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From Stability To Volatility: The Asymmetric Effects Of Macroeconomic Factors On Indonesia's Sustainable Stocks

Dwita Sakuntala[1], Eka Martyna Theodora[2], Amin Hou[3], Arsyaf Tampubolon[4]
[1]Social Science Faculty, Universitas Pembangunan Panca Budi, Medan, Indonesia, [2,3,4]Social Science Faculty, Universitas Mahkota Tricom Unggul, Medan, Indonesia

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ABSTRACT
SRI and Sharia stocks in Indonesia are part of the green assets that have outperformed other stocks. However, they are also volatile and vulnerable to shocks. This study examines the asymmetric effects of macroeconomic uncertainty-specifically domestic interest rates, global uncertainty, and domestic exchange rates-together with environmental degradation factors on the SRI and Sharia stock markets in Indonesia. The findings show that exchange rate asymmetry significantly impacts the SRI and Shariah stock markets, as evidenced by the sizable coefficients. In the SRI stock market, positive exchange rate shocks are found to have a negative impact in both the short and long run. In contrast, in the Islamic stock market, the effect of positive exchange rate shocks is only seen in the short run. This evidence suggests that an increase in positive exchange rate shocks will lead to a decline in both the SRI and Islamic stock markets. When the domestic exchange rate appreciates, Indonesian exports become more expensive in the international market, thus reducing the competitiveness of firms in export-dependent markets, which then affects their stock prices. Moreover, in the long run, negative shocks related to global uncertainty negatively impact the Islamic stock market. This finding indicates that when the global economic environment deteriorates and overseas investments are perceived as risky, domestic investors-especially those who are risk averse-tend to shift their investments to domestic Islamic assets, which they perceive as more reliable.

Corresponding Author:
Dwita Sakuntala
Universitas Pembangunan Panca Budi Medan
sakuntaladwita@gmail.com

INTRODUCTION

The rising temperatures on Earth have led to unpredictable climate patterns globally, making green economic development a critical priority. Indonesia is among the nations dedicated to achieving zero net emissions. One initiative by the Indonesian government to promote green economic growth is the encouragement of green industry development, which emphasizes the efficient and sustainable use of resources. Transitioning to a green industry necessitates substantial financial backing. Sustainable stock markets are seen as a key source of green financing, with an increase in investments expected to boost market capitalization in relation to Indonesia's Gross Domestic Product (GDP). However, data from the World Bank indicates that Indonesia's capital market contribution remains relatively low

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compared to other ASEAN countries, standing at 46% in 2022. In contrast, several ASEAN nations have much higher contributions, such as 124.3% in Singapore, 93.7% in Malaysia, 121.9% in Thailand,and 59% in the Philippines.

Investing in sustainable stock markets not only aims to enhance capital markets but also supports companies that actively work to minimize environmental impacts, address climate change, and safeguard natural resources. In Indonesia, two prominent categories of sustainable stocks embody the principles of Sustainable Responsible Investment (SRI) and Environmental, Social, and Governance (ESG) criteria: Sharia and SRI stocks. Sharia stocks are considered part of the SRI framework as they adhere to ethical screening processes that exclude certain industries (BinMahfouz & Kabir Hassan, 2013). According to Al-Mubarak and Goud (2018), Sharia finance fundamentally integrates SRI and ESG concepts. Humans are viewed as stewards (khulafa) tasked with protecting the environment, which obligates Sharia financial institutions to uphold trust (amanah) and responsibility (mas'uliyyah) in their investments and financial dealings. Lamont (2019) notes that Sharia stocks fall under the category of green investments. Similarly, Syarifuddin and Sakti (2021) highlight that Maqasid al-Syariah, which underpins Sharia finance, encompasses principles for sustainable finance, offering significant opportunities for Sharia finance to engage with global green financing and investment sectors for future sustainability. Other studies document the relationship between SRI stocks and Sharia stocks, such as Charfeddine, Najah and Teulon (2016); Yesuf and Aassouli (2020); and Qoyum *et al.* (2021) provide evidence that the combined investment performance of SRI stocks and Sharia stocks in Indonesia is better.

Although sustainable stock markets can positively influence green economic growth, it is important to monitor and address the potential risks associated with bubbles in the stock market (Lehnert, 2023). As global economic instability continues to emerge, such as the COVID-19 pandemicoutbreak, governments will inevitably adjust their economic policies to respond (Fasanya et al., 2021; Xi et al., 2023). Arbitrage Pricing Theory (APT) from Ross (1976) states that the expected return on afinancial asset is related to macroeconomic risk factors.

This research is based on the development of the results of previous studies related to sustainable assets. Several studies have investigated the various factors that can cause shocks in the Sharia and SRI stock markets in various countries using various econometric methods. Empirical evidence from the Sharia stock market, such as from Majid and Yusof (2009), using indicators of real exchange rate, M3,treasury bill rate, and federal funds rate using the ARDL method for the Malaysian Sharia stock market.Mensi *et al.* (2015) with gold and US treasury bill indicators using multivariate dependence modelling methods, and marginal and copula models (bivariate copula models) for the case of emerging markets Sharia stock markets. Hassan, Hoque and Gasbarro (2019) with oil price indicators using the univariate GARCH model (TGARCH) for the case of the Brazil-Russia-India-China (BRIC) Sharia stock market.Godil *et al.* (2020) used a quantile ARDL (QARDL) model with indicators of oil prices, gold, economicuncertainty, and geopolitical risk.

Empirical evidence from the SRI stock market includes from Hammoudeh, Ajmi and Mokni (2020) using interest rate and carbon emission indicators with Granger causality

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method; Fang, Su and Yin (2021) with characteristic, institutional and economic risk indicators using q-factor model for China's green stock market; Rehman, Ahmad and Vo (2022) using oil price indicators with asymmetric Multifractal Detrended Fluctuation, Network Connectedness Approach, Hedging Effectiveness Measures and Conditional Diversification Benefits methods for the case of the United States green stock market; Liu et al. (2021) with air pollution indicators through mediating variables of investor attention to companies that cause pollution and companies that create renewable energy, using multiple linear regression methods with sub-sample analysis; Sakuntala et al. (2022) with indicators of policy interest rates, WUI index, carbon emissions and deforestation using the ARDL method for the case of the Indonesian SRI stock market; Xi et al. (2023) using economic uncertainty variables on green bond markets and green stock markets in China with quantile-on-quantile (QQ) methods; and Tampubolon et al. (2023) use OLS method with indicators of domestic and world interest rate and exchange rate for the case of the Indonesian SRI stock market.

Although some studies have detected the impact of macroeconomic uncertainty and environmental damage factors on sustainable stock markets and provided mixed results, they are still limited for stock markets case like in Indonesia. Therefore, this study investigates the impact of asymmetric macroeconomic and environmental deterioration factors on Indonesia's Sharia and SRI stock markets are considered as stock markets that can support a sustainable economy. Ultimately, these empirical findings are expected to provide a better understanding of how asymmetric macroeconomic factors such as interest rates, global uncertainty, and exchange rates, as well as environmental damage factors such as carbon emissions and forest destruction, can impact the green stock market. This knowledge is critical for investors, policymakers, and practitioners to develop effective investment strategies and environmental policies. Asymmetric mitigation in sustainable stock markets is essential to reduce investment risk and improve market efficiency.

METHODS

This study investigates the asymmetric impact of macroeconomic uncertainty and environmental damage on Indonesia's green stock market using quarterly time series data from 2009 to 2021 obtained from reliable sources such as Bank Indonesia, Central Bureau of Statistics (BPS), Indonesia Stock Exchange (IDX), Global Carbon Budget and Indonesian Ministry of Environment. Using interest rate (IR), world uncertainty index (WUI), and exchange rate (EXC) indicators to measure macroeconomic uncertainty. Carbon emission and deforestation indicators to measure environmental damage as control variables. A linear interpolation approach was used for carbon emission and deforestation data, which were selected to be quarterly data. This approach assumes a linear trend between annual data points and calculates quarterly data. Zhou (2001) suggests that increasing observation numbers enhances statistical test robustness; thus, interpolation techniques help address data limitations effectively—an approach supported by previous empirical studies (Dees et al., 2005; Shahbaz et al., 2014; Tang & Chuab, 2012). To address asymmetric effects, this research utilizes the Nonlinear Autoregressive Distributed

Lag (NARDL) model established by Shin et al. (2014). NARDL is a dynamic regression model featuring distributed lags, designed to evaluate the connections between dependent and independent variables. This approach offers several benefits: (1) it accommodates both asymmetric and cointegrated models within a single equation; (2) it is suitable for small sample sizes; and (3) it can be utilized with integrated variables of order I(0), I(1), or a combination of both. Additionally, this model permits the inclusion of lags for both independent and dependent variables, enhancing its flexibility (Ridha et al., 2022). The NARDL model builds upon the traditional ARDL framework by differentiating exogenous variables into positive and negative changes, as illustrated in equations (1) and (2): (Chang et al., 2020)

$$\begin{aligned}\Delta \ln JII_t = {} & \gamma_0 + \alpha_1 \ln JII_{t-1} + {\alpha_2}^{+} IR^{+}_{t-1} + {\alpha_3}^{-} IR^{-}_{t-1} + {\alpha_4}^{+} \ln WUI^{+}_{t-1} + {\alpha_5}^{-} \ln WUI^{-}_{t-1} \\ & + {\alpha_6}^{+} \ln EXC^{+}_{t-1} + + {\alpha_7}^{-} \ln EXC^{-}_{t-1} + \alpha_8 \ln ECO2_{t-1} + \alpha_9 \ln DEF_{t-1} \\ & + \sum_{i=1}^{p} \beta_1 \Delta \ln JII_{t-i} + \sum_{i=0}^{q1} {\beta_2}^{+} \Delta IR^{+}_{t-i} + \sum_{i=0}^{q2} {\beta_3}^{+} \Delta IR^{-}_{t-i} + \sum_{i=0}^{q3} {\beta_4}^{+} \Delta \ln WUI^{+}_{t-i} \\ & + \sum_{i=0}^{q4} {\beta_5}^{+} \Delta \ln WUI^{-}_{t-i} \\ & + \sum_{i=0}^{q5} {\beta_6}^{+} \Delta \ln EXC^{+}_{t-i} + \sum_{i=0}^{q6} {\beta_7}^{+} \Delta \ln EXC^{-}_{t-i} + \sum_{i=0}^{q7} \beta_8 \ln ECO2_{t-i} + \sum_{i=0}^{q8} \beta_9 \ln DEF_{t-i} \\ & + \varepsilon_t \ \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (1)\end{aligned}$$

$$\begin{aligned}\Delta \ln SRI_t = {} & \gamma_0 + \alpha_1 \ln SRI_{t-1} + {\alpha_2}^{+} IR^{+}_{t-1} + {\alpha_3}^{-} IR^{-}_{t-1} + {\alpha_4}^{+} \ln WUI^{+}_{t-1} + {\alpha_5}^{-} \ln WUI^{-}_{t-1} \\ & + {\alpha_6}^{+} \ln EXC^{+}_{t-1} + + {\alpha_7}^{-} \ln EXC^{-}_{t-1} + \alpha_8 \ln ECO2_{t-1} \\ & + \alpha_9 \ln DEF_{t-1} \sum_{i=1}^{p} \beta_1 \Delta \ln SRI_{t-i} + \sum_{i=0}^{q1} {\beta_2}^{+} \Delta IR^{+}_{t-i} + \sum_{i=0}^{q2} {\beta_3}^{+} \Delta IR^{-}_{t-i} \\ & + \sum_{i=0}^{q3} {\beta_4}^{+} \Delta \ln WUI^{+}_{t-i} + \sum_{i=0}^{q4} {\beta_5}^{+} \Delta \ln WUI^{-}_{t-i} \\ & + \sum_{i=0}^{q5} {\beta_6}^{+} \Delta \ln EXC^{+}_{t-i} + \sum_{i=0}^{q6} {\beta_7}^{+} \Delta \ln EXC^{-}_{t-i} + \sum_{i=0}^{q7} \beta_8 \ln ECO2_{t-i} + \sum_{i=0}^{q8} \beta_9 \ln DEF_{t-i} \\ & + \varepsilon_t \ \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (2)\end{aligned}$$

Equation (1) represents the NARDL model for the green stock market, while equation (2) pertains to the Sharia stock market. The variables IR+, IR-, lnWUI+, lnWUI-, lnEXC+, lnEXC- indicate positive and negative partial sums. α+ and α- are vectors representing long-run asymmetric coefficients. The term $\sum_{i=0}^{q} \beta_i$ denotes the short-run coefficients reflecting the differences of each variable.

Table 1. Operational Definition Variables

No.	Variable	Description	Indicator	Source
		SRI KEHATI stock index. This index contains the top 25 stocks of companies that are free of negative lists (pesticides,	SRI	Indonesia

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No.	Variable	Description	Indicator	Source
1.	SRI Stocks	nuclear, weapons, tobacco, alcohol, pornography, gambling, genetically modified organisms, coal mining) and fulfill ESG aspects (Indonesia Stock Exchange (IDX), 2024).	Kehati Index	Stock Exchange (IDX)
2	JII Stocks	JII (Jakarta Islamic Index). This index contains 30 stocks of companies that are categorized as sharia stocks, have the bestliquidity and the highest average daily transaction value in the regular market (Indonesia Stock Exchange (IDX), 2024).	Jakarta Islamic Index	Indonesia Stock Exchange (IDX)
3.	Interest rate	Nominal interest rate is the stated interest rate on a financial product without adjustment for inflation. It represents the amount of money that borrowers pay to lenders for the use of their funds over a specific period (Mishkin & Eakins, 2018)	policy interest rate	Bank Indonesia
4.	World Uncertainty Index	The index captures global uncertainty related to economic and political developments, both in the short and long term, originating from 143 countries (Ahir et al., 2022b).	WUI	FRED ST.Louis FED -Economic Data
5.	Exchange rate	The exchange rate is defined as the currency that can be exchanged for one unit of another currency or the value of a currency in terms of another currency (Sakuntala & Meliza, 2018).	Rupiah to Dollar	Bank Indonesia
6.	Carbon emission	Carbon emissions - are national territorial emissions i.e. estimates of national carbon emissions from fossil fuel combustion and oxidation and cement production and exclude emissions from bunker fuels (Friedlingstein et al., 2021).	MtC 1 MtC = 1 juta ton karbon = 3.664 juta ton CO2	Global Carbon Atlas
7.	Deforestation	Deforestation is defined as a permanent change from a forested area to a non-forested area due to human activities (Ministry of Environment and Forestry Republic of Indonesia, 2024).	Hektar (ha)	The Ministry of Environment and Forestry Republic of Indonesia

The Wald test is employed to evaluate both short-run and long-run asymmetric hypotheses. The null hypothesis for short-run symmetry is (H0 : βi+ : βi- = 0) and for long-run symmetry, it is H0 : αi+ : αi-= 0). F statistics and critical values utilized to assess these null hypotheses (Simran & Sharma, 2023). If H0 is rejected, then there is an asymmetry in

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the Sharia and SRI stock markets. The coefficient of Error Correction Term (ECT) should be negative and significant (Narayan & Smyth, 2005), indicating the speed of adjustment of Sharia and SRI stock markets towards long-run equilibrium after asymmetric shocks from macroeconomic variables (interest rates, global uncertainty and exchange rates) and environmental damage in the short run. Other tests conducted in this study include unit root testing, determining the optimal lag length, cointegration testing, diagnostic residual testing, and model stabilitytesting.

RESULTS AND DISCUSSION

Stationarity Testing

A stationarity test is essential to determine the suitability of all variables for inclusion in the NARDL model prior to conducting empirical estimation. The Augmented Dickey-Fuller (ADF) test is employed to identify the presence of unit roots, with variables assessed under both constant and trend specifications. The findings of this test are presented in Table 2. The results indicate that the variables are integrated at the I(0) level with 5% significance and at the I(1) level with 1% significance, while none exhibit integration at the I(2) level. This supports the validity of employing NARDL estimation.

Table 2. ADF Unit Root Test Results

Sharia Stock Market			SRI Stock Market		
Variable	t-statistic	Stationerity	Variable	t-statistic	Stationerity
LnJII	-8.1482***	I(1)	LnSRI	-5.7344***	I(1)
PR	-4.7870***	I(1)	PR	-4.9534***	I(1)
LnWUI	-3.9135**	I(0)	LnWUI	-3.7225**	I(0)
LnEXC	-8.8629***	I(1)	LnEXC	-8.7374***	I(1)
LnECO2	-3.6844**	I(0)	LnECO2	-3.6950**	I(0)
LnDEF	-4.8926***	I(1)	LnDEF	-5.8378***	I(1)

Data source: research finding

Cointegration, Diagnostic and Asymmetric Testing

First, a bound test was applied to determine the cointegration relationship among the selected variables. The bound test output gives us the F-statistic value, which indicates whether there is a long-run cointegration relationship among the variables. The bound test results for the NARDL model are presented in Table 3. Here, the derived F-values of both models evaluating the green and Sharia stock markets exceed the upper bound critical value at the 1% significance level. Thus, we reject the null hypothesis of no cointegration, which means that the selected variables are cointegrated in the long run. Upon establishing the long-term cointegration relationship among several selected variables, we conducted a series of diagnostic tests to evaluate the robustness of the NARDL model. The results of these tests, applicable to the Sharia and SRI stock markets, are presented in Table 4. The NARDL model demonstrates appropriate specification, as evidenced by the normal distribution of residuals and the absence of heteroscedasticity or serial autocorrelation within the model.

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Table 3. NARDL Bound Test Results of the Sharia and SRI Stock Markets

NARDL Model	F -stat	Critical Bound		Signif.	t -stat	Critical Bound	
		Lower	Upper			Lower	Upper
		2.26	3.34	10%		-3.13	-4.68
LnJII	4.62 ***	2.55	3.68	5%	-7.63***	-3.41	-5.01
LnSRI	4.99 ***	3.15	4.43	1%	-8.13***	-3.96	-5.65

Data source: research finding

The adjusted R2 coefficient value (0.904) indicates that 90.4 percent of the variation in the Shariastock market can be explained by the asymmetry of domestic interest rates, global uncertainty and exchange rates, carbon emissions, and deforestation (see in Table 5). The adjusted R2 coefficient value (0.913) indicates that 91.3 percent of the variation in the SRI stock market can be explained by asymmetric domestic interest rates, global uncertainty, and exchange rates, as well as carbon emissions and deforestation (see in Table 6). The asymmetric test using the Wald test, which can be seen in Tables5 and 5, shows that there is an asymmetric relationship in the Sharia and SRI stock markets stemming from shocks to interest rates, global uncertainty, and exchange rate variables. Therefore, the nonlinear autoregressive distributed lag approach used in this study provides more extensive and accurate information. The selected lag model for the Sharia stock market is (1,2,2,0,1,2,3,2,2) and the selected lag model for the SRI stock market is (1,1,2,3,2,2,3,3).

Table 4. Residual Diagnostic of NARDL Model

Test	NARDL Model Sharia Stock		NARDL Model SRI Stock	
Normality test	Prob. JB	0.6741	Prob. JB	0,2167
LM test	Prob. χ^2	0.0529	Prob. χ^2	0,0948
Heterokedasticity test	Prob. χ^2	0.5904	Prob. χ^2	0,5756

Data source: research finding

The Error Correction Term (ECT) value is statistically negative and significant, indicating an adjustment to equilibrium in the green and Sharia stock markets in the model. The value of the ECT coefficient in the Sharia stock market (see Table 5) is -1.0319 with significance at the 1% level, indicating a high value of ECT, which means that the error correction process fluctuates around its long- term value and decreases over time until it finally becomes zero or reaches long-term equilibrium. This process of convergence to the equilibrium path in a dampening manner is called oscillation (Narayan & Smyth, 2006) and (Chandio et al., 2019). The ECT coefficient value in the SRI stock market (see Table 6) is -0.5778 with significance at the 1% level, indicating that the speed of adjustment is 57.78% in correcting the imbalance so that the green stock market can return to its equilibrium.

The results of the model stability test conducted on the selected NARDL model show that it doesnot exceed the 5% significance limit; therefore, the selected NARDL model can be considered unbiased.For further details, see Figures 1 and 2.

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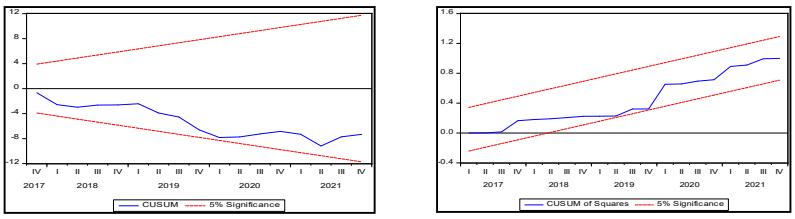
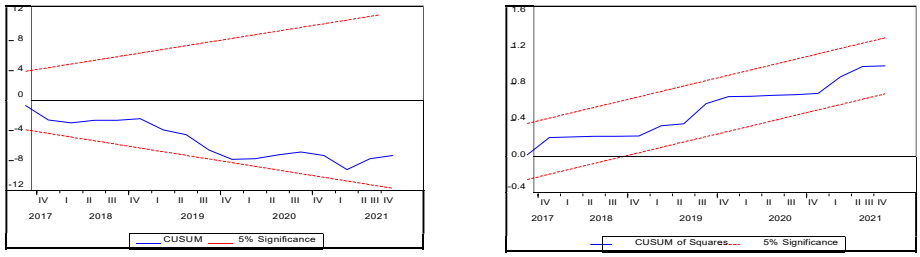


Data source: research finding

Figure 1. CUSUM and CUSUMQ Test Results of NARDL Model of Sharia Stock Market



Data source: research finding

Figure 2. CUSUM and CUSUMQ Test Results of NARDL Model of SRI Stock Market

NARDL Results

Asymmetric interest rates influence the sustainable stock markets (Sharia and SRI) in Indonesia, but the impact of interest rate shocks provides different results in the short and long term. In the Shariastock market, positive interest rate shocks have a significant effect in the short term. In the long run, positive and negative interest rate shocks have a significant effect on the Sharia stock market. However, in the short term, only negative interest rate shocks significantly impact the SRI stock market. In the long run, positive and negative interest rate shocks significantly impact the SRI green stock market. The results from these two sustainable stock markets provide evidence that the asymmetric relationship between interest rates and sustainable stock is complex. The two Indonesian sustainable stock markets have different characteristics, which explains that each market has a different response to the asymmetric impact of interest rates. This result is similar to the empirical evidence described by Xi et al. (2023) that asymmetric interest rates may vary depending on the market conditions.

As an indicator of global uncertainty, it was measured using the World Uncertainty Index developed by Ahir et al. (2018), (2020), (2022). In the Sharia stock market, in the short term, only negative shocks of global uncertainty have a significant effect. In the long run, positive and negative shocks of global uncertainty have a significant influence on Indonesia's Sharia stock market. While in the short term, positive and negative shocks of global uncertainty have a significant effect on the SRI stock market in Indonesia. In the long run, only positive shocks to global uncertainty significantly affectthe SRI stock market. These results provide evidence that asymmetric global uncertainty has a significant influence on Indonesia's sustainable stock market in the long run.

According to Bernanke (1983), uncertainty is one source of macroeconomic

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fluctuations. The WUI index is calculated from the economic, political, security, and health conditions in various countries. This empirical evidence is in line with Suh & Yang (2021), who explain that some empirical findings provide different results about the effects of uncertainty.

Consequently, the effects of uncertainty must be analyzed with caution due to several factors: (1) uncertainty cannot be quantified with precision, and (2) the theoretical literature presents both negative and positive pathways through which uncertainty influences investment. For instance, the growth option framework proposed by Bar-Ilan & Strange (1996) and Lamont (2019) suggests that there is empirical evidence indicating that uncertainty may actually stimulate investment (Gulen & Ion, 2016; Ludvigsonet al., 2018).

Asymmetric exchange rates affect sustainable stock markets in Indonesia. In both the short and long run, positive and negative shocks have a significant effect on both sustainable stock markets. In the Sharia stock market, the exchange rate asymmetric coefficient that shows the strongest influence only occurs in the short term. Whereas in the SRI stock market, the coefficient of the asymmetric exchange rate shows a very strong asymmetric effect in both the short and long run This result explains that the asymmetric exchange rate in the sustainable stock market has a complex and diverse relationship, and the results depend on market conditions. In line with the empirical evidence provided by Ahmed (2020) both positive and negative exchange rate changes have a significant impact on stock returns, indicating a potential asymmetric relationship between exchange rate changes and stock marketperformance.

Table 5. Estimation of NARDL in the Sharia Stock Market

Variable	Coefficient	t-stat.	Prob.
Part A: Short-Term Asymmetric			
C	13.2976	7.6851	0.0000
@TREND	0.1492	7.5439	0.0000
D(IR_POS)	0.1888	6.8396	0.0000
D(IR_POS(-1))	0.1343	4.4232	0.0003
D(IR_NEG)	-0.0248	-1.4971	0.1500
D(IR_NEG(-1))	-0.0323	-1.7178	0.1013
D(WUI_NEG)	0.2179	6.6100	0.0000
D(EXC_POS)	-2.6171	-15.2264	0.0000
D(EXC_POS(-1))	-1.1944	-4.2439	0.0004
D(EXC_NEG)	0.6282	1.8431	0.0802
D(EXC_NEG(-1))	-0.5015	-2.2198	0.0382
D(EXC_NEG(-2))	-0.7559	-3.2110	0.0044
D(ECO2)	0.2004	0.7053	0.4888
D(ECO2(-1))	1.2476	3.0958	0.0057
D(DEF1)	0.1225	2.3609	0.0285
D(DEF1(-1))	-0.1309	-2.6510	0.0153
Part B: Long-Term Relations			
IR_POS	-0.0517	-3.0487	0.0063
IR_NEG	0.0416	2.8380	0.0102
WUI_POS	-0.8176	-4.0516	0.0006

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Variable	Coefficient	t-stat.	Prob.
WUI_NEG	2.1044	6.3867	0.0000
EXC_POS	-0.1157	-3.9025	0.0009
EXC_NEG	0.4145	7.4928	0.0000
ECO2	-2.1550	-10.3525	0.0000
DEF	0.0311	1.0766	0.2945
Part C: Statistic			
ECT	-1.0319	-7.6282	0.0000
Adj. R2	0.9041		
WLR	62.1032		0.00000
WSR	196.1916		0.00000

Data source: research finding

Carbon emissions and deforestation have a significant effect on the Sharia stock market, both in the short and long terms, with various lags. The signs of this effect were also different. In the long run, carbon emissions have a negative impact, whereas deforestation has a positive impact. In the short term, carbon emissions have positive signs and deforestation have negative signs.

Table 6. Estimation of NARDL in the SRI Stock Market

Variable	Coefficient	t-stat	Prob.
Part A: Short-Term Asymmetric			
C	4.6131	8.3692	0.0000
@TREND	0.0757	8.0248	0.0000
D(IR_POS)	0.0110	0.5575	0.5845
D(IR_NEG)	-0.0111	-0.9603	0.3504
D(IR_NEG(-1))	0.0774	6.3883	0.0000
D(WUI_POS)	-0.0732	-3.4770	0.0029
D(WUI_POS(-1))	0.1694	5.6707	0.0000
D(WUI_POS(-2))	0.0478	2.1244	0.0486
D(WUI_NEG)	0.0467	2.4058	0.0278
D(WUI_NEG(-1))	0.0654	2.6226	0.0178
D(EXC_POS)	-1.0858	-8.8084	0.0000
D(EXC_POS(-1))	-0.8971	-6.8856	0.0000
D(EXC_NEG)	-0.0298	-0.1381	0.8918
D(EXC_NEG(-1))	-0.5578	-3.2357	0.0049
D(ECO2)	-0.8479	-5.5311	0.0000
D(ECO2(-1))	-0.6473	-3.6891	0.0018
D(ECO2(-2))	-0.5987	-3.6285	0.0021
D(DEF)	0.1895	8.4431	0.0000
D(DEF(-1))	-0.0053	-0.2666	0.7930
D(DEF(-2))	-0.0836	-4.0102	0.0009
Part B : Long Term Relations			
IR_POS	0.1211	4.6987	0.0002
IR_NEG	-0.0619	-2.2131	0.0409
WUI_POS	-0.4558	-8.0571	0.0000
WUI_NEG	0.0317	0.4326	0.6708

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Variable	Coefficient	t-stat	Prob.
EXC_POS	-1.4493	-5.0971	0.0001
EXC_NEG	1.5981	3.2735	0.0045
ECO2	-1.5785	-6.8105	0.0000
DEF	0.2077	5.6728	0.0000
Part C : Statistic			
ECT	-0.5778	-8.1245	0.0000
Adj. R2	0.9132		
WLR	28.6385		0.0000
WSR	72.1414		0.0000

Data source: research finding

Both variables have significant effects at various lags, but only carbon emissions have a significant influence on the Sharia stock market in Indonesia. The empirical findings are in line with the explanation from El Ouadghiri et al. (2021), who states that environmental issues can have different impacts on the stock market. However, some studies state that environmental issues positively influence the share of environmentally responsible companies. Public attention or investor sentiment favors shares in sustainable companies Liu & Lai (2021) and investors care about carbon risk, where investors demand high compensation exposure to carbon emission risk (Bolton & Kacperczyk, 2021). This empirical evidence suggests that carbon emissions and deforestation factors can have a significant impact on the green stock market, with potential implications for investor behavior, financial policy, and sustainable investment strategies.

CONCLUSION

The study reveals that environmental factors, represented by carbon emissions and deforestation, exert a significant influence on sustainable stock markets. This implies that investors and policymakers should be attuned to environmental issues, as they can shape market dynamics and investor behavior. Additionally, the research highlights the importance of incorporating sustainability principles into financial decisions, aligning with global efforts towards green economic development. Moreover, the study's utilization of the NARDL model contributes to the methodological discourse, showcasing its effectiveness in capturing both short- and long-term asymmetries in the context of sustainable stock markets. The robustness of the model is supported by various diagnostic tests, confirming its suitability for analyzing the complex interactions in these markets. Overall, the empirical evidence presented in this study contributes valuable insights that can inform decision-makers in their pursuit of sustainable finance and investment strategies. As global initiatives for green economic development gain momentum, understanding the intricate relationships explored in this research becomes imperative for steering financial markets towards a more sustainable and resilient future. As we know, the Indonesian government has not yet established a standardised standard for green assets derived from the stock market that can support green economic development. We, the researchers, would like to recommend policies among others: (1) Expansion of Green Criteria Standardization: establish clear and

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standardized criteria for classifying Sharia stocks as green, aligned with global standards such as the Principles of Responsible Investment (PRI). This will provide clarity for investors, issuers, and regulators and facilitate the integration of Sharia stocks into the broader green finance framework. (2) Incentivizing Green and Sustainable Initiatives: Incentivize corporate income tax rebates to all Sharia companies andfinancial institutions that engage the most in green and sustainable initiatives. Incentivize a 25% reduction of the registration and declaration fees not only for Green Sukuk but also for sustainable stock. This initiative will not only promote the advancement of projects in sectors such as clean energy, mass transportation, water conservation, forestry, and low-carbon technologies, but it will also contribute to the attainment of the Sustainable Development Goals (SDGs). Furthermore, these incentives have the potential to enhance the availability of green financial products within the Sharia capital market.

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