

Article

The Asymmetric Effects of Oil Price Volatility on Stock Returns: Evidence from Ho Chi Minh Stock Exchange

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Abstract: This study is the first to investigate the asymmetric effects of oil price volatility on stock returns for the Ho Chi Minh Stock Exchange (HOSE). We utilized weekly series of VN30-Index, WTI crude oil prices, geopolitical risks (GPR) index, and gold prices spanning from 6 February 2012 to 31 December 2023 as data sources. Using a nonlinear autoregressive distributed lag (NARDL) bounds testing approach, we found that, in the shortterm, oil price volatility has negative asymmetric effects on market returns. Specifically, in the shortterm, a 1 percent increase in oil price volatility immediately leads to a 2.6868 percent decrease in the market returns, while a similar magnitude decrease in oil price volatility is associated with a 6.3180 percent increase in the market returns. In addition, the results obtained from the NARDL model indicated that, in the longterm, the negative and positive changes of oil price volatility have significantly negative effects on the market returns. Finally, the findings derived from the error correction model (ECM) show that a 98.21 percent deviation from the equilibrium level in the previous week is converged and corrected back to the long-term equilibrium in the current week.

Keywords: HOSE; market returns; NARDL; oil price volatility

JEL Classification: E44; G12; G41



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1. Introduction

Since the beginning of the industrial age, hydrocarbons have played an ever more critical role in civilization's development. In the 1800s, coal was the dominant source of energy for the propulsion of ships and trains, as well as for electricity generation for an ever more integrated global economy. In the early 1900s, following the introduction of the internal combustion engine, oil took over as the dominant energy source for the planet, currently accounting for nearly one-third of the globe's total energy consumption. This led to the greatest scramble for natural resources ever, as countries and companies sought to acquire reliable supplies of the critical black gold that powers their economies. Oil is an essential life blood of economic prosperity and wellbeing, especially as the planet's population has grown because of increasing food production, fueling global trade and transportation that moves people and materials from one side of the planet to the other, often in a matter of days or even hours.

Clearly, people's economic prosperity is directly tied to such a critical natural resource. Movements in prices tied to supply and demand dynamics ripple through economies, substantially hurting the prospects of oil-dependent economies, while greatly enhancing the wealth of oil-providing economies like those in the Middle East. Oil drives up the prices of all goods in the economy through production and transportation costs, thus increasing inflation and, in turn, interest rates for oil-dependent economies. These economic drags or windfalls related to oil price movements reverberate through economies and, in turn, their stock markets, having both negative and positive benefits depending on a country's

relative production and consumption. In addition, the stock market plays an important role in economic development for each country. Deep and broad financial market development has been shown to have a positive impact on the economic growth of countries (Asteriou and Spanos 2019; Kapaya 2020; Bhattarai et al. 2021). Therefore, the effects of oil prices and oil price volatility on stock returns have attracted considerable attention from scholars in the last decades. However, the existing literature has provided mixed evidence on the effect of oil price volatility on stock returns. Specifically, most of the studies have reported negative effects of oil prices volatility on stock returns (Diaz et al. 2016; Raza et al. 2016; Joo and Park 2017; Luo and Qin 2017; Xiao et al. 2018; Joo and Park 2021; Rahman 2021), while some empirical studies have found positive influences of oil price volatility on stock market returns (Joo and Park 2021; Chen et al. 2017; Raza et al. 2016). It is important to stress that the empirical studies have mostly focused on the U.S. and other oil-importing developed countries and less on developing countries. In addition, most of these studies have assumed that the impact of oil price volatility on stock returns is symmetric. However, the impact of oil price volatility on stock returns could be asymmetric, meaning that an increase in oil price volatility has a different effect on stock returns compared to a decrease in oil price volatility of the same magnitude.

Vietnam, a transition economy well on the path to emerging-market status, is critically dependent on oil imports to fuel its economic machine, especially considering that domestic production has fallen over the last decade. In 2022, Vietnam's oil consumption was about 515,000 barrels per day, while the oil production of the country was only around 194,000 barrels, meaning that Vietnam had to import approximately 321,000 a day (Nguyen 2024). Therefore, oil price movements could impact the Vietnam stock market. Although the effects of oil price changes and oil price volatility have been substantially documented in the literature, to our best knowledge, no study on these effects has been found for the Ho Chi Minh Stock Exchange (HOSE). To fill the gap in the literature, this study is devoted to investigating the effects of oil price volatility on stock returns for the HOSE. The contributions of the study to the literature are as follows. First, this study provides unique insights into the literature covering the effects of oil price volatility on stock returns in a transitional economy due to the fact that the Vietnamese economy has been in a transitional period with growing consumption of oil and deep integration into the world economy. Therefore, it is expected that the effect of oil price volatility on stock returns will be more pronounced in the Vietnam stock market. Second, while most studies on this topic investigate the symmetric effects of oil price volatility on stock returns, this study focuses on the asymmetric effects of oil price volatility on stock returns. It is important to note that the HOSE is characterized by a large number of small individual investors (Truong et al. 2021). Therefore, the response of investors in the market to oil prices could be asymmetric. The key hypothesis of the study is that oil price volatility has negative asymmetric effects on stock returns for the HOSE. This hypothesis is tested by using the NARDL bounds testing approach. The main finding of this study is that oil price volatility has negative asymmetric effects on the market returns. This paper is ordered as follows. Section 2 provides the theoretical background underpinning our analysis, as well as a review of the relevant literature on the topic. Section 3 contains a description of the data and the methodology employed in this analysis, while Section 4 provides the empirical results. Conclusions are drawn in Section 5.

2. Theoretical Background and Empirical Literature Review

The cashflow theory can be utilized as a theoretical framework to explain the impact of oil prices on returns of financial equities. Generally, according to the cashflow theory, financial equities value is equal to the present value of anticipated cash flows. Based on this theory, oil prices could have negative or positive effects on stock returns (Smyth and Narayan 2018). On the one hand, the negative effects of oil prices on stock returns could be justified in two ways. First, because oil is used as an essential input for most companies, an increase in oil prices leads to an increase in production costs; hence, future cash flows

decrease. Second, an increase in oil prices can result in an increase in expected inflation; thus, nominal interest rates increase. Financial experts use interest rates as discount rates to determine the value of stocks. Therefore, higher interest rates lead to lower stock returns. On the other hand, oil prices could have a positive impact on stock returns. A possible reason to explain this effect is that investors could positively respond to increasing oil prices because higher oil prices are associated with greater economic growth and the stronger performance of firms (Kollias et al. 2013). Furthermore, oil price volatility could have negative effects on stock returns because oil price volatility can positively influence the risk premium component of the discount rate used in the equity pricing model. Therefore, higher oil price volatility is associated with higher discount rates and lower stock returns.

In earlier empirical studies in this field, researchers mainly investigated the effects of oil prices on stock returns for specific countries or groups of countries (Smyth and Narayan 2018). The findings from these studies did not reach a consensus. Specifically, most of studies found negative effects of oil prices on stock returns (Jones and Kaul 1996; Gjerde and Sættem 1999; Sadorsky 1999; Papapetrou 2001; Basher and Sadorsky 2006; Park and Ratti 2008; Driesprong et al. 2008; Chen 2010; Filis 2010; Basher et al. 2012; Raza et al. 2016). In contrast, others reported positive influences of oil prices on stock returns (Narayan and Narayan 2010; Zhu et al. 2011; Zhu et al. 2014; Bouri 2015; Raza et al. 2016; Silvapulle et al. 2017; Luo and Qin 2017; de Jesus et al. 2020). Some researchers documented that oil prices have asymmetric effects on stock returns (Bahmani-Oskooee et al. 2019; Jiang and Liu 2021).

Recently, some empirical studies have focused on the effects of oil price volatility on stock returns. Most of them have focused on developed countries. Specifically, Rahman (2021) investigated the impact of oil price volatility on U.S. stock market returns from 1973 to 2015. The researcher found that oil price volatility has a significantly negative effect on the market returns. In addition, Diaz et al. (2016) determined the relationship between oil price volatility and stock market returns in the G7 countries during the period from 1970 to 2014. Using a vector autoregressive model, they found a negative effect of oil price volatility on stock market returns. Similarly, Joo and Park (2017) estimated the effects of stock and oil price uncertainty measured by conditional variance on oil returns and stock market returns for the United States, Japan, Korea, and Hong Kong during the period from 1996 to 2015. Using the VAR-DCC-BGARCH-in-mean approach, they reported that oil price volatility has a significantly negative impact on the market returns for the United States, Japan, and Hong Kong. In a later study, Joo and Park (2021) investigated the effects of oil price volatility on stock market returns for 10 major oil-importing countries. In their analysis, they considered China, France, Germany, India, Italy, Japan, Korea, the Netherlands, Spain, and the United States from May 2001 to December 2019. They found that oil price volatility has asymmetric effects on stock returns. Specifically, oil price volatility has a negative effect on stock returns in the case that both oil price volatility and stock returns are low. However, when oil price volatility is low and stock market returns are high, oil price volatility has a positive effect on stock returns. As the world's largest importer of crude oil, China has been the focus of investigations of the effects of oil price volatility on Chinese stock market returns. Specifically, Luo and Qin (2017) examined the effects of oil price volatility on Chinese stock market returns from 10 May 2007 to 31 December 2015. In that study, they used the crude oil volatility index (OVX) and realized a variance in the oil price volatility. In their findings, they confirmed that the oil price volatility has significantly negative effects on the market returns. In addition, Xiao et al. (2018) investigated the asymmetric effects of oil price volatility, measured by the crude oil volatility index, on Chinese stock returns from 10 May 2007 to 20 September 2017. They found that the oil price volatility has a significantly negative asymmetric impact on Chinese stock returns in a bearish market. Specifically, the effects of positive changes in oil price volatility on the stock returns are larger than the effects of the negative changes. Moreover, Chen et al. (2017) examined the predictive ability of oil returns and oil return volatility on stock market momentum in the same market. They found that oil price volatility and stock market momentum are positively correlated. Raza et al. (2016) also examined the long-term and short-term asymmetric effects of gold

prices, oil prices, and gold and oil price volatilities on market returns. In their analysis, they considered emerging stock markets, such as those in China, India, Brazil, Russia, South Africa, Mexico, Malaysia, Thailand, Chile, and Indonesia. Using monthly data from January 2008 to June 2015, the empirical findings derived from a nonlinear autoregressive distributed lag (NARDL) approach indicated several trends. In the short run, negative changes in oil price volatility had a negative impact on stock returns in the Indian, South African, Malaysian, Thai, Chilean, and Indonesian markets. At the same time, positive changes in oil price volatility had a positive effect on the stock returns of the Chinese and South African stock markets. In addition, the researchers documented that, in the long run, oil price volatility has an asymmetric negative impact on the market returns of all emerging stock markets.

Furthermore, some researchers have investigated the relation between oil price volatility and stock return volatility. Specifically, [Anand et al. \(2014\)](#) explored the volatility spillover between oil prices and Indian stock market returns from January 2000 to December 2012. The researchers documented that oil price volatility has positive spillover effects on the volatility of market returns, but the market return volatility did not impact oil price volatility. In addition, [Dutta et al. \(2017\)](#) examined the effects of oil price volatility on the stock return volatility of the Middle Eastern and African stock markets from 10 May 2007 to 31 December 2014. Using an extended GARCH model, their empirical results revealed that oil market volatility has significant positive effects on the market return volatility of most studied markets. [Sarwar et al. \(2020\)](#) also investigated the volatility spillover between oil prices and stock returns for Pakistan, China, and India from 1997 to 2014. Using the bivariate BEKK-GARCH model, they found that oil price volatility has negative spillover effects on the volatility of market returns for all markets.

In summary, theoretically, oil price changes could have negative or positive effects on stock returns, while oil price volatility could have negative effects on stock returns. In the last decades, researchers have extensively documented the effects of oil price changes and oil price volatility on stock returns. However, scholars have not come to a consensus. Specifically, most researchers have reported negative effects of oil prices on stock returns, while others have indicated positive influences of oil prices on stock market returns. In addition, using empirical research, most researchers have documented that oil price volatility has negative effects on stock returns. Especially, some provide evidence that oil price volatility has asymmetric effects on stock returns. Based on this theoretical framework and empirical evidence, we hypothesized that oil price volatility has negative asymmetric effects on stock returns for the HOSE.

3. Data and Methodology

3.1. Data Sources

The data used in this study comprise the weekly series of VN30-Index, oil prices (WTI crude oil), geopolitical risks (GPR) index, and gold prices from 6 February 2012 to 31 December 2023. It is important to note that the VN30-Index, which was officially launched on 6 February 2012, is a market-capitalization-weighted index calculated from 30 big capitalization and high liquidity stocks traded on the HOSE. The GPR index is the index developed by [Caldara and Iacoviello \(2022\)](#). These series are collected on Wednesdays. The choice of Wednesday aims to avoid the weekend effects of stock trading and to minimize the number of holidays ([Huber 1997](#)). Table 1 includes the specific data sources.

Table 1. Data sources of the study.

Data	Data Source
VN30-Index	Investing.com (https://www.investing.com , accessed on 30 January 2024)
Oil prices	Investing.com (https://www.investing.com , accessed on 15 January 2024)
GPR index	Caldara and Iacoviello's website (https://www.matteoiacoviello.com , accessed on 15 January 2024)
Gold prices	Investing.com (https://www.investing.com , accessed on 15 January 2024)

3.2. Research Methodology

To investigate the asymmetric effects of oil price volatility on stock returns for the HOSE, we use the following baseline regression model:

$$R_t = \beta_0 + \beta_1 VOL_t + LNGPR_t + LNG_t + \varepsilon_t \quad (1)$$

where R_t : market return of week t . The weekly market returns are calculated by the following equation:

$$R_t = \text{Log}(I_t) - \text{Log}(I_{t-1}) \quad (2)$$

where:

- I_t : VN30-Index at week t ;
- I_{t-1} : VN30-Index at week $t - 1$;
- VOL_t : oil price volatility at week t generated from a GARCH(1,1) model. In this study, the GARCH(1,1) takes the following form:

$$\begin{aligned} LNOP_t &= \alpha_0 + \alpha_1 LNOP_{t-1} + \varepsilon_t \quad \varepsilon_t \approx N(0, h_t) \\ h_t &= \omega + \delta h_{t-1} + \gamma \varepsilon_{t-1}^2 \end{aligned} \quad (3)$$

where:

- $LNOP_t$: natural logarithm of oil price at week t ;
- $LNOP_{t-1}$: natural logarithm of oil price at week $t - 1$;
- $LNGPR_t$: natural logarithm of the GPR Index at week t ;
- LNG_t : natural logarithm of gold price at week t .

We employ the NARDL bounds testing approach proposed by Shin et al. (2014) to investigate the short-term and long-term asymmetric effects of oil price volatility on the market returns. The approach is an extended model of the ARDL model developed by Pesaran et al. (2001). In this model, oil price volatility is decomposed in positive and negative partial sum series. It is important to note that the NARDL bound does not require all variables to be integrated in the same order. Instead, it only requires that the order of integration of all variables is less than 2 (Truong et al. 2024). Therefore, researchers should examine the order of integration of all variables before conducting the bounds test. In this study, we employ the ADF (augmented Dickey–Fuller) test to determine the order of integration of the studied variables. The ADF test takes the following form:

$$\Delta y_t = \alpha_0 + \beta y_{t-1} + \sum_{j=1}^k \delta_j \Delta y_{t-j} + \varepsilon_t \quad (4)$$

where Δ is first-difference operator.

Because the ADF test results are sensitive to the selection of the lag length (k), the Akaike information criterion (AIC) is used for choosing the optimal k of the ADF regression.

Moreover, the null hypothesis in the ADF test is the existence of a unit root ($\beta = 0$), and it is rejected if the ADF test statistic is larger than the critical value.

Before estimating the short-term and long-term effects of oil price volatility on the market returns, the NARDL bound test is applied in order to determine the cointegration between variables in the model. Specifically, the NARDL bound test used in this study takes the following equation:

$$\Delta R_t = \beta_0 + \sum_{i=1}^{q_1} \beta_{1i} \Delta R_{t-i} + \sum_{i=0}^{q_2} \beta_{2i} \Delta VOL_{t-i}^+ + \sum_{i=0}^{q_3} \beta_{3i} \Delta VOL_{t-i}^- + \sum_{i=0}^{q_4} \beta_{4i} \Delta LNGPR_{t-i} + \sum_{i=0}^{q_5} \beta_{5i} \Delta LNG_{t-i} + \lambda_1 R_{t-1} + \lambda_2 VOL_{t-1}^+ + \lambda_3 VOL_{t-1}^- + \lambda_4 LNGPR_{t-1} + \lambda_5 LNG_{t-1} + \varepsilon_t \quad (5)$$

where:

- Δ represents the first difference of the variables;
- The null hypothesis (H_0) of the NARDL bound test is $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0$ (no co-integration in the longterm between variables).

If the F-statistic calculated from the bounds test is larger than the critical value of the selected significance level, the null hypothesis is rejected, meaning that a long-term relationship (co-integration) between the variables exists in the model. If a long-term equilibrium relationship is detected, the short-term and long-term effects of the oil price volatility on the market returns are estimated by Equations (6) and (7), respectively.

$$\Delta R_t = \varphi_0 + \sum_{i=1}^{q_1} \varphi_{1i} \Delta R_{t-i} + \sum_{i=0}^{q_2} \varphi_{2i} \Delta VOL_{t-i}^+ + \sum_{i=0}^{q_3} \varphi_{3i} \Delta VOL_{t-i}^- + \sum_{i=0}^{q_4} \varphi_{4i} \Delta LNGPR_{t-i} + \sum_{i=0}^{q_5} \varphi_{5i} \Delta LNG_{t-i} + \delta ECM_{t-1} + \varepsilon_t \quad (6)$$

$$R_t = \beta_0 + \beta_1 R_{t-1} + \beta_2 VOL_{t-1}^+ + \beta_3 VOL_{t-1}^- + \beta_4 LNGPR_{t-1} + \beta_5 LNG_{t-1} + \varepsilon_t \quad (7)$$

4. Empirical Results

4.1. Oil Price Volatility and Market Returns of the HOSE for the Period from 2012 to 2023

Table 2 includes the descriptive statistics of the oil price volatility and market returns of the HOSE from 1986 to 2021 based on the obtained data. It shows that the oil price volatility measured by the conditional variances of the GARCH(1,1) model ranges from 0.0001 to 0.0103 with a mean of 0.0005. Specifically, Figure 1 shows oil price volatility from 2012 to 2023 with four periods, namely the post-global-financial-crisis period (2012–2015), the U.S.–Saudi oil conflict and the U.S.–China trade conflict period (2016–2019), the COVID-19 crisis period (2020–2021), and the Russia–Ukraine war period (2022–2023). In the post-financial-crisis period from 2012 to 2015, oil price volatility showed a stable fluctuation amplitude due to post-crisis production. During the U.S.–Saudi oil conflict and the U.S.–China trade conflict between 2016 and 2019, there was great volatility in oil prices with a severe decline and bottoming out at 40% in 2018 from 2012. The reason was because Saudi Arabia sharply increased production under pressure from the U.S. and the U.S.–China trade conflict. The oil price volatility decreased by more than 10% in 2023 because of the COVID-19 pandemic from 2020 to 2021 that led to an oil demand decline. At the end of 2021, oil prices dropped because of the new variant of COVID-19 in South Africa with a high risk of infection.

Table 2. Summary statistics of oil prices volatility and market returns (2012–2023).

Variables	Observations	Minimum	Mean	Maximum	Standard Deviation
VOL	607	0.0001	0.0005	0.0103	0.0008
R	607	−0.0435	0.0006	0.0483	0.0118

Source: Own calculation on the data obtained from [Investing.com](https://www.investing.com).

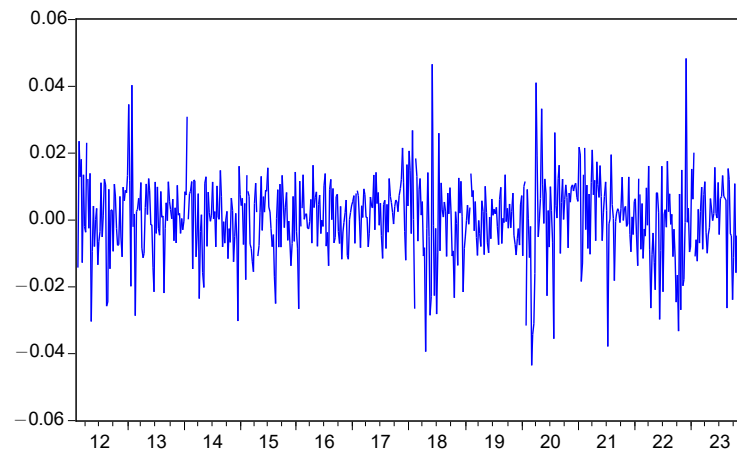


Figure 1. Oil prices volatility during the period 2012–2023. Source: Data generated from the GARCH(1,1) model of oil prices obtained from [Investing.com](https://www.investing.com).

Oil price volatility fluctuated strongly between 2022 and 2023 and reached the highest level of more than 45% in March 2022 from 2008. The Russia–Ukraine war and the G7 and its allied countries’ imposing of sanctions on Russian sectors (banking, logistics, and energy) caused the volatility. After that, oil prices “slid” because of weak oil demand from China, central banks raising interest rates, and concerns about an economic recession. Toward the end of 2023, amid the oil price volatility, the annual price had slid since 2020, despite geopolitical risks and the ongoing Israeli– Hamas conflict in the Middle East.

Regarding market returns, we observed that the mean weekly market return for the studied period was 0.0006 with a standard deviation of 0.0118 (see Table 2). Figure 2 includes the market returns from 2012 to 2023 with three similar periods, like oil price volatility. First, market returns in the post-global-financial-crisis period fluctuated slightly and maintained positive low profits due to the TPP and FTA, expanding room for foreign investors. Second, market returns from 2016 to 2019 significantly rebounded and declined from April 2016 to December 2018, respectively. The undesirable impacts of negative events, such as the Chinese stock market interrupting trading, the UK leaving the EU, and the results of the U.S. presidential election, were the causes. From January to August 2019, market returns had a strong recovery due to the comprehensive restructuring of the stock market and the passage of a new security law. Third, market returns recovered spectacularly from 2021 to 2022. Fourth, market returns experienced multiple negative changes in the period 2022–2023, declining more than 33.6% compared to the peak on 10 January 2022. The prolonged geopolitical tensions between Russia and Ukraine and between Israel and Hamas contributed to the negative effects.

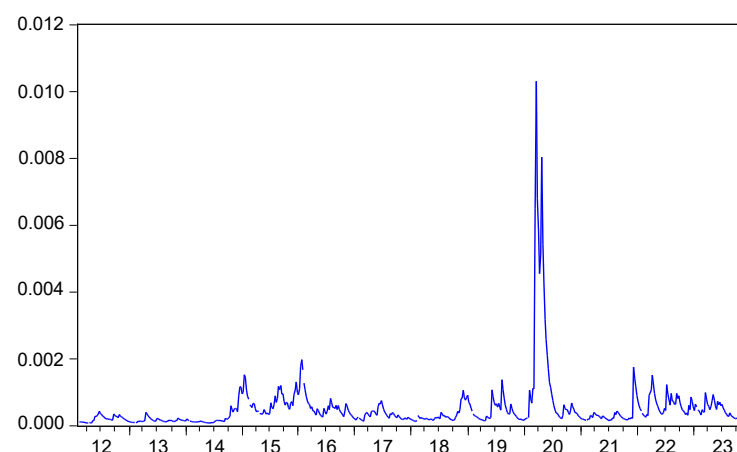


Figure 2. The market returns for the period 2012–2023. Source: Data were collected from [Investing.com](https://www.investing.com).

In summary, in 2012–2023, notable changes, such as the post-global-financial-crisis period, the U.S.–Saudi oil conflict, the U.S.–China trade conflict, the COVID-19 crisis, and the Russia–Ukraine war, significantly impacted oil price volatility and market returns. However, the oil price volatility and market yield changes have been reversing since 2023.

4.2. The Estimation of Oil Price Volatility

In this study, oil price volatility (conditional variance) is generated by using the GARCH(1,1) model. Table 3 includes a summary of results derived from the GARCH(1,1) model. The estimated values of the conditional variance equation (h_t) provide a series showing the real oil price volatility. Specifically, the results of GARCH(1,1) reveal that the coefficients of ARCH (γ) and GARCH (δ) are significant at one level, and the sum of the two coefficients is less than one, indicating that the model is stationary.

Table 3. The results of the GARCH(1,1) model.

Variables	Coefficients	t-Statistics
Conditional mean equation		
α_0	0.02666	2.52 **
α_1	0.98617	174.59 ***
Observations	607	
Conditional variance equation		
ω	0.00003	4.49 ***
γ	0.75242	22.37 ***
δ	0.20103	7.33 ***

Note: *** and ** indicate significance at the 1% and 5% levels, respectively. Source: Own estimation on the data obtained from [Investing.com](https://www.investing.com) and Caldara and Iacoviello's website.

4.3. Unit Root Tests

Before conducting the NARDL bound test for cointegration, we employed the ADF test to check whether the variables used in the model fulfil the stationary condition of the bound test. We performed for both cases of constant only and constant with time trend. Table 4 contains the results of the ADF test. The null hypothesis of a unit root is significantly rejected at the 1 percent level for the R and LNGPR series, meaning that these series are integrated to the order zero. In addition, the results of the ADF test reveal that the null hypothesis of a unit root cannot be rejected at the significant level of 5 percent for the VOL^+ , VOL^- , and LNG series. However, when the test is applied for the first differences of these variables, the null hypothesis is significantly rejected at the 1 percent level. According to these findings, the VOL^+ , VOL^- , and LNG series are integrated in order 1. With this evidence, we concluded that all the variables in the model fulfil the conditions of the NARDL bound test.

Table 4. Results of ADF unit root tests.

Variable	Constant without Trend	Constant with Trend
R		
Level	−23.17 *** (0)	−23.17 *** (0)
VOL^+		
Level	0.26 (7)	−2.18 (7)
First difference	−7.12 *** (6)	−7.18 *** (6)
VOL^-		
Level	0.61 (10)	−1.95 (10)
First difference	−6.51 *** (9)	−6.63 *** (9)
LNGPR		
Level	−8.30 *** (2)	−8.67 *** (2)
LNG		
Level	−0.94 (0)	−2.44 (0)
First difference	−25.07 *** (0)	−25.17 *** (0)

Note: *** indicates significance at the 1% level. The numbers in the parentheses represent the lag section based on AIC criteria. Source: Own estimation on the data obtained from [Investing.com](https://www.investing.com) and Caldara and Iacoviello's website.

4.4. ARDL Bound Test for Cointegration

As discussed above, we employed the NARDL bound test proposed by Shin et al. (2014) to determine the cointegration between variables in the model. Based on the Akaike information criterion, the best model for the bounds test is ARDL (1,0,2,0,1). Table 5 contains the results of the bounds reported. According to these results, the null hypothesis of no cointegration among variables can be rejected at the significance level of 1 percent. The rejection of the null hypothesis means that there is a long-term equilibrium relationship between the market returns and the independent variables in the model. Therefore, the NARDL model can be employed to estimate the short-term and long-term coefficients of the model.

Table 5. Results of the bounds test.

Model	k	F-Statistic	Significance Level	Critical Value	
				Lower Bounds I(0)	Upper Bounds I(1)
NARDL (1,0,2,0,1)	4	115.40 ***	5%	2.86	4.01
			1%	3.74	5.06

Note: k indicates the number of regressors. *** represents significance at the 1% level. Source: Own estimation on the data obtained from [Investing.com](https://www.investing.com) and Caldara and Iacoviello's website.

4.5. Short-Term and Long-Term Effects of Oil Price Volatility on Market Returns

With the evidence of a long-run equilibrium relationship between the market returns and the regressors, the short-term and long-term asymmetric effects of oil price volatility on the market returns are estimated by employing the NARDL (1,0,2,0,1) model. Table 6 has the summary of the estimated short-term and long-term coefficients of the NARDL model. In the shortterm, oil price volatility has significantly negative asymmetric effects on the market returns at the 5percent level. This means that the positive and negative changes in oil price volatility have different effects on the market returns. Specifically, a 1percent increase in oil price volatility immediately leads to a 2.6868 percent decrease in the market returns, while the same magnitude of decrease in oil price volatility is associated with a 6.3180 percent increase in the market returns. In addition, the short-term results indicate that the previous week's negative shocks in oil price volatility have a significantly negative effect on the market returns at the 1percent significance level. Specifically, a 1percent decrease in oil price volatility at the current week is associated with an 11.6117 percent increase in the market returns in the next week. However, according to the results summarized in Table 6, in the shortterm, the GPRs and gold prices have no effects on the market returns. Moreover, the coefficient-of-error correction term is -0.9821 and is statistically significant at the 1percent level, implying that 98.21 percent of the disequilibria from the previous week converged and corrected back to the long-run equilibrium in the current week.

In the longterm, the estimated results confirm that both the negative and positive changes in oil price volatility have significantly negative effects on the market returns at the 1percent level. Specifically, in the longterm, a 1percent increase in oil price volatility is associated with a 2.7358 percent decrease in the market returns, while a 1percent decrease in the oil price volatility results in a 2.7298 percent increase in the market returns. In addition, the results of the NARDL model indicate that in the longterm, the GPRs have a significantly negative effect on the market returns at the 5percent level. Specifically, in the longterm, a 1percent increase in the GPRs index leads to a 0.0077 percent decrease in the HOSE's returns. However, in the longterm, gold prices have no significant effects on the market returns.

The overall finding of this study is that oil price volatility has negative asymmetric effects on market returns for the HOSE. This evidence is in line with previous findings by Diaz et al. (2016), Joo and Park (2017), Joo and Park (2021), Luo and Qin (2017), Rahman (2021), and Xiao et al. (2018). The negative effects of oil price volatility on the market returns of the HOSE could be explained by other reasons. First, oil price volatility could deteriorate

economic activities. Therefore, it has a negative effect on the expected returns of stocks. In addition, oil price volatility can be seen as a systematic stock risk. Therefore, higher oil price volatility is associated with higher discount rates. According to the cashflow theory, higher oil price volatility leads to lower stock returns. Moreover, according to results of the error correction model, 98.21 percent of the disequilibria from the previous week converges and corrects back to the long-run equilibrium in the current week. The adjustment speed in this case is very high, meaning that the system quickly reverts to the long-term equilibrium after a short-term shock.

Table 6. Estimated short-term and long-term coefficients of the NARDL model.

Variables	Coefficients	t-Statistic
Panel A: The estimated short-term coefficients		
ΔVOL^+	−2.6868	−3.66 ***
ΔVOL^-	−6.3180	−2.00 **
$\Delta VOL^-(-1)$	−11.6117	−4.50 ***
$\Delta LNGPR$	−0.0019	−0.66
ΔLNG	0.0036	0.38
ECM(−1)	−0.9821	−24.18 ***
Panel B: The estimated long-term coefficients		
Constant	0.0046	0.14
VOL^+	−2.7358	−3.72 ***
VOL^-	−2.7298	−3.67 ***
LNGPR	−0.0077	−2.30 **
LNG	−0.0037	−0.38

Note: *** and ** indicate significance at the 1% and 5% levels, respectively. Source: Own estimation on the data obtained from [Investing.com](https://www.investing.com) and Caldara and Iacoviello's website.

4.6. Diagnostic Tests for the ARDL Model

We used the diagnostic tests of Breusch–Godfrey for serial correlation and ARCH (autoregressive conditionally heteroscedastic) for heteroscedasticity to check the validity and reliability of the estimated results from the NARDL approach. Table 7 includes the results of the Breusch–Godfrey and ARCH tests. According to these results, the null hypothesis of no serial correlation in the model at the significance level of 5percent cannot be rejected, meaning that serial correlation is not present in the residuals. Moreover, according to the results of the ARCH test, we cannot reject the null hypothesis of no ARCH effects at the significance level of 5 percent. This evidence implies that the residuals of the model are homoscedasticity. These diagnostic tests ensure the reliability and validity of the estimated results.

Table 7. Results of Breusch–Godfrey and ARCH tests.

Diagnostic Test	Statistics	p-Value	Conclusions
Autocorrelation (Breusch–Godfrey test) H_0 : No serial correlation	1.38	0.24	Fail to reject H_0
Heteroscedasticity (ARCH test) H_0 : No ARCH effects	1.02	0.31	Fail to reject H_0

Source: Own estimation on the data obtained from [Investing.com](https://www.investing.com) and Caldara and Iacoviello's website.

4.7. Structural Stability Tests

We need to check the stability of the estimated coefficients because the NARDL approach is sensitive to structural breaks, while the studied variables are sensitive to global events. In this study, we used the cumulative sum of the recursive residuals (CUSUM) and the cumulative sum of squared recursive residuals (CUSUMSQ) tests proposed by [Brown et al. \(1975\)](#) to investigate the long-term stability of the coefficients in the model. Figures 3 and 4 include the results of the tests. According to these findings, the plots of

the CUSUM and CUSUMSQ lines are within the critical bounds at the 5percent level of significance. These results indicate that the model is stable over the sample period.

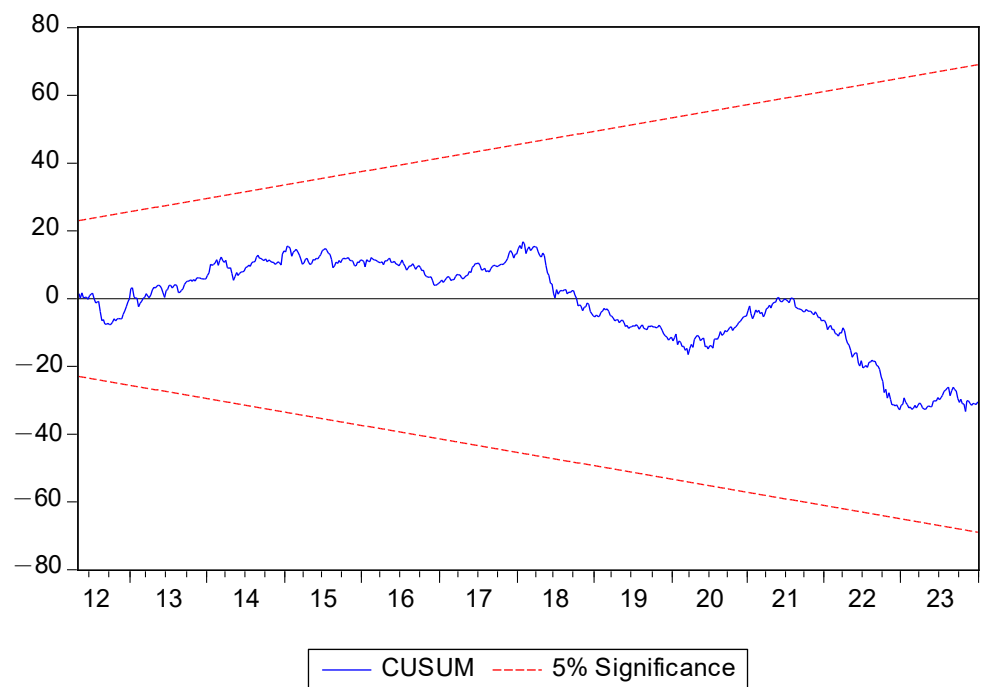


Figure 3. Plots of cumulative sum of recursive residuals.

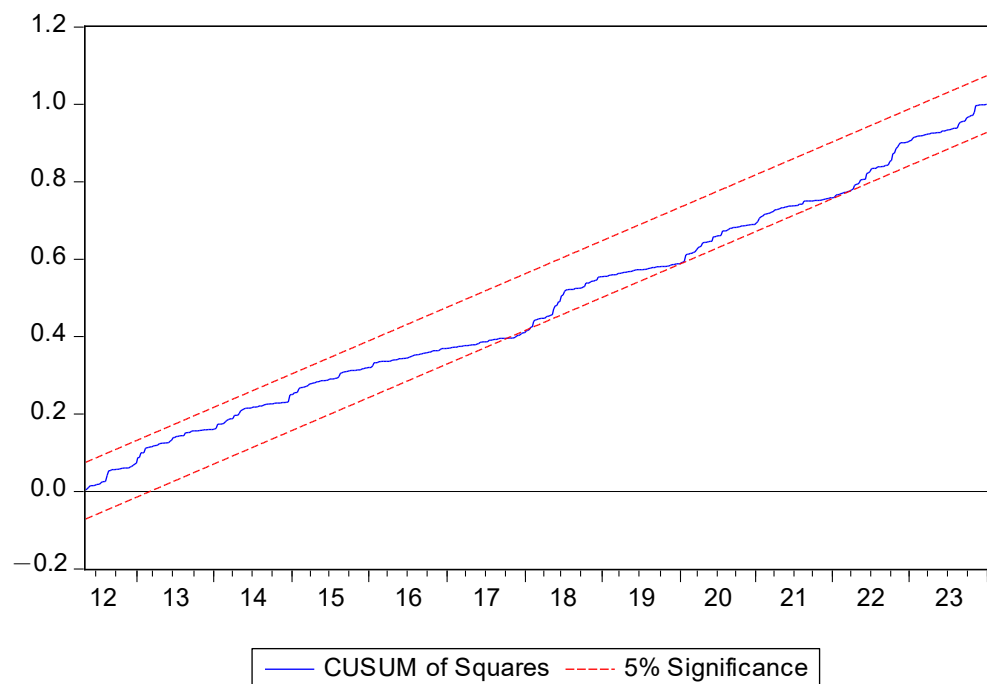


Figure 4. Plots of cumulative sum squares of recursive residuals.

5. Conclusions

We sought to investigate the asymmetric effects of oil price volatility on stock returns for the HOSE, a frontier stock market, from 6 February 2012 to 31 December 2023. Using the NARDL bounds testing approach, the empirical results indicate that oil price volatility has negative asymmetric effects on the market returns in both the shortterm and longterm. This means that positive and negative changes in oil price volatility have different impacts

on market returns. Specifically, in the shortterm, a 1 percent increase in oil price volatility immediately leads to a 2.6868 percent decrease in the market returns, while a 1percent decrease in oil price volatility is associated with a 6.3180 percent increase in market returns. In the longterm, a 1 percent increase in oil price volatility is associated with a 2.7358 percent decrease in market returns. Similarly, a 1 percent decrease in oil price volatility is associated with a 2.7298 percent increase in market returns. In addition, the results of the NARDL model indicate that the GPRs have no effect on the market returns in the shortterm but has a significantly negative effect on the market returns in the longterm. Moreover, this study does not find any evidence for the relationship between gold prices and market returns. Finally, the results of the error correction model confirm that 98.21 percent of the disequilibria from the previous week converges and corrects back to the long-run equilibrium in the current week. The findings of this study imply that the HOSE is capturing the effects of oil price volatility on various economic activities. Therefore, financial experts could use oil price fluctuation to forecast the future economics. Based on this implication, we propose that investors in frontier markets utilize oil price volatility to predict stock returns and establish effective hedging strategies.

Although this study's findings add to and enhance people's knowledge about the effects of oil price volatility on stock returns in a frontier stock market, the study has limitations that researchers need to address in future empirical studies. First, we only examined the effects of oil price volatility on the aggregative stock market returns. However, the effects of oil price volatility on stock returns differ among industries. Therefore, researchers could focus on the effects of oil price volatility on stock returns at the industry level. Second, a single country analysis is another limitation of the study that could be addressed in future studies. Finally, in this study, we investigated the effects of oil price volatility on stock returns without considering the moderating effect of the COVID-19 pandemic. This limitation could be an interesting topic for further research.

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References

- Anand, B., Sunil Paul, and M. Ramachandran. 2014. Volatility spillover between oil and stock market returns. *Indian Economic Review* 49: 37–56.
- Asteriou, Dimitrios, and Konstantinos Spanos. 2019. The relationship between financial development and economic growth during the recent crisis: Evidence from the EU. *Finance Research Letters* 28: 238–45. [\[CrossRef\]](#)
- Bahmani-Oskooee, Mohsen, Seyed Hesam Ghodsi, and Muris Hadzic. 2019. Asymmetric causality between oil price and stock returns: A sectoral analysis. *Economic Analysis and Policy* 63: 165–74. [\[CrossRef\]](#)
- Basher, Syed A., and Perry Sadorsky. 2006. Oil price risk and emerging stock markets. *Global Finance Journal* 17: 224–51. [\[CrossRef\]](#)
- Basher, Syed Abul, Alfred A. Haug, and Perry Sadorsky. 2012. Oil prices, exchange rates and emerging stock markets. *Energy Economics* 34: 227–40. [\[CrossRef\]](#)
- Bhattarai, Jeevan Kumar, Ramji Gautam, and Keshab Khatri Chettri. 2021. Stock market development and economic growth: Empirical evidence from Nepal. *Global Business Review, Online First*. [\[CrossRef\]](#)
- Bouri, Elie. 2015. Oil volatility shocks and the stock markets of oil-importing MENA economies: A tale from the financial crisis. *Energy Economics* 51: 590–98. [\[CrossRef\]](#)
- Brown, Robert L., James Durbin, and James M. Evans. 1975. Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society* 37: 149–63. [\[CrossRef\]](#)
- Caldara, Dario, and Matteo Iacoviello. 2022. Measuring geopolitical risk. *American Economic Review* 112: 1194–225. [\[CrossRef\]](#)
- Chen, Chun-Da, Chiao-Ming Cheng, and Riza Demirer. 2017. Oil and stock market momentum. *Energy Economics* 68: 151–59. [\[CrossRef\]](#)
- Chen, Shiu-Sheng. 2010. Do higher oil prices push the stock market into bear territory? *Energy Economics* 32: 490–95. [\[CrossRef\]](#)

- de Jesus, Diego Pitta, Bruno Felipe Lenin Souza Bezerra, and Cássio da Nóbrega Besarria. 2020. The non-linear relationship between oil prices and stock prices: Evidence from oil-importing and oil-exporting countries. *Research in International Business and Finance* 54: 101229. [CrossRef]
- Diaz, Elena Maria, Juan Carlos Molero, and Fernando Perez de Gracia. 2016. Oil price volatility and stock returns in the G7 economies. *Energy Economics* 54: 417–30. [CrossRef]
- Driesprong, Gerben, Ben Jacobsen, and Benjamin Maat. 2008. Striking oil: Another puzzle? *Journal of Financial Economics* 89: 307–27. [CrossRef]
- Dutta, Anupam, Jussi Nikkinen, and Timo Rothovius. 2017. Impact of oil price uncertainty on Middle East and African stock markets. *Energy* 123: 189–97. [CrossRef]
- Filis, George. 2010. Macro economy, stock market and oil prices: Do meaningful relationships exist among their cyclical fluctuations? *Energy Economics* 32: 877–86. [CrossRef]
- Gjerde, Øystein, and Frode Sættem. 1999. Causal relations among stock returns and macroeconomic variables in a small, open economy. *Journal of International Financial Markets, Institutions & Money* 9: 61–74. [CrossRef]
- Huber, Peter. 1997. Stock market returns in thin markets: Evidence from the Vienna Stock Exchange. *Applied Financial Economics* 7: 493–98. [CrossRef]
- Jiang, Wei, and Yan Liu. 2021. The asymmetric effect of crude oil prices on stock prices in major international financial markets. *North American Journal of Economics and Finance* 56: 101357. [CrossRef]
- Jones, Charles M., and Gautam Kaul. 1996. Oil and the stock markets. *Journal of Finance* 51: 463–91. [CrossRef]
- Joo, Young C., and Sung Y. Park. 2017. Oil prices and stock markets: Does the effect of uncertainty change over time? *Energy Economics* 61: 42–51. [CrossRef]
- Joo, Young C., and Sung Y. Park. 2021. The impact of oil price volatility on stock markets: Evidences from oil-importing countries. *Energy Economics* 101: 105413. [CrossRef]
- Kapaya, Saganga Mussa. 2020. Stock market development and economic growth in Tanzania: An ARDL and bound testing approach. *Review of Economics and Political Science* 5: 187–206. [CrossRef]
- Kollias, Christos, Catherine Kyrtou, and Stephanos Papadamou. 2013. The effects of terrorism on the oil price-stock index relationship. *Energy Economics* 40: 743–52. [CrossRef]
- Luo, Xingguo, and Shihua Qin. 2017. Oil price uncertainty and Chinese stock returns: New evidence from the oil volatility index. *Finance Research Letters* 20: 29–34. [CrossRef]
- Narayan, Paresh Kumar, and Seema Narayan. 2010. Modelling the impact of oil prices on Vietnam's stock prices. *Applied Energy* 87: 356–61. [CrossRef]
- Nguyen, Minh Ngoc. 2024. Oil production in Vietnam 2012–2022. *Statista*. Available online: <https://www.statista.com/statistics/608982/oil-production-in-vietnam> (accessed on 13 June 2024).
- Papapetrou, Evangelia. 2001. Oil price shocks, stock market, economic activity and employment in Greece. *Energy Economics* 23: 511–32. [CrossRef]
- Park, Jungwook, and Ronald A. Ratti. 2008. Oil price shocks and stock markets in the US and 13 European countries. *Energy Economics* 30: 2587–608. [CrossRef]
- Pesaran, M. Hashem, Yongcheol Shin, and Richard J. Smith. 2001. Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics* 16: 289–326. [CrossRef]
- Rahman, Sajjadur. 2021. Oil price volatility and the US stock market. *Empirical Economics* 61: 1461–89. [CrossRef]
- Raza, Naveed, Syed Jawad Hussain Shahzad, Aviral Kumar Tiwari, and Muhammad Shahbaz. 2016. Asymmetric impact of gold, oil prices and their volatilities on stock prices of emerging markets. *Resources Policy* 49: 290–301. [CrossRef]
- Sadorsky, Perry. 1999. Oil price shocks and stock market activity. *Energy Economics* 21: 449–69. [CrossRef]
- Sarwar, Suleman, Aviral Kumar Tiwari, and Cao Tingqiu. 2020. Analyzing volatility spillovers between oil market and Asian stock markets. *Resources Policy* 66: 2–12. [CrossRef]
- Shin, Yongcheol, Byungchul Yu, and Matthew Greenwood-Nimmo. 2014. Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In *Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications*. Edited by Robin C. Sickles and William C. Horrace. New York: Springer, pp. 281–314.
- Silvapulle, Param Silvapulle, Russell Smyth, Xibin Zhang, and Jean-Pierre Fenech. 2017. Nonparametric panel data model for crude oil and stock prices in net oil importing countries. *Energy Economics* 67: 255–67. [CrossRef]
- Smyth, Russell, and Paresh Kumar Narayan. 2018. What do we know about oil prices and stock returns? *International Review of Financial Analysis* 57: 148–56. [CrossRef]
- Truong, Loc Dong, Anh Thi Kim Nguyen, and Dut Van Vo. 2021. Index future trading and spot market volatility in frontier markets: Evidence from Ho Chi Minh Stock Exchange. *Asia-Pacific Financial Markets* 28: 353–66. [CrossRef]
- Truong, Loc Dong, H. Swint Friday, and Tan Duy Pham. 2024. The effects of geopolitical risk on foreign direct investment in a transition economy: Evidence from Vietnam. *Journal of Risk and Financial Management* 17: 101. [CrossRef]
- Xiao, Jihong, Min Zhou, Fengming Wen, and Fenghua Wen. 2018. Asymmetric impacts of oil price uncertainty on Chinese stock returns under different market conditions: Evidence from oil volatility index. *Energy Economics* 74: 777–86. [CrossRef]

- Zhu, Hui-Ming, Rong Li, and Sufang Li. 2014. Modelling dynamic dependence between crude oil prices and Asia Pacific stock returns. *International Review of Economics and Finance* 29: 208–23. [[CrossRef](#)]
- Zhu, Hui-Ming, Su-Fang Li, and Keming Yu. 2011. Crude oil shocks and stock markets: A panel threshold cointegration approach. *Energy Economics* 33: 987–94. [[CrossRef](#)]

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