vietnam are influenced by environmental conditions, investor attention, market uncertainty, and macroeconomic fundamentals, all of which affect investors' expectations regarding future corporate cash flows, discount rates, and risk perceptions as follows.

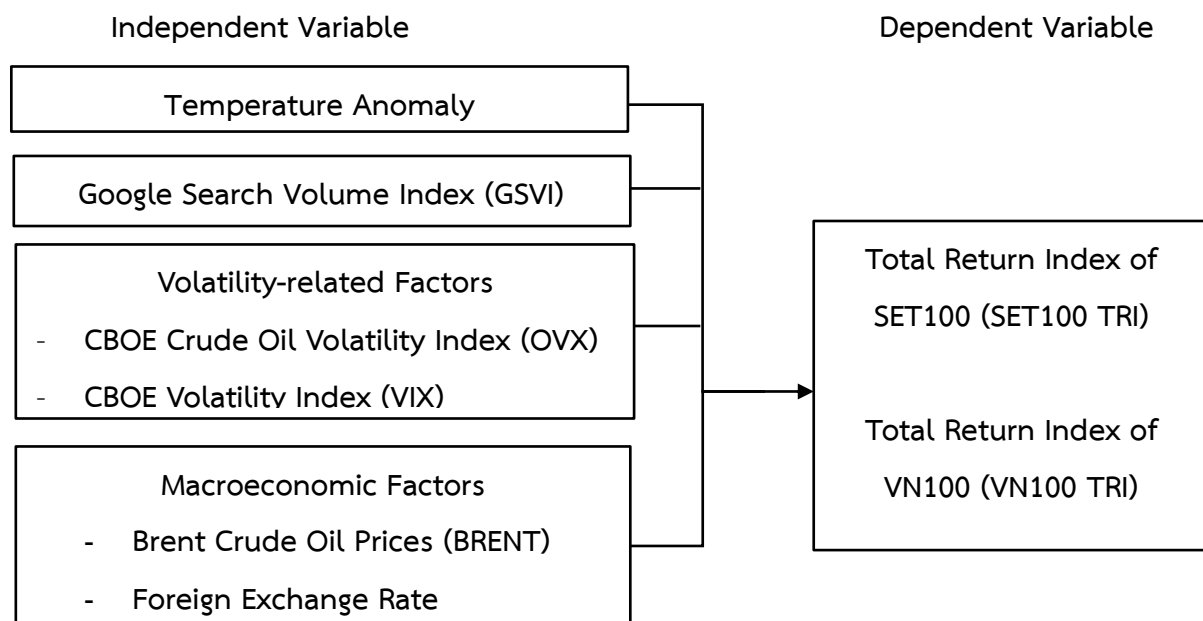


Figure 1 Conceptual Framework

Hypotheses

1. Temperature anomaly is negatively associated with SET100 TRI and VN100 TRI.
2. Google Search Volume Index is negatively correlated with SET100 TRI and VN100 TRI.
3. The CBOE Crude Oil Volatility Index (OVX) is negatively related to SET100 TRI and VN100 TRI.
4. The CBOE Volatility Index (VIX) is negatively associated with SET100 TRI and VN100 TRI.
5. Brent crude oil price is negatively correlated with SET100 TRI and VN100 TRI.
6. Foreign exchange rate is negatively related to SET100 TRI and VN100 TRI.

Research Methodology

This study aims to examine the relation among the independent variables, including temperature anomaly, Google Search Volume Index (GSVI), the CBOE Crude Oil Volatility Index (OVX), the CBOE Volatility Index (VIX), brent crude oil price and foreign exchange rate, and the dependent variables which are the total return indices of SET100 in the Stock Exchange of Thailand (SET100 TRI) and VN100 in Ho Chi Minh Stock Exchange (VN100 TRI). Specifically, temperature anomaly of Thailand (TEMP_TH) and Vietnam (TEMP_VN) were downloaded from ourworldindata.org. OVX, VIX, brent crude oil price, foreign exchange rate, SET100 TRI and VN100 TRI were collected from investing.com. Google Search Volume Index

in Thailand and Vietnam (GSVI_TH and GSVI_VN) were retrieved from Google Trends using the keywords for the topic of pollution and selecting the locations for Thailand and Vietnam on December 19, 2025. This quantitative research employs secondary time-series data based on a monthly basis from April 2018 to April 2025, covering a total of 85 observations. Multiple Regression Analysis with Newey-West estimator is utilized to assess the relations between explanatory and dependent variables. Two Multiple Linear Regression models for two countries are specified as follows.

$$\begin{aligned} \text{DLOG}(\text{SET100TRI}_t) &= \beta_0 + \beta_1 \% \Delta \text{TEMP_TH}_t + \beta_2 \text{DLOG}(\text{GSVI_TH}_t) + \beta_3 \text{DLOG}(\text{OVX}_t) \\ &\quad + \beta_4 \text{DLOG}(\text{VIX}_t) + \beta_5 \text{DLOG}(\text{BRENT}_{t-1}) + \beta_6 \text{DLOG}(\text{THB_USD}_t) + \varepsilon_t \\ \text{DLOG}(\text{VN100TRI}_t) &= \beta_0 + \beta_1 \% \Delta \text{TEMP_VN}_t + \beta_2 \text{DLOG}(\text{GSVI_VN}_t) + \beta_3 \text{DLOG}(\text{OVX}_t) \\ &\quad + \beta_4 \text{DLOG}(\text{VIX}_t) + \beta_5 \text{DLOG}(\text{BRENT}_{t-1}) + \beta_6 \text{DLOG}(\text{VND_USD}_t) + \varepsilon_t \end{aligned}$$

where

SET100TRI _t	is the total return index of SET100 at time t which is transformed to the first difference of the natural logarithm or DLOG(SET100TRI _t)
VN100TRI _t	is the total return index of VN100 at time t which is transformed to the first difference of the natural logarithm or DLOG(VN100TRI _t)
β ₀	is constant.
β ₁ -β ₆	are coefficients.
TEMP_TH _t	is temperature anomaly in Thailand at time t which is transformed to the percentage change or %Δ(TEMP_TH _t)
TEMP_VN _t	is temperature anomaly in Vietnam at time t which is transformed to the percentage change or %Δ(TEMP_VN _t)
GSVI_TH _t	is Google Search Volume Index in Thailand at time t which is transformed to the first difference of the natural logarithm or DLOG(GSVI_TH _t)
GSVI_VN _t	is Google Search Volume Index in Vietnam at time t which is transformed to the first difference of the natural logarithm or DLOG(GSVI_VN _t)
OVX _t	is the CBOE Crude Oil Volatility Index at time t which is transformed to the first difference of the natural logarithm or DLOG(OVX _t)

VIX_t	is the CBOE Volatility Index at time t which is transformed to the first difference of the natural logarithm or $DLOG(VIX_t)$
$BRENT_{t-1}$	is brent crude oil price at time t-1 which is transformed to the first difference of the natural logarithm or $DLOG(BRENT_{t-1})$
THB_USD_t	is foreign exchange rate of Thai Baht per U.S. dollar at time t which is transformed to the first difference of the natural logarithm or $DLOG(THB_USD_t)$
VND_USD_t	is foreign exchange rate of Vietnamese Dong per U.S. dollar at time t which is transformed to the first difference of the natural logarithm or $DLOG(VND_USD_t)$
ε_t	is standard error at time t.

Results and Discussion

Descriptive statistics in Table 1 demonstrate maximum, minimum, mean and standard deviation of data used in this study. Inferential statistics in Table 2 display the Multiple Regression result for the impact of independent variables on SET100 TRI estimated from the first model. Moreover, inferential statistics in Table 2 exhibit the Multiple Regression result for the effect of independent variables on VN100 TRI analyzed from the second model.

Table 1 Descriptive Statistics

Variable	Max	Min	Mean	S.D.	Skewness	Kurtosis
SET100 TRI	4,279.66	2,833.26	3,820.18	317.82	-0.9314	3.3335
VN100 TRI	1,728.40	655.54	1,237.38	286.23	0.0452	1.6554
TEMP_TH	2.6913	-1.2954	0.4498	0.7154	-0.1036	3.5961
TEMP_VN	2.7220	-1.1838	0.5017	0.7232	-0.0095	3.6827
GSVI_TH	53.00	3.00	8.9647	7.3621	3.5968	18.6997
GSVI_VN	50.00	3.00	13.7882	8.7547	2.0778	7.9115
OVX	163.65	25.29	41.1572	19.2874	4.2377	24.7007
VIX	53.54	12.12	20.2142	7.3648	1.0416	4.8032

Table 1 (Continue)

Variable	Max	Min	Mean	S.D.	Skewness	Kurtosis
BRENT	125.53	14.85	73.3179	19.3586	-0.3258	4.2463
THB_USD	38.05	29.76	33.20	2.0482	0.3363	2.2913
VND_USD	26,005.00	22,645.00	23,666.15	863.9128	1.1201	2.9922

SET100 Total Return Index (SET100 TRI) reached its highest value of 4,279.66 points in June 2019. Overall, the index exhibited a sustained upward trend over the 2019–2025 period, reflecting the long-term growth of the total returns generated by the 100 largest listed companies on the Stock Exchange of Thailand despite periods of moderate market volatility. In this regard, easing global economic pressures and expectations that the U.S. Federal Reserve would begin reducing interest rates encouraged capital inflows into emerging markets, including Thailand. In contrast, the lowest value of SET100 TRI was 2,833.26 points, recorded in March 2020, during the outbreak of COVID-19 pandemic. Widespread border closures and suspension of economic activity at both the national and global levels triggered a sharp deterioration in investor sentiment. Consequently, investors shifted their portfolios away from equities toward safer assets, such as cash and government bonds, resulting in a substantial decline in the stock index. SET100 TRI recorded a mean value of 3,820.18 and a standard deviation of 317.82.

VN100 Total Return Index (VN100 TRI) reached its highest value of 1,728.40 points in December 2021. Overall, VN100 TRI exhibited a sustained upward trend over the 2019–2025 period, reflecting the continuous growth in total returns of the 100 largest listed companies on Ho Chi Minh Stock Exchange (HOSE). Although this index experienced fluctuations in response to domestic economic conditions and major global events, its long-term trajectory highlights the strong growth potential of Vietnam's capital market. During 2020, the COVID-19 pandemic triggered a sharp decline in VN100 TRI as global supply chain disruptions and the slowdown in domestic economic activity adversely affected the revenues and profitability of firms operating in the export and manufacturing sectors. VN100 TRI recorded a minimum value of 655.54 points, a mean of 1,237.38 points, and a standard deviation of 286.23, indicating considerable market volatility despite its overall upward trend.

Temperature anomaly for Thailand (TEMP_TH) reached its highest value of 2.6913°C in April 2024, primarily due to the combined effects of a strong El Niño event and the

long-term warming trend associated with climate change. These factors caused surface temperatures to rise substantially above the historical average. The lowest temperature anomaly in Thailand was -1.2954°C , recorded in January 2025, when stronger-than-average winter conditions and cold air masses originating from China reduced average temperatures below their seasonal norms. During the same period, SET100 TRI increased, suggesting that lower-than-average temperatures were accompanied by more favorable equity market performance. Thailand's temperature anomaly recorded a mean of 0.4498°C and a standard deviation of 0.7154.

For Vietnam, temperature anomaly (TEMP_VN) reached a maximum of 2.7220°C in April 2024 and remained at an unusually elevated level through December 2024, substantially exceeding the levels observed in other years. The exceptionally high temperature anomalies during 2023–2024 coincided with a strong El Niño episode, which caused surface temperatures to rise well above their long-term average and resulted in widespread hot and dry weather conditions across the country. Vietnam's temperature anomaly recorded a mean of 0.5017°C and a standard deviation of 0.7232.

Google Search Volume Index for the topic of pollution in Thailand (GSVI_TH) reached its highest value of 53.00 in January 2019, primarily because of the severe PM_{2.5} air pollution crisis. The episode was largely attributable to open biomass burning, heavy traffic congestion, and atmospheric temperature inversion conditions that trapped pollutants near the ground, leading to a substantial deterioration in air quality. The lowest GSVI value for the pollution topic was 3.00, recorded in May 2021. This decline coincided with Thailand's rainy season, during which PM_{2.5} concentrations generally decreased and overall air quality improved. Moreover, COVID-19-related travel restrictions reduced road traffic and open burning activities, further contributing to lower pollution levels. Thailand's GSVI for the pollution topic recorded a mean of 8.9647 and a standard deviation of 7.3621.

Google Search Volume Index for the topic of pollution in Vietnam (GSVI_VN) reached its highest value of 50.00 in March 2022. The resumption of industrial production, construction activities, transportation, and other economic sectors contributed to increased public awareness of environmental pollution, which was reflected in a higher volume of online searches related to pollution. Heightened public awareness of environmental issues, as evidenced by the increased search intensity for pollution-related information. Vietnam's GSVI for the pollution topic recorded a mean of 13.7882 and a standard deviation of 8.7547.

The CBOE Volatility Index (VIX) reached its highest value of 53.54 in March 2020, reflecting the onset of the first wave of the COVID-19 pandemic. The declaration of a state of emergency, the implementation of travel restrictions, and the sharp increase in economic uncertainty led to a substantial deterioration in investor confidence, resulting in heightened expected market volatility. In contrast, VIX recorded its lowest value of 12.12 in September 2018, a period characterized by a relatively stable macroeconomic environment and ample financial market liquidity. These favorable conditions encouraged investors to increase their exposure to riskier assets. Lower expected market volatility was associated with higher stock market returns, whereas increases in the VIX coincided with weaker equity market performance. VIX recorded a mean value of 20.2142 and a standard deviation of 7.3648.

The CBOE Crude Oil Volatility Index (OVX) reached its highest value of 163.65 in April 2020, primarily due to the unprecedented disruption caused by the COVID-19 pandemic. The global health crisis triggered severe volatility in world oil demand as widespread lockdown measures substantially reduced economic activity, causing global oil consumption to decline by more than ten million barrels per day. In addition, the oil price war between Russia and Saudi Arabia generated an unexpected surge in crude oil supply, further exacerbating uncertainty in the oil market. In contrast, OVX recorded its lowest value of 25.29 in August 2018, reflecting relatively stable conditions in the global oil market prior to the escalation of international trade tensions. During this period, production agreements among OPEC members to limit oil output, followed by gradual and well-managed production increases, helped stabilize crude oil prices. Seasonal demand for crude oil also contributed to keeping oil prices within a relatively narrow trading range. OVX recorded a mean value of 41.1572 and a standard deviation of 19.2874.

Brent crude oil price reached its highest level of USD 125.53 per barrel in June 2022, primarily due to the Russia-Ukraine conflict. The disruption of Russian oil exports, given Russia's position as one of the world's largest crude oil exporters, significantly reduced global oil supply, while demand remained relatively strong. This supply-demand imbalance placed substantial upward pressure on international crude oil prices. Conversely, Brent crude oil price fell to their lowest level of USD 14.85 per barrel in April 2020, primarily due to the COVID-19 pandemic. Widespread lockdown measures and the sharp contraction in global economic activity led to an unprecedented decline in worldwide oil demand. As crude oil demand is closely linked to real economic activity, consumption fell dramatically, while oil-

producing countries largely maintained production levels, resulting in a substantial oversupply in the global oil market. Brent crude oil price recorded a mean value of USD 73.3179 per barrel and a standard deviation of 19.3586.

Foreign exchange rate between THB and USD reached its lowest level of 29.76 Thai Baht per U.S. dollar in December 2019, reflecting a period of significant appreciation of the Thai baht. This appreciation was primarily driven by Thailand's substantial current account surplus and strong foreign currency inflows generated by the tourism sector. In contrast, the exchange rate reached its highest level of 38.05 Thai baht per U.S. dollar in October 2022, indicating a substantial depreciation of Thai Baht. This movement was primarily attributable to elevated inflation in the United States, which prompted the U.S. Federal Reserve to implement its most aggressive monetary tightening cycle in decades. Higher U.S. interest rates strengthened U.S. dollar and encouraged investors to shift capital toward U.S. dollar-denominated assets perceived as offering higher returns with relatively lower risk. Exchange rate between THB and USD recorded a mean of 33.20 and a standard deviation of 2.0482.

Foreign exchange rate between VND and USD reached its highest level of 26,005 Vietnamese Dong per U.S. dollar in April 2025. The primary driver of USD appreciation was the series of interest rate hikes initiated by the U.S. Federal Reserve beginning in 2022 in response to elevated inflation, which led to a broad appreciation of U.S. dollar. Consequently, Vietnamese Dong depreciated, capital flowed out of Vietnamese equity market toward U.S. financial markets, and foreign investors concerned about exchange rate losses. Conversely, exchange rate between VND and USD recorded its lowest value of 22,645 Vietnamese Dong per U.S. dollar in January 2022, reflecting a period of highly accommodative U.S. monetary policy. At that time, the U.S. Federal Reserve had maintained policy interest rates near zero and implemented quantitative easing (QE) measures to inject liquidity into the financial system, stimulate lending and consumption, and encourage investment in riskier assets. Exchange rate between VND and USD recorded a mean of 23,666.15 and a standard deviation of 863.9128.

Prior to inferential statistical, the diagnostic tests for statistical issues are appropriately addressed to ensure model robustness. Multiple Regression Analysis is then conducted, and the standard errors are estimated using the Newey–West heteroskedasticity and autocorrelation consistent (HAC) estimator to correct for potential autocorrelation and heteroskedasticity in the regression residuals. The empirical results of the relation between

the independent variables and two dependent variables including the total return index of SET100 as well as that of VN100, are presented in Tables 2 and 3, respectively, as follows.

Table 2 Multiple Regression results for the relation between independent variables and SET100 TRI

Variable	Coefficient	Std. Error	t-Statistic	P-Value
%ΔTEMP_TH	0.0000	0.0000	-1.2719	0.2072
DLOG(GSVI_TH)	-0.0195	0.0073	-2.6868	0.0088***
DLOG(OVX)	-0.0518	0.0307	-1.6905	0.0950*
DLOG(VIX)	-0.0793	0.0234	-3.3895	0.0011***
DLOG(BRENT)	-0.0673	0.0272	-2.4731	0.0156**
DLOG(THB_USD)	-0.6276	0.1886	-3.3276	0.0013***
Constant	-0.0022	0.0046	-0.4756	0.6357
R-Squared		0.4623	Prob(F-Statistic)	0.0000***
Adjusted R-Squared		0.4208	Durbin-Watson	1.7605

Statistical significant level of ***0.01, **0.05, and *0.10

To begin with, the first diagnostic test of data stationarity using the Augmented Dickey–Fuller (ADF) unit root test, is utilized. The results of all variables are found to be non-stationary, and thus SET100 TRI, GSVI_TH, OVX, VIX, BRENT and THB_USD are transformed using the first-difference procedure and take the logarithm to make data less sensitive to extreme values and concentrate the analysis on proportional changes. For temperature anomaly in Thailand (TEMP_TH), it is transformed to percentage change in temperature anomaly. Subsequently, multicollinearity among the independent variables, is examined using both the pairwise correlation coefficient and the Variance Inflation Factor (VIF). The results of multicollinearity exhibit that correlation coefficients are below 0.80 and VIF values are below 10, indicating that multicollinearity is not a concern. Next, the presence of autocorrelation is assessed using the Durbin-Watson (DW) statistic, following by heteroskedasticity that is examined using the Breusch–Pagan–Godfrey test. According to Durbin-Watson (DW) statistic of 1.7605, serial correlation detection is in the indecision zone as well as there is an absence of heteroskedasticity from Breusch–Pagan–Godfrey test. Hence, the estimation is corrected using the Newey–West heteroskedasticity and autocorrelation consistent (HAC) estimator.

The results of inferential statistical display that F-Statistic is significant at the 0.01 significance level, indicating that at least one independent variable is significantly associated with the dependent variable and that the explanatory variables jointly possess significant predictive power for SET100 TRI. The model yields an R-Squared value of 0.4623, and an Adjusted R-Squared of 0.4208, indicating that approximately 46.23% of the variation in SET100 TRI can be explained by the independent variables included in the model, while the remaining 53.77% is attributable to other factors not considered in this study.

The results of the t-statistics reveal that many independent variables significantly explain variations in the dependent variable. Specifically, Google Search Volume Index (GSVI_TH) for the topic of pollution in Thailand, the CBOE Volatility Index (VIX), and exchange rate between THB and USD (THB_USD) have negative coefficients of -0.0195, -0.0793 and -0.6276 at the 0.01 significance level, respectively. In addition, the CBOE Crude Oil Volatility Index (OVX) and Brent crude oil price have negative coefficients of -0.0518 and -0.0673 at the 0.10 and 0.05 significance levels, respectively. Among these variables, foreign exchange rate between THB and USD (THB_USD) exhibits the greatest influence on SET100 TRI, whereas Google Search Volume Index (GSVI_TH) has the smallest effect on it.

Table 3 Multiple Regression results for the relation between independent variables and VN100 TRI

Variable	Coefficient	Std. Error	t-Statistic	P-Value
%ΔTEMP_VN	0.0031	0.0017	1.8842	0.0633*
DLOG(GSVI_VN)	-0.0039	0.0153	-0.2562	0.7985
DLOG(OVX)	-0.1417	0.0293	-4.8354	0.0000***
DLOG(VIX)	-0.0647	0.0224	-2.8882	0.0050***
DLOG(BRENT)	-0.0896	0.0344	-2.6055	0.0110**
DLOG(VND_USD)	-1.7238	0.5738	-3.0040	0.0036***
Constant	0.0100	0.0058	1.7375	0.0863*
R-Squared		0.4315	Prob(F-Statistic)	0.0000***
Adjusted R-Squared		0.3872	Durbin-Watson	1.8816

Statistical significant level of ***0.01, **0.05, and *0.10

First, the diagnostic test of data stationarity using the Augmented Dickey–Fuller (ADF) unit root test, is implemented. The results of all variables are found to be non-stationary, and therefore VN100 TRI, GSVI_VN, OVX, VIX, BRENT and VND_USD are transformed to the first difference and take the logarithm. For temperature anomaly in Vietnam (TEMP_VN), it is transformed to percentage change in temperature anomaly. Second, multicollinearity among the independent variables, is examined using both the pairwise correlation coefficient and the Variance Inflation Factor (VIF). The results of multicollinearity demonstrate that correlation coefficients are below 0.80 and VIF values are below 10, indicating that there is an absence of multicollinearity. Third, autocorrelation using the Durbin-Watson (DW) as well as heteroskedasticity using the Breusch–Pagan–Godfrey test, are assessed. Durbin-Watson (DW) statistic of 1.8816 proposes that there is no serial correlation detection. The result from Breusch–Pagan–Godfrey test suggests that there is no heteroskedasticity. However, to ensure consistent methods with the first model, the estimation in the second model also employs the Newey–West heteroskedasticity and autocorrelation consistent (HAC) estimator.

To examine the effects of independent variables on the total return index rather than to estimate long-run equilibrium relationships, Multiple Regression Analysis is utilized. The results indicate that F-statistic is statistically significant at 0.01 significance level. This finding suggests that at least one independent variable is significantly associated with the dependent variable, and that the explanatory variables jointly possess significant predictive power for VN100 TRI. The model produces an R-Squared value of 0.4315, indicating that 43.15% of the variation in VN100 TRI can be explained by the independent variables included in the model, and Adjusted R-Squared is 0.3872.

The t-test results reveal that five independent variables significantly explain variations in the dependent variable. Specifically, temperature anomaly in Vietnam has a positive coefficient of 0.0031 at 0.10 significance level. On the contrary, OVX, VIX and exchange rate between VND and USD have negative coefficients of -0.1417 , -0.0647 and -1.7238 at 0.01 significance level. Brent crude oil price also has negative coefficients of -0.0896 at 0.05 significance level. Among these significant predictors, exchange rate between VND and USD exhibits the largest effect on VN100 TRI, whereas temperature anomaly in Vietnam has the smallest effect on this index.

The results of inferential statistics from Multiple Regression results in Tables 2 and 3 lead to these following discussions. The first hypothesis of the negative relation between temperature anomaly and both total return indices, is not supported. In fact, the findings suggest that there is no such relation in Thailand while the correlation in Vietnam is positive. One possible explanation is that rising temperature anomaly in Vietnam may coincide with rapid industrial expansion and the relocation of manufacturing facilities from other countries to Vietnam. These developments are associated with strong economic growth prospects, high expected corporate earnings, and increased domestic demand for goods and services, all of which outweigh investors' concerns regarding climate-related risks in the short run. In the context of a developing economy such as Vietnam, which remains vulnerable to climate-related risks, capital market participants may place greater emphasis on inflows from foreign direct investment, the relocation of manufacturing activities, and the future profitability of listed companies than on the adverse consequences of global warming. Consequently, equity returns continue to increase despite rising temperature anomalies. This suggests that the negative effects of climate change on stock market returns in Vietnam may not yet be fully reflected in the short term.

The empirical evidence of the negative association between Google Search Volume Index in Thailand (GSVI_TH) and SET100 TRI only supports the second hypothesis while there is no significant correlation between GSVI in Vietnam and VN100 TRI. This negative relation between GSVI_TH and SET100 TRI can be explained by Attention Theory that Barber & Odean (2008) and Da, Engelberg, and Gao (2011) suggest that investors have limited cognitive resources and cannot process all available information simultaneously. Instead, they selectively allocate their attention to salient or highly publicized events. An increase in Google search intensity for pollution reflects heightened public and investor attention toward environmental problems, indicating that pollution has become a prominent concern. When environmental issues receive greater attention, investors may reassess firms' future profitability by incorporating expected environmental costs into their valuation. The result of Thailand is consistent with that of El Ouadghiri et al. (2021), who document a negative relation between GSVI for the topic of pollution and returns of S&P 500 and FTSE USA indices. From investor perspectives, increasing public attention to environmental issues may reflect growing awareness of environmental, social, and governance (ESG) considerations. As businesses place greater emphasis on environmental responsibility, they may face additional costs associated

with pollution control, production adjustments, and operational compliance with environmental policies aimed at mitigating climate change risks. Since climate change represents risk that can adversely affect corporate performance, firms may need to modify their operational processes and strategic approaches to address these challenges. Such adjustments increase operating expenditure, potentially reducing corporate earnings and stock returns.

Moreover, the negative relations between OVX and SET100 TRI as well as VN100 TRI support the third hypothesis. Oil is considered the critical input cost across various business sectors, and therefore increased volatility in oil prices can negatively affect investor confidence and increase operating costs for firms. These effects subsequently reduce the performance of the total return indices of listed companies in both countries. Likewise, He et al. (2020) demonstrate that fluctuations in OVX significantly reduce stock market returns which are consistent with Vu (2019) who addresses the negative relations between oil price volatility and stock markets in Southeast Asian countries. Similarly, Dutta et al. (2017) show that greater uncertainty is associated with lower asset returns.

VIX and Brent crude oil price negatively affect both SET100 TRI and VN100, supporting the fourth and fifth hypotheses. On the one hand, the results of VIX and both indices are consistent with Cheuathonghua et al. (2019), Padungsaksawasdi and Daigler (2014), and Badshah et al. (2016) that higher VIX is associated with lower returns in international equity markets. Meanwhile, the results of Brent crude oil price and both indices are consistent with Darmawan et al. (2020) who find the negative relation between Brent crude oil price and Indonesia Composite Index (IHSG) performance. These findings can be explained by the positions of Thailand and Vietnam that are also net importers of oil which is similar to that of Indonesia.

The negative associations between foreign exchange rate and TRI of both countries support the sixth hypothesis. An increase in exchange rate between THB and USD, which indicates a depreciation of Thai Baht, leads to lower total stock returns. This is because foreign-denominated costs or liabilities become more expensive when converted into Thai Baht, reducing corporate profitability. In addition, a depreciation of domestic currency may reduce international capital inflows, as foreign investors withdraw their investments or convert Thai Baht holdings back into U.S. dollar to mitigate exchange rate losses. Similarly, a decrease in exchange rate between VND and USD, representing an appreciation of Vietnamese Dong, contributes to higher total stock returns. These findings are consistent with Chopra (2026),

who finds that exchange rates significantly influence stock market performance in India as well as Wong (2017) who demonstrates that exchange rate returns negatively affect stock price returns in many countries including Malaysia, Singapore, Korea and the UK. Likewise, El-Diftar (2023) suggests that there is a significant negative long-run relation between exchange rate and stock market performance for Indonesia. More importantly, exchange rates exhibit the greatest influence on both total return indices because they directly affect firms' expected cash flows, production costs, financing costs, and investors' capital allocation decisions simultaneously. Unlike other macroeconomic variables that primarily influence one aspect of firm performance, exchange rate movements propagate through multiple transmission channels, thereby exerting a broader impact on corporate profitability and stock market performance.

Recommendations

Recommendations for Practical Application

1. The increases in Vietnam's temperature anomaly are accompanied by higher VN100 TRI, suggesting that investors can monitor changes in Vietnam's temperature anomaly as an indicator when making investment decisions, particularly for sectors that are sensitive to climate-related conditions.

2. The increases in investor attention to pollution in Thailand, measured by Google Search Volume Index (GSVI_TH) for the topic of pollution, are associated with lower stock market returns. Therefore, investors can consider changes in GSVI_TH when evaluating investment opportunities in sectors that are sensitive to environmental concerns.

3. Expected market volatility, as measured by OVX for the oil market and VIX for the equity market, are the determinants of both SET100 TRI and VN100 TRI, highlighting transmission of uncertainties from U.S. to Thailand and Vietnam. Accordingly, investors should closely monitor OVX and VIX which serve as leading indicators to evaluate investment opportunities to manage portfolio and assess risk exposure from external factors in both countries.

Recommendations for Policy Makers

1. Policy makers should continue to impose regulations that require listed companies in Thailand and Vietnam to follow Environmental, Social, and Governance (ESG) practices and provide transparent disclosures since the empirical evidence shows that temperature anomaly

and GSVI_TH significantly affect VN100 TRI and SET100 TRI, respectively. ESG reporting particularly helps listed companies convey how sustainability issues affect performance, risk, and competitiveness as well as encourages explicit communication with stakeholders.

Recommendations for Companies

1. Foreign exchange rates inversely affect TRI in both countries, suggesting that foreign exchange risk plays the vital role in explaining stock performance, and hence listed companies should hedge against exchange rate volatility by using financial instruments.

Recommendations for Future Research

1. Future research can extend the analysis to other countries with different market environments, or time periods to determine whether the empirical evidence differs across market, economic and institutional contexts.

2. Future studies can perform comparative analyses by incorporating the determinants of stock market performance across countries that would enhance existing studies to support investment decision-making in diverse international financial markets.

3. Future research can employ non-linear models such as GARCH or Threshold regression models to capture the more complex and asymmetric relationships among factors for financial data.

Research Limitations

The analysis is constrained by the availability of observations for certain variables. To maintain consistency across variables, this study uses observations for which complete and comparable data are available.

References

- Badshah, I., Frijns, B., Knif, J. & Tourani-Rad, A. (2016). Asymmetries of the intraday return-volatility relation. *International Review of Financial Analysis*, 48, 182–192. <https://doi.org/10.1016/j.irfa.2016.09.016>
- Bao, N. K. Q. & Van, L. (2023). The relation between stock return and air quality in Vietnam under impacts of COVID-19. *International Journal of Economic Policy in Emerging Economies*, 17(2), 143-161. <https://doi.org/10.1504/IJEPEE.2023.129781>
- Barber, B. M. & Odean, T. (2008). All that glitters: the effect of attention and news on the buying behavior of individual and institutional investors. *The Review of Financial Studies*, 21(2), 785–818. <https://doi.org/10.1093/rfs/hhm079>

- Cao, M. & Wei, J. (2005). Stock market returns: A note on temperature anomaly. *Journal of Banking & Finance*, 29(6), 1559-1573. <https://doi.org/10.1016/j.jbankfin.2004.06.028>
- Chang, T., Nieh, C. C., Yang, M. J., & Yang, T. Y. (2006). Are stock market returns related to the weather effects? Empirical evidence from Taiwan. *Physica A: Statistical Mechanics and its Applications*, 364, 343–354. <http://doi.org/10.1016/j.physa.2005.09.040>
- Cheuathonghua, M., Padungsaksawasdi, C., Boonchoo, P. & Tongurai, J. (2019). Extreme spillovers of VIX fear index to international equity markets. *Financial Markets and Portfolio Management*, 33, 1-38. <https://doi.org/10.1007/s11408-018-0323-6>
- Chopra, A. (2026). Impact of Macroeconomic variables on stock market returns: an ARDL analysis of the Indian market. *International Journal of Social Science Research and Review*, 9(4), 43-55. <https://doi.org/10.47814/ijssrr.v9i4.3324>
- Da, Z., Engelberg, J. & Gao, P. (2011), In search of attention. *The Journal of Finance*, 66, 1461-1499. <https://doi.org/10.1111/j.1540-6261.2011.01679.x>
- Darmawan, I., Siregar, H. & Hakim, D. B. & Manurung, A. H. (2020). The effect of crude oil price shocks on Indonesia stock market performance. *Jurnal Organisasi dan Manajemen*, 16(1), 11-23. <http://doi.org/10.33830/jom.v16i1.785.2020>
- Dutta, P., Noor, M. H., & Dutta, A. (2017). Impact of oil volatility shocks on global emerging market stock returns. *International Journal of Managerial Finance*, 13(5), 578–591. <https://doi.org/10.1108/IJMF-03-2017-0039>
- El-Diftar, D. (2023). The impact of exchange rates on stock market performance of the Emerging 7. *Journal of Capital Markets Studies*. 7(2), 125-139. <https://doi.org/10.1108/JCMS-03-2023-0005>
- El Ouadghiri, I., Guesmi, K., Peillex, J. & Ziegle, A. (2021). Public attention to environmental issues and stock market returns. *Ecological Economics*, 180, 106836. <https://doi.org/10.1016/j.ecolecon.2020.106836>
- He, Z., Chen, J., Zhou, F., Zhang, G. & Wen, F. (2020). Oil price uncertainty and the risk-return relation in stock markets: Evidence from oil-importing and oil-exporting countries. *International Journal of Finance & Economics*, 27(1), 1154-1172. <http://doi.org/10.1002/ijfe.2206>
- Kang, S. H., Jiang, Z., Lee, Y., & Yoon, S. M. (2010). Weather effects on the returns and volatility of the Shanghai stock market. *Physica A: Statistical Mechanics and its Applications*, 389(1), 91–99. <http://doi.org/10.1016/j.physa.2009.09.010>

- Khanthavit, A. (2025). PM2.5 Pollution, retail trading, and stock market returns. *ABAC Journal*, 45(2), 68 – 79. <https://doi.org/10.59865/abacj.2025.6>
- Mollet, J. C. & Ziegler, A. (2014). Socially responsible investing and stock performance: New empirical evidence for the US and European stock markets. *Review of Financial Economics*, 23(4), 208-216. <https://doi.org/10.1016/j.rfe.2014.08.003>
- Padungsaksawasdi, C. & Daigler, R. T. (2014). Testing the behavioral approach of the return-implied volatility relation: the 2008 financial crisis versus normal markets. *Review of Futures Market*, 21(4), 479–509. <https://doi.org/10.1002/fut.21592>
- Peillex, J. & Ureche-Rangau, I. (2016). Identifying the Determinants of the Decision to Create Socially Responsible Funds: An Empirical Investigation. *Journal of Business Ethics*, 136(1), 101-117. <http://doi.org/10.1007/s10551-014-2507-y>
- Vu, T. N. (2019). Impact of crude oil price volatility on Southeast Asian stock returns. *International Journal of Economics and Finance*, 11(4), 40–48. <https://doi.org/10.5539/ijef.v11n4p40>
- Whaley, R. E. (1993). Derivatives on market volatility: Hedging tools long overdue. *Journal of Derivatives*, 1, 71-84. <https://doi.org/10.3905/jod.1993.407868>
- Wong, H. T. (2017). Real exchange rate returns and real stock price returns. *International Review of Economics & Finance*, 40, 340-352. <https://doi.org/10.1016/j.iref.2017.02.004>