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The Effects of Green Technology, Clean Energy, and Green Finance on Faith-Based Investments: Evidence from Islamic Stock Markets

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Abstract: This study examines the long-term relationship between Islamic Stock prices, faith-based investments, green technology, clean energy, and green finance. The variables used in the study are the Clean Energy Index for clean energy, Green Bond Index for green finance, the Renewable Energy and Clean Technology Index for green technology and the Islamic Market Index for Islamic Stocks' closing prices, as explained by S&P. The utilized research model is the NARDL model, and the findings reveal a cointegration relationship between faith-based and green finance instruments. Green finance instruments are unsuitable for the research period to be used as a safe-haven or effective diversification instrument for faith-based portfolios. Comprehending faith-based investments' relationship with other green finance assets is critical in supporting sustainable development with financial market instruments, which provide environmental and societal benefits. As a result, apprehending the relationship between faith-based investments and green finance instruments can contribute to increasing social and environmental responsibility awareness in financial markets. The study's outcomes hold significance in understanding how investors in financial markets react to positive and negative shocks, estimating these effects, efficiently managing portfolios comprising green financial assets and faith-based investments, and formulating an appropriate investment strategy.

Keywords: Islamic Stock, Green Bonds, Clean Energy, Clean Technology, Green Finance, Faith-Based Investments, NARDL

Jel Codes: G10, G11, G15

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Introduction

Sustainable development aims to eliminate all factors that harm the environment, nature, and human beings or minimize their effects. For this reason, the concept of green finance, which supports production processes that do not harm the environment and do not cause climate change, and the use of clean energy and green technology, is critical in financial markets. Green finance aims to develop instruments that facilitate the allocation of resources toward environmental responsibility, support the financing of green technologies, and catalyze renewable energy generation, ultimately fostering sustainable growth (Madaleno et al., 2022). The instruments that can be used for these purposes in green finance are sustainable development investments, socially responsible investments, and religious faith-based investments. Accordingly, sustainable development investments aim to prevent the irreversible consumption of natural resources and the consequent deterioration of the ecological balance. Socially responsible investments are economic activities that allow finding the balance between ethics, the environment, and the individual to reduce environmental, social, and institutional degradation. Faith-based investments, on the other hand, have been created to encourage people's welfare, beliefs, lives, and wealth, according to faith criteria, which have gained increasing attention, especially after the 2008 financial crisis (Kuzulu, 2021). Therefore, in many ways, green finance instruments provide product diversity for financial markets and support sustainable economic development.

The Paris Agreement states that 1.5 trillion dollars of green financing are needed yearly for sustainable development. Common instruments of green finance include green bonds, and clean energy stock. The use of green technology and clean energy, one of the components of green finance, has significant advantages as it is sustainable, causes less environmental degradation, and reduces CO2 emissions (Shan et al., 2021; Shao et al., 2021). Hence, the utilization of clean energy has emerged as a foremost alternative strategy for sustainable development, actively contributing to the advancement of environmental and social responsibility (J.-L. Liu et al., 2020)renewable energy consumption has become one of the best alternative strategies for sustainable development. Based on this, this paper employs the 3SLS model to conduct an empirical study on the relations among real output, renewable energy consumption, and CO2 emissions of BRICS countries (except Russia. However, although the use of clean technology is environmentally friendly, its cost is relatively high, and the supporting institutions are limited. For this reason, the number of projects using green finance instruments, which aim to expand the use of clean energy and technology, is quite limited. However, it is essential to disseminate the use of green technology for sustainable development. At this point, it is important to know the relationship between green bonds, clean energy, and green technology stocks, which can be used as an instrument to achieve sustainable development goals without harming the environment, nature, and all living creatures, and faith-based investments that unite around similar goals and principles. Faith-based investments often support investments that address social and environmental issues and promote sustainability. These investments can also contribute to environmental sustainability by investing in environmentally friendly energy production, renewable energy sources, energy efficiency, and waste reduction, in line with the goals of green finance. Therefore, faith-based financial investments can significantly contribute to green finance by promoting sustainability with projects that respect nature, people, and society. Therefore, questions for faith-based investments that emphasize the principle of valuing the environment, nature, and people are tried to be answered in this research: i) Are faith-based investments cointegrated with green bonds and other green financial assets? (ii) What are the long- and short-term relationships between faith-based investments and green asset groups? (iii) Do green assets offer a safe haven for investors in mitigating risks associated with faith-based investments?

The reasons for examining the relationship between green finance instruments and Islamic stocks selected to represent faith-based investments in this study can be stated at several points. First, faith-based investments and green finance instruments are becoming increasingly popular in financial markets (Cortellini & Panetta, 2021; F. H. Liu & Lai, 2021; Yeow & Ng, 2021)we analyse the recent development of green sukuk (often referred to as an Islamic green bond. Both faith-based investments and green finance instruments attract investors who adopt a responsible approach to the environment and society (Ali et al., 2021) because faith-based investments attract investors who support sustainable and environmentally friendly companies. Green finance instruments are likewise used to finance sustainable and environmentally friendly projects. Furthermore, based on research from the Pew Research Center, the expanding Muslim population indicates significant growth potential for Islamic financial markets within the global financial landscape. Therefore, considering the rapid growth in the Securities Markets, comprehending the relationship between faith-based investments and green finance instruments is very important for investors and policy practitioners. Therefore, faith-based investments and green finance instruments provide different instruments investors can use to create sustainable investment strategies. Thus, knowing the relationship between faith-based investments and green finance instruments is essential.

Another important reason is that faith-based investments and green finance instruments are also accepted as ethical and social responsibility-based investment instruments in financial markets. For this reason, investors aim to provide social and environmental benefits as well as financial returns by investing in faith-based investments and green finance instruments. The Islamic tradition is also strongly committed to environmental and social principles, emphasizing ethical regulatory standards and the sustainability of Islamic finance, especially environmental protection (CFA Institute, 2019; Tiwari, Abakah, Adekoya, et al., 2023). Therefore, there is likely to be a strong relationship between faith-based investments and green finance instruments (Tiwari, Abakah, Adekoya, et al., 2023). At this point, knowing its relationship with other green finance assets is very important in terms of support for sustainable development with financial market instruments. At the same time, the relationship between faith-based investments and green finance instruments focuses on the importance of sustainability in financial markets. The use of these instruments can help increase sustainability in financial markets and provide environmental and societal benefits. Also, Islamic law mandates specific responsibilities, including environmental stewardship, which adherents, namely Muslims, must fulfill (AL-Rawi et al., 2023). Grounded in the belief that humans are integral components of the natural world, Islamic environmental ethics is deeply rooted in a resolute commitment to safeguarding the Earth. This commitment reflects a profound respect for the natural world, perceived as a manifestation of God's power and wisdom (Hayat et al., 2023) the prophet's sayings, and the opinions of classical jurists. Islamic environmental principles entail the concept of the Oneness of God (Hayat et al., 2023). Consequently, environmental responsibility becomes a pivotal element reinforcing the Islamic law principle of safeguarding the interests of all beings (Nasir et al., 2022). Within this framework, this study delves into examining the effects of Green Technology, Clean Energy, and Green Finance stocks—indicators of investments in Islamic stock markets—on environmental preservation. As a result, knowing the relationship between faith-based investments and green finance instruments can contribute to increasing social and environmental responsibility awareness in financial markets.

One of the pioneering studies examining the relationship between faith-based investments and green finance instruments, this research will contribute significantly to the literature at several points. The Dow Jones Islamic stock index was used to represent faith-based investments. Islamic stocks serve a common purpose with green bonds, clean energy stocks, and renewable, clean technology stocks due to the criterion of continuing the activities without harming the environment, nature, and people. In the widespread literature, there is generally a concentrated interest in the relationship between green finance and the prices of commodities such as oil, bitcoin, and gold. However, almost no study directly examines the relationship between the Islamic stock market and the green bond, green energy, and technology markets. Therefore, knowing the relationship between green finance instruments and Islamic stocks in achieving sustainable development goals is extremely important. Thus, it is thought that the study will be a pioneer in filling this gap in the literature.

Another significant contribution is related to the model used. The NARDL (Nonlinear Autoregressive Distributed Lag) model used in the research allows seeing the positive and negative effects of green finance instruments, which are independent variables, on Islamic stock prices. As positive and negative shocks exert distinct impacts on the variables, understanding their asymmetric relationship becomes crucial (Shahbaz et al., 2017). In addition, the findings obtained are significant with regard to the different reactions of investors in financial markets to positive and negative shocks, the estimation of this effect, and the development of an appropriate investment strategy. This is important in effectively managing portfolios of green financial assets and faith-based investments. Thus, it is thought that it will make significant contributions to policy practitioners and researchers in terms of obtaining new information.

Accordingly, the research was organized as follows. After the introduction, the following section gives the relevant literature review, and the data set and methodology used are given in the third part. The empirical findings are given in the fourth part, and the results and recommendations are given in the last part.

Literature Review

No study in the literature deals with the Green Bonds, Clean Energy, Islamic Stocks, and Clean Technology stock variables used in this study. This study tried to examine the literature review, the separate variables of each, or the studies on two or more variables in the same study.

In recent years, many studies have examined the connectedness of green bonds in the literature. These studies are based on the connectedness of green bonds and (clean) energy markets (Abakah et al., 2022; Chai et al., 2022; Chatziantoniou et al., 2022; Ferrer et al., 2021; Hammoudeh et al., 2020; Saeed et al., 2021), stock market (Chai et al., 2022; Mensi et al., 2022; Nguyen et al., 2021), financial market (Elsayed et al., 2022; Karim & Naeem, 2022; Reboredo & Ugolini, 2020), green equity (Chatziantoniou et al., 2022; Pham, 2021), sustainable investments (Chatziantoniou et al., 2022), commodities (Bibi et al., 2022; Naeem et al., 2021; Nguyen et al., 2021; Rao et al., 2022; Tsagkanos et al., 2022). Based on the research findings, the relationships between the examined variables exhibit variations across different periods. For instance, Ferrer et al. (2021) observed no correlation between green stocks and bonds. Their conclusion highlights a robust return and volatility interconnection between green bonds and treasury, as well as investment-grade bonds. However, there is no discernible spillover of return and volatility between general stocks and green bonds. Chai et al. (2022) examined the dynamic nonlinear connectedness between green bonds, clean energy, and stock prices based on the COVID-19 pandemic period. As a result of the study, stock prices increase when clean energy experiences a positive shock, and it has been determined that this positive effect is more robust in the economic recovery period than in the pandemic periods. As per Mensi et al. (2022), the connectedness between Green bonds and the S&P 500 index strengthens during crises and pandemics, with green bonds exhibiting relatively lower volatility amid extraordinary events. Conversely, Rizvi et al. (2022) concluded that Green Bonds and Islamic Bonds are safe-haven only during normal market conditions. Especially during the COVID-19 pandemic, the interest in green finance instruments has increased in academic circles and the financial markets. One of the most important reasons for this is the change in the amount of CO2 emissions and the increase in people's sensitivity to the environment due to the bans and measures taken due to the pandemic. The price connectedness between the green bond and financial markets investigated by Reboredo and Ugolini (2020) noted that the green bond market is the receiver of a net price spillover, and green bonds receive significant price spillovers from treasury and currency markets. Nguyen et al. (2021) investigated the interrelationship between green bonds and various asset markets. The findings indicate that there is a significant level of comovement among stocks, commodities, and clean energy. However, the diversification benefit of green bonds is notable due to their low or negative correlation with stocks and commodities.

Faith-based investments have become popular in financial markets, just like green finance instruments. It is known to outperform other markets, especially in times of crisis. In many studies in the literature, it has been revealed that faith-based investments exhibit resilience to shocks and maintain stability amid crises in other markets, unlike conventional stocks. (Abduh, 2020; Arif et al., 2021; Bossman et al., 2022; Erdoğan et al., 2020; Naeem et al., 2023; Tiwari, Abakah, Yaya, et al., 2023). Also, traditional stocks are more prone to volatility than Islamic stocks during market turmoil (Karim & Naeem, 2022).

Islamic stocks and green finance instruments have the potential to be the focus of attention for investors who make up their portfolios based on the criteria of being respectful to the environment, nature, and people. For this reason, studies examining the relationship between these asset groups find their place in the literature. Chopra and Mehta (2023) analyzed the advantages of utilizing green bonds for hedging and establishing a safe haven within a stock portfolio. Their findings indicate that green bonds are robust hedges for eleven U.S. stock sectors. In a separate study, Tang and Zhang (2020) explored the impact of green bond issuance on companies' returns, determining that the issuance of green bonds has a positive impact on stock prices. In a similar vein, Kuchin et al. (2019) confirmed that green bond issuance generates a positive market reaction and raises the company's value.

Ejaz et al. (2022) have explored the advantages of portfolio diversification involving green bonds, Islamic and conventional equity, and energy markets. The study suggests that investors should avoid treating international financial markets as homogeneous assets when combining them with green bonds, as they exhibit distinct risk profiles. Additionally, the authors assert that Islamic bonds emerge as the most fitting hedge when paired with green bonds, conventional bonds, equity markets, and the Islamic equity market. Similarly, the benefits of hedging and diversification on green investments for conventional stock portfolios are examined by Yousaf et al. (2022), who conclude that Green bonds are a safe haven against significant stock market fluctuation compared to sustainable investments and other alternative investments. Naeem et al. (2023) investigated the hedging and safe-haven attributes of Sukuk and green bonds in the context of stock markets. Their findings highlight the robust safe-haven characteristics of green bonds, suggesting that incorporating green bonds into investment portfolios provides significant diversification benefits, particularly for investors with a lower risk tolerance during economic stress and turbulence periods.

As can be seen from the current literature research, no study has been found focusing on the connection between Islamic stocks and green bonds, clean energy, and green technology stocks. Therefore, when evaluated in terms of sustainable finance, the research will significantly contribute to the literature in evaluating the effect of clean energy, clean technology, and environmentally friendly financial resources on the stock price of an environmentally friendly business.

Methodology and Data

Methodology

This research explores the asymmetric impact of green finance instruments on investments guided by religious beliefs. The study employs the NARDL (Nonlinear Autoregressive Distributed Lag) model, a methodology introduced by Shin et al. (2014) that presents several advantages compared to the conventional ARDL model. Notably, the NARDL model does not rely on linearity assumptions, examines the asymmetric long-term effects of positive and negative influences, and facilitates the capture of cointegration within a single equation (Çıtak et al., 2020).

To investigate the long-run relationship between Dow Jones Islamic Market World Index, S&P Global Clean Energy Index, S&P Green Bond Index, and S&P Renewable Energy and Clean Technology Index, the linear equation framework can be modelled as follows:

$$IS_t = \beta_0 + \beta_1 CE_t + \beta_2 GB_t + \beta_3 CT_t + \varepsilon_t \quad (1)$$

Where CE, GB and GT represent clean energy stock, green bonds, renewable energy, and clean technology stock ındex in a given time period t, respectively. β_i represents the long-run coefficients, and ε_t is an error term. Eq. (2) to express the asymmetric long-run regression of stock price as follows:

$$IS_t = \delta_0 + \delta_1(CE^+_t) + \delta_2(CE^-_t) + \delta_3(GB^+_t) + \delta_4(GB^-_t) + \delta_5(CT^+_t) + \delta_6(CT^-_t) + \varepsilon_t \quad (2)$$

where δ_i indicates coefficients vector for long-run parameters to be estimated and CE^+_t, CE^-_t, GB^+_t, GB^-_t, CT^+_t, CT^-_t denote the positive and negative partial sum process variation in clean energy, green bond, and clean technology, respectively. Following Shin et al. (2014), the values of CE^+_t, CE^-_t, GB^+_t, GB^-_t, CT^+_t, CT^-_t, can be framed through the equations below (3a, 3b, 3c, 3d, 3e and 3f):

$$CE^+ = \sum_{i=1}^{t} \Delta CE^+_i = \sum_{i=1}^{t} \max(\Delta CE_i, 0) \quad (3a)$$

$$CE^- = \sum_{i=1}^{t} \Delta CE^-_i = \sum_{i=1}^{t} \min(\Delta CE_i, 0) \quad (3b)$$

$$GB^+ = \sum_{i=1}^{t} \Delta GB^+_i = \sum_{i=1}^{t} \max(\Delta GB_i, 0) \quad (3c)$$

$$GB^- = \sum_{i=1}^{t} \Delta GB^-_i = \sum_{i=1}^{t} \min(\Delta GB_i, 0) \quad (3d)$$

$$CT^+ = \sum_{i=1}^{t} \Delta CT^+_i = \sum_{i=1}^{t} \max(\Delta CT_i, 0) \quad (3e)$$

$$CT^- = \sum_{i=1}^{t} \Delta CT^-_i = \sum_{i=1}^{t} \min(\Delta CT_i, 0) \quad (3f)$$

NARDL can be formulated as follows (4):

$$\Delta IS_t = \vartheta_0 + \sum\vartheta_1 \Delta IS_{t-1} + \sum\vartheta_2 \Delta CE^{+}_{t-1} + \sum\vartheta_3 \Delta CE^{-}_{t-1} + \sum\vartheta_4 \Delta GB^{+}_{t-1} + \sum\vartheta_5 \Delta GB^{-}_{t-1} + \sum\vartheta_6 \Delta CT^{+}_{t-1} + \sum\vartheta_7 \Delta CT^{-}_{t-1} + \zeta_1 stock_{t-1} + \zeta_2 CE^{+}_{t-1} + \zeta_3 CE^{-}_{t-1} + \zeta_4 GB^{+}_{t-1} + \zeta_5 GB^{-}_{t-1} + \zeta_6 CT^{+}_{t-1} + \zeta_7 CT^{-}_{t-1} + \varepsilon_t \ldots (4)$$

After confirming the presence of the long-run cointegration between the variables, the long-run asymmetric effect of CE, GB, and CT on stock prices was examined. Several robustness tests were applied to check the results' validity, including residual independence (autocorrelation), residual heteroscedasticity, and residual normality (Çıtak et al., 2020).

Data

In this study, the S&P Global Clean Energy Index for clean energy (CE), the S&P Green Bond Index for green finance (GB), the S&P Renewable Energy and Clean Technology Index for green technology (CT), and the S&P Islamic Market for Islamic Stocks (IS) are analyzed. World Index is used. The data set is taken from www.spglobal.com, where detailed explanations of the variables are available. The data set used in the research is as in Table 1.

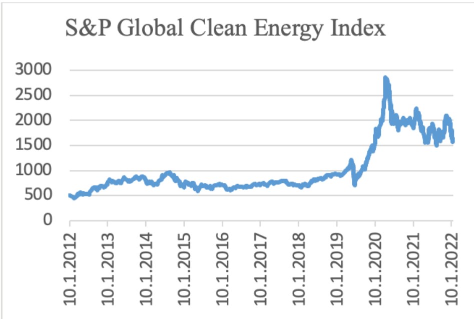
Table 1

Data Presentation

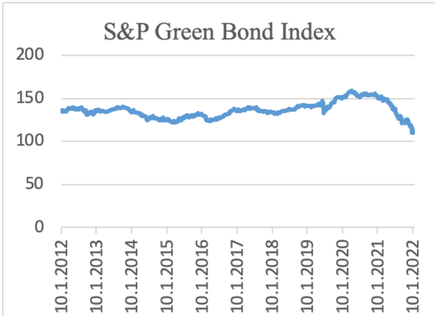
Variables	Description	Definition
IS	Dow Jones Islamic Market World Index	The DJGI used in this study includes indexes for 10 financial industries, 19 Super sectors, 41 sectors, and 114 subsectors from the United States, Canada, Japan, Hong Kong, Singapore, and Australia/New Zealand.
CE	S&P Global Clean Energy Index	The S&P Global Clean Energy Index is designed to calculate the performance of companies in global clean energy-related businesses from both developed and emerging markets, with a constituent target count of 100.
GB	S&P Green Bond Index	The S&P Green Bond Index, which is used to finance environmentally friendly projects, is designed to track the global green bond market.
CT	S&P Renewable Energy and Clean Technology Index	The S&P/TSX Renewable Energy and Clean Technology Index measures the performance of companies listed on the TSX whose core business is the development of green technologies and sustainable infrastructure solutions.

Source: www.spglobal.com

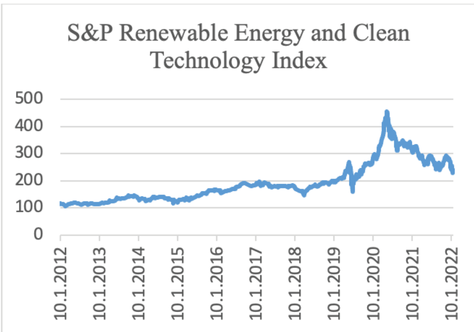
The period examined in the study covers 2518 days starting from 01.12.2012 and ending with 20.10.2022. Accordingly, the variables examined and the price changes for the period are as in Figure 1-4.



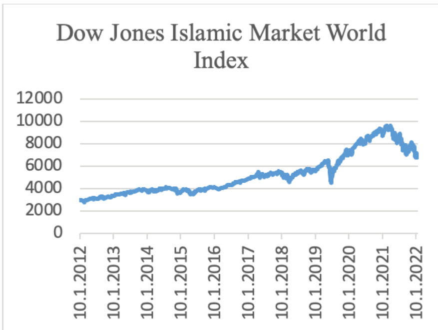
(1)



(2)



(3)



(4)

Figure 1. Price Change of Variables

According to Figure 1-4, among the variables examined in the study, the green bond has the lowest volatility, while Islamic stocks have very high volatility. In addition, it is noteworthy that with the COVID-19 epidemic, significant increases in green bonds, clean energy, and clean technology stock prices have emerged. The basic statistical values of the examined variables are as in Table 2.

Table 2

Descriptive Statistic for Variables

Variables	CE	GB	CT	IS
Mean	1013.845	136.5579	192.0248	5268.552
Median	786.1700	135.8500	177.4950	4836.995
Maximum	2856.160	158.9900	454.5100	9668.470
Minimum	446.6200	110.0400	106.7400	2823.350
Std. Dev.	507.1724	9.132524	71.74964	1828.356
Skewness	1.440221	0.402087	1.156274	0.840372
Kurtosis	3.871700	3.025364	3.654334	2.545021
Jarque-Bera	950.2101	67.91658	606.0018	318.0975
Probability	0.000000***	0.000000***	0.000000***	0.000000***

***, ** and * denote rejection of the null hypothesis at the 1%, 5%, and 10% levels, respectively.

According to Table 2, the lowest standard deviation belongs to green bonds, and the highest belongs to Islamic stocks. Looking at the average price changes, while green bond has the lowest value, Islamic stocks have the highest average value. The skewness values obtained for all the variables examined in the study are positive, and the series is right-slanted. In addition, kurtosis values are positive, and the series have leptokurtic properties. In addition, according to the Jarque-Bera test results obtained from Table 2, all variables do not show normal distribution at the 1% significance level. This result also supports the conclusion that the variables have a nonlinear distribution. This supports that nonlinear estimation methods are suitable for these variables (Anwar et al., 2021; Godil et al., 2021; Hu et al., 2022). Therefore, the nonlinear ARDL (NARDL) model is suitable for examining the cointegration relationship between variables. However, the NARDL model also has significant limitations regarding unit root results. This is because the variables used in the research are not I(2). Because if any variable becomes stationary at the second difference, cointegration occurs where the F-statistics are invalid (Meo et al., 2018). At the same time, the unit root results of the variables are significant in order not to obtain spurious results from the models used.

Empirical Results

One of the most important constraints of the NARDL model used as a research method is related to stationarity. Not all variables must be in the second order of integrations. The unit root test analysis of the variables used in this study was carried out with the Augmented Dickey-Fuller (ADF) unit root test. Accordingly, the ADF unit root test results of the variables used in the research are given in Table 3.

Table 3

Results Of Unit Root Tests (ADF)

Level				
	Intercept		Intercept and Trend	
	t-Stat.	Prob.	t-Stat.	Prob.
IS	-1.118968	0.7105	-1.904861	0.6516
CE	-1.182357	0.6843	-1.86100	0.6743
GB	-0.097679	0.9479	0.679537	0.9997
CT	-1.438644	0.5646	-2.163444	0.5093
First Difference				
	Intercept		Intercept and Trend	
	t-Stat.	Prob.	t-Stat.	Prob.
IS	-15.54183	0.0000***	-15.54489	0.0000***
CE	-42.32834	0.0000***	-42.31998	0.0000***
GB	-31.72866	0.0000***	-31.79270	0.0000***
CT	-14.33978	0.0000***	-14.34294	0.0000***

***, **, * represents the level of significance at 1%, 5%, and.10% levels, respectively.

According to Table 3, all the variables used in the research are both constant and constant at the level, and the trend is also unit-rooted. When first-order differences are taken, all variables become stationary. This result supports the conclusion that these variables are suitable for applying the NARDL model.

BDS (Brock et al., 1987) test was applied to determine the nonlinear structures of the series on the mean. The nonlinear dependence between the variables is examined with the BDS test. The BDS test results applied for the variables are as in Table 4.

Table 4

Results of BDS Tests

	m=2	m=3	m=4	m=5	m=6
IS	0.203686***	0.347012***	0.447609***	0.518062***	0.567342***
CE_t^+	0.208253***	0.354445***	0.457174***	0.529437***	0.580326***
CE_t^-	0.208411***	0.354619***	0.457290***	0.529461***	0.580248***
GB_t^+	0.208969***	0.355504***	0.458315***	0.530495***	0.581210***
GB_t^-	0.208163***	0.354396***	0.457219***	0.529578***	0.580549***
CT_t^+	0.208486***	0.354717***	0.457382***	0.529535***	0.580300***
CT_t^-	0.207511***	0.353528***	0.456373***	0.528883***	0.580059***

***, **, * represents the level of significance at 1%, 5%, and.10% levels, respectively.

According to the BDS results in Table 4, the existence of nonlinearity between the various dimensions of the variables was confirmed. Accordingly, it is appropriate to apply the NARDL model. The Wald bounds test was employed to ascertain a long-term relationship among the variables (Syed et al., 2022)the current study measures the asymmetric relationship between green bonds, U.S. economic policy uncertainty (EPU. In this direction, the F statistic values obtained for the NARDL model are as in Table 5.

Table 5

Results of NARDL Bound Test

F-bounds test statistics	Null hypothesis: no levels relationship	DECISION
F-statistic	4.401654	Cointegration
K= 6		
Significance	**I(0)**	**I(1)**
10%	1.99	2.94
5%	2.27	3.28
2.5%	2.55	3.61
1%	2.88	3.99

***, **, *, indicates statistical significance at 1%, 5% and 10% respectively.

As per the findings in Table 5, the F-statistic surpasses the critical value, leading to the rejection of the null hypothesis that posits no cointegration between the variables. This provides evidence supporting the assertion that there exists a long-term cointegration among the variables. With the confirmation of a long-term relationship, the estimation of coefficients governing this asymmetric relationship has been initiated. Consequently, the short-run coefficients of the NARDL model are detailed in Table 6.

Table 6

NARDL Short-Run Esimates

	Dependent Variable:IS			
Variables	**Coefficient**	**St. Error**	**t-Statistic**	**Prob**
ΔCE_t^+	-0.014439	0.004652	-3.103918	0.0019***
ΔCE_t^-	0.010639	0.005369	1.981475	0.0476**
ΔGB_t^+	0.038557	0.018165	2.122640	0.0339**
ΔGB_t^-	0.038100	0.015018	2.536940	0.0112**
ΔCT_t^+	0.019660	0.006234	3.153726	0.0016***
ΔCT_t^-	-0.012345	0.005125	-2.408766	0.0161**
ECT(-1)	-0.013412	0.002231	-6.010517	0.0000***
Wald Test	F-Value	Prob		
CE_{SR}	112.096	0.0000***		
GB_{SR}	7.816704	0.0052***		
CT_{SR}	3.360539	0.0668*		

***, **, * denote the statistical significance at the 1%, 5%, and 10% levels, respectively.

H0: denotes no short-run asymmetric relationship.

Table 6 shows a short-run asymmetric relationship between clean energy, green bonds, clean technology, and Islamic stocks. According to these results, the increase (decrease) in clean energy decreases (increases) the Islamic stock price. A 1 percent increase in clean energy prices reduces Islamic stock performances by 0.014 percent. A 1 percent decrease in clean energy prices reduces Islamic stock performances by 0.011 percent. According to the result of the short-term coefficients applied for the NARDL model, any change in green bond prices has a positive effect on Islamic stock prices. In addition, all changes in clean technology stock prices, up or down, increase Islamic stock prices. In addition, the ECT coefficient in the model is negative and statistically significant (1%). This means that a short-term imbalance in one of the independent variables in the model will be corrected in the long run. The long-term coefficients of the NARDL model are as in Table 7.

Table 7

NARDL Long-run Estimates

	Dependent Variable:IS			
Variables	**Coefficient**	**St. Error**	**t-Statistic**	**Prob**
ΔCE_t^+	-0.054053	0.017543	-3.081234	0.0021***
ΔCE_t^-	0.040233	0.020084	2.003239	0.0453**
ΔGB_t^+	0.148362	0.071597	2.072187	0.0384**
ΔGB_t^-	0.139225	0.057711	2.412457	0.0159**
ΔCT_t^+	0.071164	0.023417	3.039040	0.0024***
ΔCT_t^-	-0.045832	0.019275	-2.377791	0.0175**
C	0.046495	0.011188	4.155826	0.0000***
Wald Test	F-Value	Prob		
CE_{LR}	109.7072	0.0000***		
GB_{LR}	7.852221	0.0051***		
CT_{LR}	3.247119	0.0717*		

***, **, * denote the statistical significance at the 1%, 5%, and 10% levels, respectively.

H0: denotes no long-run asymmetric relationship.

According to Table 7, a 1% increase in clean energy prices reduces Islamic stock prices by 0.05%. A 1% decrease in clean energy prices reduces Islamic stock prices by 0.04%. A 1% increase in green bond prices caused Islamic stock prices to increase by 0.14 percent, a decrease in green bond prices to decrease Islamic stock prices by 0.13 percent, an increase in clean technology share prices to an increase in Islamic stock prices by 0.07 percent, a decrease in clean technology share prices. The decrease causes Islamic stock prices to increase by 0.04 percent.

According to the long-term coefficients in the cointegration results in Table 7, a long-term asymmetric relationship exists between clean energy, green bonds, and clean technology with Islamic stocks. Accordingly, increases in clean energy share prices reduce Islamic stock prices. At the same time, decreases in clean energy stock prices increase Islamic stock prices. A 1 percent increase (decrease) in clean energy stock prices reduces (reduce) Islamic stock prices by 0.05 percent (0.04 percent). While the change in Green bond prices positively affects the price of Islamic stocks. On the other hand, the increase in Clean Technology increases the price of

Islamic stock, while the decrease in Clean Technology decreases the price. So, the price movement in Clean technology and Islamic stocks are in the same direction.

Robustness Checks

The Breusch-Godfrey LM test was used for the serial correlation test, the Breusch-Pagan-Godfrey and ARCH test was used for the heteroskedasticity problem, and the Ramsey Reset Test was used to test the model suitability to strengthen the validity of the results obtained with the NARDL model applied in the study. Accordingly, the obtained results are as in Table 8.

Table 8

Diagnostic Tests

Diagnostic Test	Problem	F stat.	p-Value
Ramsey Reset	Model Specification	0.002588	0.9594
LM Test	Serial Correlation	1.037611	0.3545
Bruesh-Pagan	Heteroskedasticity	0.7500	0.7092
ARCH	Heteroskedasticity	0.159590	0.6904

Table 8 shows no serial correlation according to the LM test results in the models in which the long-term relationship between green bonds, clean energy, renewable energy, and clean technology with Islamic Stock price variables are examined. In addition, the applied models have no heteroscedasticity problem according to the Bresch-Pagan-Godfrey and ARCH test results. Established model specifications are also correct according to the Ramsey Reset Test.

Conclusion and Policy Implications

Green bonds, clean energy and clean technology stocks, and faith-based investment instruments are very popular among the financial instruments developed for sustainable finance practices. This research examines the asymmetric relationship between Islamic stock markets and clean energy, green finance, and green technology stocks for the long and short term. For this purpose, an examination was made for the period between 01.10.2012 and 20.10.2022. The model used in the research is NARDL, which allows for examining asymmetric relationships. According to the research results, a cointegration relationship exists between Islamic stock markets and green bonds, clean energy, and clean technologies. According to the estimation of the short- and long-term correlation coefficients, green bonds and Islamic stocks move in the same direction both in decreases and increases, which supports the findings of Nguyen et al. (2021). Any change in clean technology (clean energy) stocks causes the prices of Islamic stocks to increase (decrease). The evidence supports the findings of Chai et al. (2022), Tang and Zhang (2020), and Kuchin et al. (2019). However, the effect of the increase in the prices of clean technology (clean energy) stocks on Islamic stock prices is greater than the effect of the decrease in the prices of clean technology stocks. In addition, according to these results, clean energy, clean technology, and green bonds are not suitable for the research period to be used as a safe investment or effective diversification instrument for Islamic stock portfolios, which contradicts the findings of Chopra and Mehta (2023), and Ferrer et al. (2021). However, the most crucial point is that the relationship between the variables may change over time. For this reason, future studies can be carried out using econometric and statistical methods in which time-varying relationships can be considered.

Expanding the use of green financial instruments through the joint initiative of individuals, institutions, and governments in sustainable environmental management makes significant contributions to the improvement of society and the planet. However, policy practitioners and investors can contribute to creating new funding sources in the financial markets and developing new investment strategies by considering the relationships between these environmentally friendly investment instruments. Governments and policymakers can contribute to sustainable environmental management by implementing policies to popularize and encourage environmentally friendly investment funds (Tuna et al., 2023) and Faith-based investments that serve Islamic environmental ethics in financial markets. While diversifying the portfolio, it is essential to know the assets that should not be included, and the recommended assets in the portfolio. At this point, in the investment recommendations that can be given to investors who focus on portfolio management for hedging, it may be recommended not to collect these assets in the same portfolio. By its very nature, Islamic finance harmonizes seamlessly with the principles of green finance (Campisi et al., 2018), aiming to direct investments towards endeavours that yield environmental benefits (F. H. Liu & Lai, 2021; Obaidullah, 2018). Faith-based investments, serving as environmentally friendly investment funds, are significantly pivotal for enhancing both overall ecological health and financial sustainability. Consequently, there should be proactive encouragement for the expansion and wider dissemination of green financial investment instruments (Zhou et al., 2023).

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