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Article

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Does Green Energy Investment Effects on Islamic and Conventional Stock Markets? New Evidence from Advanced Economies

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ABSTRACT

This study investigates the long-run and short-run nexus between renewable energy investment, and Islamic and conventional stock markets in advanced economies, namely the United States, United Kingdom, and European Union over the period from January 1, 2002 to August 1, 2023. The study uses the Nonlinear Autoregressive Distributed Lag (NARDL) model to examine the long-run and short-run asymmetric effects between selected variables under study. The results of empirical model estimation suggested that the green energy investment adjustment is running towards the long- and short-run steady increment regarding positive and negative shocks in conventional and Islamic stock markets. Indeed, the shocks of the green energy investment on conventional stock markets of the US and EU are positively asymmetric in the long run; the UK has an insignificant effect in the long run. Importantly, green energy investment positively has significant effects on conventional and Islamic stock markets in the US. UK and EU (except the conventional stock market of the US). The short-run coefficients of green energy investment have a significant positive effect on Islamic stock markets for the selected U.S, UK, and EU markets. Likewise, the EU conventional stock market has a significant positive effect in the short run. Change in green energy investment has a negatively insignificant impact on Islamic and conventional markets of the EU and the UK. Indeed, short-run coefficients of green energy investment negatively on the U.S. conventional stock market. The increase in green energy investment may result in an increase in the cost of energy generation, which reduces the renewable energy production firm's profitability and finally decreases the stock market prices in the short run. These findings have important implications for the portfolio diversification and hedging decisions of environmentally concerned investors. In sum, investors should consider the presence of extreme tail dependence between green investments and stock markets an important factor in making more informed and rational choices.

Keywords: Green Energy Investment, Renewable Energy, Islamic Stock Markets, Asymmetric Analysis, Nonlinear ARDL
JEL Classifications: F47, G15, G17, Q20, Q40

1. INTRODUCTION

The reliance on conventional energy sources has resulted in a slew of worldwide concerns. Renewable energy sources are a critical component of green economic growth in the world. Since the world's population is increasing at an alarming rate, the demand for energy generated from non-renewable conventional resources has surged dramatically in the last decades. Thus, environmental concerns and rising energy prices endanger the long-term viability of the expanding economy. On the other hand, green energy is created via the replenishment of natural resources in order to provide energy security while also addressing the challenges of global warming and climate change (Li et al. 2021).

It should be noted that renewable energy capacity is expected to grow at a faster rate over the next 5 years, accounting for approximately 95 percent of the increase in global electricity capacity through 2026. Renewable power capacity is expected to grow by more than 60% between 2020 and 2026, reaching more than 4,800 gigawatts globally. In terms of global power capacity, this is similar to the existing combined capacity of fossil fuels and nuclear power energy (Renewables 2021. Analysis and forecast to 2026, International Energy Agency). The post-pandemic has the potential to change the priority of government policies and budgets, developers' investment decisions, and the availability of financing through 2025. This casts a great deal of uncertainty on a market that had been expanding at a rapid pace over the last 5 years. At the same time, several countries are introducing extensive incentive programs to respond to the current economic meltdown and support the economies of the countries. Some of these stimulus measures may be relevant for renewables. There is little doubt that significant cost reductions over the past decade are one of the main reasons behind renewables rapidly transforming the global electricity mix. The cost of electricity from onshore wind and solar PV is getting cheaper and cheaper than from new and some existing fossil fuel plants. In some emerging economies, renewables are the cheapest way of meeting growing demand (Renewable Energy Market update. Outlook for 2020 and 2021, International Energy Agency).

Financial markets, especially US stock market, suffered extreme declines in just a few weeks, elevating fears and tumbling cross-market network (Chen et al., 2021). Similarly, the bond market experienced liquidity problems during the pandemic (Kargar et al., 2021; Liu et al., 2021). In the meantime, several financial markets have been exposed to lower economic activity, financial instability, elevated uncertainty, and risk management. Compared with the prior pandemics, the COVID-19 pandemic shackled the economy across the globe adversely. The World Bank reported that global GDP declined by 5.2% in 2020, with developed economies dwindling around 7%. Given these distressing periods, the role of sustainable, religious, and conventional markets is noteworthy in rescuing investments from extreme market settings. Investors' rising concerns toward risk-adjusted portfolios during distressed episodes have resulted in multiple investment opportunities to mitigate tail risk.

Due to the world economic crisis and the outbreak of COVID pandemic, continued investment in green initiatives such as clean energy, energy efficiency, etc. has been significantly reduced. Also, with the COVID-19 pandemic and economic recession, oil and gas prices have also fallen sharply. Lower fossil fuel prices are detrimental to the development of renewable energy projects, such as solar, wind, and other renewable energy sources are less economical as compared to power sources. The expansion of wind, solar and other renewable energy sources associated with renewable energy projects is not conducive to falling fossil fuel prices. Green finance or green infrastructure financing often requires heavy borrowing because they are capital-intensive and remain a pressing issue (Taghizadeh-Hesary et al., 2021). Moreover, green initiatives in the early stages of R&D are often associated with greater danger and less reward (Husted and de Sousa-Filho, 2017). Funding green initiatives, especially in Europe and Asia, is difficult because banks are the main source of funding and control the entire financial system.

Nowadays, renewable energy resources have become increasingly more important because they have fewer negative impacts on the environment than other sources of energy and the growing limitations of fossil fuels. Its consumption contributed to about 22% of the World's final energy consumption by 2015 (Balsalobre-Lorente et al., 2018). Due to the comprehensive benefits of using renewable energy, the global demand for renewable energy is predicted to rise to 31% by 2035 (Sieminski, 2016).

There is a wealth of empirical literature on renewable energy investment in assessing the role of various environmental, financial and economic indicators. For policymakers, however, the main area of focus is green finance or green bonds as a counterweight to the energy, environment and stock markets. Compared to traditional methods, green bond investment projects have positive environmental benefits, especially in projects that avoid carbon emissions. In 2022, the largest regional investments into renewable energy came from China and Europe. China alone invested over 270 billion U.S. dollars, while Europe contributed roughly 54 billion to sustainable energy technologies. Investment in the United States was also significant on a global scale (Figure 1). Indeed, the United States is one of the largest consumer of renewable energy worldwide. Though hydroelectric power was the most common source of renewable electricity until 2018. After that, wind took over, reaching 435 terawatt hours in 2022. In recent years, wind and solar account for most of the new installed capacity. Investment in renewables in the United States is expected to increase greatly in the next years with the introduction of the Inflation Reduction Act, the most significant climate legislation in U.S. history.[1]

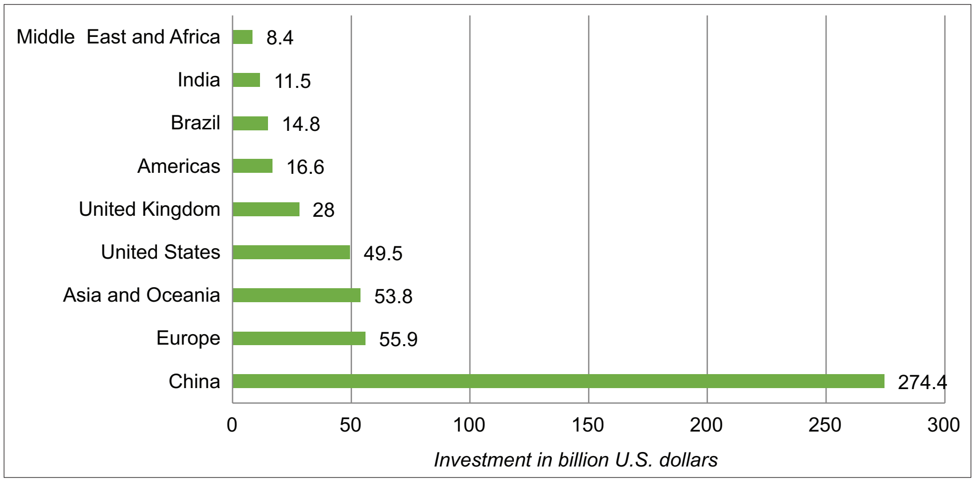
In EU, Germany holds a significant position as a leading consumer and producer of renewables worldwide, notable for its onshore wind capacity. Spain, the United Kingdom, and France are also among the largest installers of total wind power capacity in the world. Biomass is another major source of renewable energy for Europe, particularly in the heating and cooling sector. The UK's investment in clean energy and the low-carbon economy fell by 10% last year, in contrast to the EU and US. Over 2021-22, the UK's investment in the energy transition fell from USD$31bn to USD$28bn, while similar investment in the US rose by 24% to USD$141bn. Across the EU, investment rose by USD$26bn to USD$180bn, following Russia's invasion of Ukraine.[2]

The common point in energy transition and decarbonisation concepts is the need to operationalize environment-friendly projects, which are often slow and low-yielding. Due to the mentioned feature, the private sector does not welcome environmentally green projects and seeks economic benefits rather than addressing environmental concerns. Therefore, investing in

1 https://www.statista.com/statistics/186923/new-investments-worldwide-in-sustainable-energy-by-region/#statisticContainer

2 https://www.cieh.org/ehn/environmental-protection/2023/may/uk-investment-in-clean-energy-fell-by-10-in-2022/

Figure 1: Investments in green energy worldwide in 2022, by region



green energy is an important issue. With attention to it, goals such as decarbonization or energy transition will be available. Lee and Zhong (2015) developed that the primary reason for green targets' failures is the lack of insufficient investment in green energy. Zhao et al., (2022) discussed the importance of increasing investment flows in sustainable projects because, with the implementation of these projects, green energy deployment can be achieved by countries. According to climate initiative (2021), in 2020, global green investment reached over 297 billion US dollars and is predicted to reach a record of 1 trillion US dollars by 2023.

Moreover, investment in green energy plays an important role in both Islamic and conventional stock markets, as the world's major renewable energy producers follow the Islamic faith, thereby sharing their risk with each other, particularly during financial downturns. The ongoing pandemic crisis is increasingly arousing the interest of international investors in secondary risks in the Islamic stock and capital markets during the period of social slumps. However, before the crisis, the significant rise in commodity prices since January 2020 has revived the debate on the role of commodities in the strategic and tactical asset allocation process. Therefore, an understanding of the relationship between energy and stock markets is crucial, especially during the crisis, when investors are looking for alternative investment opportunities.

Therefore, the relationship between green energy and Islamic stock markets is important for international investors and the marketplace, particularly those interested in faith-oriented investments. The effects of extreme downward or upward renewable energy price movements have important implications not only for Islamic stock but also for hedging strategies used by international investors. Actually, all previous studies concerning the relationship of green energy investment have focused only on conventional stock markets. For instance, few recent and past studies investigated the relationship between stock market returns and economic uncertainty (Jones and Olson, 2013, for the US market; Chang et al., 2015, for Organisation for Economic Co-operation and Development countries; Guo et al., 2021, for G7 cuntries). In addition, other studies examined the relationship between energy prices and stock market returns (Sadorsky, 1999; Hammoudeh and Choi, 2007; Salisu and Oloko, 2015), while others focused on the effect of investor sentiment on stock returns (Wang et al., 2013; Aloui et al., 2018; Bekiros et al., 2016; Perez-Liston et al., 2016; Zhao et al., 2016; Dash and Maitra, 2017; Mamasobirov et al., 2023; Avazkhodjaev et. al., 2022).

For the case of Islamic stock markets, limited attention was paid to the causal nexus between energy and Islamic stock markets obtained which reflected mixed results. For example, Bahloul and Khemakhem (2021) examined that commodity index showed the highest source of shocks to Islamic stock market. Using the Windowed Scalogram Difference and Wavelet Coherence approaches, Boubaker and Rezgui (2020) investigated that investors in Islamic stock market indices do not base their decisions on oil, gas or gold prices. Likewise, Hassan et al. (2019) found that an optimal minimum-variance portfolio without reducing expected return can be achieved by investing in lower weights of BRIC Islamic indexes and oil compared to conventional indexes. Using the wavelet analysis to Islamic stock index and Energy and Precious Metal indices Khan and Masih (2021) investigated to reveal how they commoved in the period of the Global Financial crisis, which began in the USA as the Subprime mortgage crisis.

By employing the nonlinear ARDL approach (NARDL) approach Avazkhodjaev et al. (2022) have examined the asymmetric impact of renewable energy production and clean energy prices on the green economy in Asia, Europe, and the US. The authors' empirical results indicated that renewable energy production significant positive impact on green economy stock prices. Clean energy prices have a positive and negative significant impact on the green economy in selected economies. The short-run coefficients of clean energy stock prices have a significant positive effect on green economy stock prices. Finally, the negative shocks dominate positive shocks in renewable energy generation and clean energy, and results indicate that a positive and negative relationship was noted between these covariates and green economy stock prices. However, authors have had a gap in the study regarding how long short-run and long-run (positive and negative) effects continue in selected economies.

Moreover, Salari et al., (2021) have investigated the causal nexus between economic growth and energy consumption in the US. The authors applied four known hypotheses: Growth conservative, feedback, and neutral, differentiating between renewable and non-renewable energy consumption. Results for renewable energy, industrial energy, and residential energy consumption showed more support for the growth hypothesis. Their results have policy implications in terms of optimizing decisions and investments to efficiently improve economic growth while reducing energy consumption. More recently, Li et al., (2021) evaluated the renewable energy-economic growth nexus in seven European countries from 1985 through 2018. In the study, long-run causality is found to flow from all explanatory variables to renewable energy consumption. Short-run causality is also detected from the two fossil fuel prices to renewable energy consumption. The authors provide empirical support for the important role of economic growth and non-renewable energy prices in the renewable energy transition. Their findings showed that there is no evidence of Granger causality from renewable energy consumption to economic growth.

In addition, other empirical studies investigated the nexus between returns of energy and commodity market prices (Sadorsky,1999; Hammoudeh and Choi, 2007; Salisu and Oloko, 2015), while other researchers examined the influence of investor sentiment on energy and commodity markets (Wang et al., 2013; Aloui et al., 2018; Mamasobirov et al., 2023; Perez-Liston et al., 2016; Dash and Maitra, 2017; Hasanov and Avazkhodjaev, 2022; Shakhabiddinovich et al., 2022; Avazkhodjaev et. al., 2022).

This paper differs from other empirical research on this issue as most papers in this field study green energy investment on conventional and Islamic stock markets in selected markets. For our research objective, we make three key contributions. First, green investment, especially renewable energy investment, can help develop green energy industries and raise and circulate capital within the broader financial system. While, as mentioned above, some empirical studies have examined the relationship between energy and financial markets, there is a gap in research about the relationship between green investment, and conventional and Islamic stock markets in the US, UK, and EU countries. The study covers this gap by focusing on the renewable energy industry which has largely been ignored in prior research.

Secondly, we argue that analyses of the relationship between the variables in a nonlinear setting have at least two important reasons: (1) a time series can have hidden cointegration if positive and negative components of a series are cointegrated (Granger and Yoon, 2002) and (2) asymmetry is types of nonlinearities that affect the market dynamics, especially when the sample period is marked. To achieve these purposes, we employ the Nonlinear Autoregressive Distributed Lag (NARDL) approach proposed by Shin et al. (2014) which allows testing the long-run and short-run asymmetries. Moreover, unlike the standard cointegration techniques, this method permits time series to have different orders of integration (Shin et al., 2014). Thirdly, Indeed, when the time series are noted to have cointegration using their positive and negative components (Granger and Yoon, 2002), the case of nonlinear cointegration is implied. Finally, we apply the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) of the recursive residuals to test the robustness (Brown et. al, 1975). This type of analysis has the potential to support future policy recommendations.

The remainder of this paper is structured as follows. Section 2 presents a literature review. Section 3 describes the data and the descriptive statistics. Section 4 introduces the empirical methodology, including model specifications. In section 5, we report and analyze the empirical results and discussion. Finally, section 6 provides conclusions and policy implications.

2. LITERATURE REVIEW

The advancement of sustainable development goals such as energy transition and carbon neutralization requires the implementation of various environmental projects. Due to the problem of the lack of sufficient capital for governments to invest in green projects, this issue has been studied by many scholars in recent decades. Generally, investment in green projects has been drawn to attention by many earlier studies. Studying this issue is essential primarily due to the financial constraints in many countries.

Eyraud et al. (2013) expressed that the main determinants of green investments are carbon pricing schemes and capital accumulation in an economy. Doval and Negulescu (2014) highlighted the main challenges of increasing investment flows in green projects. They concluded that the absence of advantages prevents capital entry into these projects from the private and public sectors. Dutta et al. (2021) investigated the relationship between commodity market risk and green investment in India in another study. The results depicted the importance of oil and gold market risks on the volume of green investments. Employing the method of Markov-Switching Equilibrium Hassan et al. (2022) explored the positive impact of green investment on deteriorating greenhouse gas emissions. Furthermore, the major findings confirmed the significant impacts of economic policy uncertainty and GDP on investment flows in environmentally friendly projects. Le and Ferasso (2022) surveyed 556 respondents of managers and directors to find the impacts of green investment on sustainable business performance in an emerging economy. They revealed that green investment promotes green innovation and corporate social responsibilities in small and medium-sized enterprises.

Chan et al. (2022) studied the critical factors influencing green investment decision-making. The significant findings revealed that investment profit, guarantee, and financial motivational factors are among the most critical influencing elements to promote sustainable investment. Li et al. (2021) tried to find the linkages between green finance, risk, and sustainable investment in China from 2015 to 2020. The paper concluded that issued green bonds, and environmental tax are the two most influencing factors in enhancing sustainable investment. Moreover, the issuance of green bonds can have a positive impact on the long-term green efficiency of the tourism industry.

Bahloul and Khemakhem (2021) examined on the dynamic connectedness between returns and volatilities of commodities and

Islamic developed and emerging market indices using the Diebold and Yilmaz (2014) connectedness index based on the forecast error variance decomposition from vector autoregression (VAR) framework. They suggested that commodities indices exhibits the highest source of shocks to Islamic stock market whatever the period. Using a rolling-window procedure with, DCC, ADCC and GO-GARCH models Hachicha et al. (2021) examined the time-varying optimal hedging ratios for the Dow Jones Islamic and conventional emerging stock market indices, hedged with oil, gold, as well as four emerging-country sectoral CDS indices (raw materials, industry, health care, and telecommunications. Authors concluded CDS indices are the best hedging instruments for both Islamic and conventional portfolios, as they have the highest hedging effectiveness.

The positive impact of green financing tools on green investment has been confirmed by earlier studies like (Chen et al. 2021, Wang and Wang 2020); and Haseeb et al. (2013) expressed that a country needs to enhance trade openness, FDI inflows, and economic growth to motivate green investment. This way, the country can find a more robust financial system to attract capital from abroad and invest more in sustainable projects. Shang et al. (2023) found through empirical research that the most important success factors for achieving green economy recovery through electronic exhibitions are international cooperation, green culture, and visitor attitudes. Another study by Ref. Dutta et al. (2023) addressed the importance of climate policy uncertainty (CPU) on the volatility of green projects. The significant findings confirmed that countries need to find ways to decrease climate risks to make green projects more attractive to investors. Bei and Wang (2022) studied the characteristics of sustainable investment and found that economic growth, green finance, and economic stability accelerate the promotion of private investment in environmentally friendly projects.

Furthermore, Boubaker and Rezgui (2020) studied the common movement of three commodities (Oil, gas and gold) and the Dow Jones Islamic Market index (DJIM) using daily price observations. Using the Windowed Scalogram Difference (WSD), author's findings that that investors in Islamic stock market indices do not base their decisions on oil, gas or gold prices. Indeed, Mishra et al., (2020) analysed the association among the fluctuations in global crude oil prices and the Dow Jones Islamic Stock Index by employing daily data from January 1996 to April 2018. The authors found the positive influence starts decreasing and with the advent of stability in the time series of global crude oil prices, the negative effect becomes stronger. The analysis of the present study indicates that oil prices fluctuations may have a positive effect on Islamic stock index in short run, but on attaining stability, the oil prices exert a negative influence on the Islamic stock index.

Despite these studies, which have examined the relationship between green energy investment, Islamic stock, and commodity markets, this subject is still at an early stage of development under the current pandemic crisis. Keeping in view the lack of literature, especially on Islamic stock indices, this paper explores the long-run and short-run effects of green energy investment on stock markets using the Nonlinear ARDL-VECM model. Finally, we also studied whether asymmetric models perform better than symmetric models.

2.1. Theoretical Framework

Considering that there is no specific theory in the field of investment in green energy and projects, in this section, we informed some key concepts of investment in green growth and stock markets from the literature perspective. Investment volume in green energy depends on different factors. The first important factor is the size of a country's economy, which can affect the economy's investment. A larger economic size means more production, higher productivity, and the economic power of the government and the private sector to participate in various economic projects, such as environmentally friendly projects, which will be the factor in the development of renewable energy generation and consumption. Pal et al. (2022) declared that a larger GDP makes the investment climate more stable for investors. Hence the volume of investment in economic projects can surge consequently. Huawei (2022) expressed that economic power (GDP) is an influential factor in investment and private's participation realization in investing in economic projects. Another critical factor in financial development in a country can show the facilitation of green investment or the difficulty of green investment if the financial sector still needs to be developed. Abid et al., (2022) and Hung (2023) confirmed the positive impact of financial development on green investments. In addition, green finance as an efficient instrument can make green projects more attractive, leading to more participation from private investors. The profound role of green finance on sustainable investment has been supported by earlier studies like Tetti et al. (2022). Lastly, uncertainty impacts the volume of investments in green projects. Dutta (2022) addressed the importance of climate policy uncertainty (CPU) in developing sustainable energy projects.

3. DATA AND DESCRIPTIVE STATISTICS

We rely on the three most widely used stock indices in renewable energy investment to represent the conventional and Islamic stock markets. First, we use the World Renewable Energy Generation Index as a proxy for green energy investment. This index is a primary sector index of the Green Economy Index designed to track companies that produce energy through renewable sources such as solar, wind, geothermal, wave, and fuel cells. Second, we used the Dow Jones conventional and Islamic stock market indices for the U.S., UK, and EU. The daily sample periods for all variables end on August 1, 2023, and commence on January 1, 2022. We retrieve the data on these Islamic stock and conventional market indices from the www.investing.com and world Renewable Energy Generation index from the Nasdaq Global Index database. All data were expressed in US Dollar in order to have a homogeneous dataset.

The descriptive statistics for green energy investment, and conventional and Islamic stock market indices of the US, UK, and EU are shown in Table 1. The monthly series have structured as the first differences of the natural logarithm, where denotes REI – Renewable energy investment; CMEU – Conventional stock market EU; CMUK – Conventional stock market UK;

CMUS – Conventional stock market US; IMEU – Islamic stock market EU; IMUK – Islamic stock market UK; IMUS – Islamic stock market US, respectively. The entries in the table indicate that in every circumstance, the averages of the daily series are less than the standard deviations that have been computed for them. We compare the maximum and minimum values of green energy investment and find that the minimum and maximum values are comparable.

Furthermore, we found that the standard deviation of conventional markets is much lower than the standard deviation of the other selected series. Both the skewness and the kurtosis of the selected series are statistically significant. In sum, it seems as if the selected variables that were investigated exhibit conditional heteroskedasticity when considering the sample size that was taken into account for this paper.

Since the meaningful nonlinear framework requires the stationarity of all series under consideration, we first test for a unit root by employing the conventional augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests for the series that are being investigated. These tests are carried out to determine whether or not there is a unit root.

The findings are described in Table 2, and they imply that none of the variables under consideration is stationary in levels. However, when their first difference form is employed, which includes the intercept and trend, the variables do become stationary. It is important to note that when the variables are integrated in order one or more, denoted by the symbol I(I), the Nonlinear ARDL approach produces results that are comparable to those produced by the other cointegration procedures proposed by Fousekis et al., 2016. As a result, we are free to go on with the testing of cointegration inside a framework that is nonlinear. In sum, the tests reject the null hypothesis of the existence of unit root at one percent significance level, and thus the returns follow a stationary process regardless of whether a trend variable or/and incorporated in the model.

4. EMPIRICAL METHODOLOGY

We employ the nonlinear autoregressive distributed lag (NARDL) model to examine the long-run and short-run asymmetric effects of green energy investment on conventional and Islamic stock markets from US, UK and EU. The nonlinear ARDL (hereafter, NARDL) approach proposed by Shin et al. (2014) allows testing the long-run and short-run asymmetries. NARDL approach provides robust empirical results even for the small sample sizes (Siddiki and Ghatak 2001; Narayan and Narayan, 2007; Pesaran et.al, 2001) and can be applied regardless of the order of integration with the exception that the series is integrated with the maximum order of one. The order of integration can be verified using unit root tests. Indeed, when the time series are noted to have cointegration using their positive and negative components (Granger and Yoon, 2002), the case of nonlinear cointegration is implied. Finally, we apply the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) of the recursive residuals to test the robustness (Brown et. al, 1975).

4.1. Nonlinear Autoregressive Distributed Lag (NARDL) Model

The NARDL approach allows modelling asymmetric cointegration using positive and negative partial sum decompositions and detecting the asymmetric effects both in the short-and long-run. It also allows the joint analysis of the issues of non-stationarity and nonlinearity in the context of an unrestricted error correction model. The nonlinear cointegration regression (Shin et al., 2014) is specified as follows:

Table 1: Descriptive statistics for selected variables

Series	REI	CMEU	CMUK	CMUS	IMEU	IMUK	IMUS
Mean	8.1142	5.8543	5.3902	6.9153	8.4012	7.8523	9.0015
Maximum	8.2931	6.0306	6.1083	7.0808	8.6068	9.3870	9.2006
Minimum	7.9479	5.6222	5.1774	6.7764	8.1742	7.6334	8.8485
St. Deviation	0.0614	0.0902	0.0800	0.0651	0.0897	0.1060	0.0775
Skewness	0.2392	−0.5728	1.1232	0.2412	−0.4998	7.1548	0.2593
Kurtosis	3.0895	2.7609	18.107	2.3828	2.7606	109.18	2.1479
Jarque-Bera	8.1142	5.8543***	5.3902***	6.9153***	8.4012***	7.8523***	9.0015***

Here, REI, CMEU, CMUK, CMUS, IMEU, IMUK and IMUS represent log changes in renewable energy investment, conventional and Islamic stock markets, respectively

Table 2: Results of unit root tests

Variable	ADF		PP		KPSS	
	Level	1st Diff.	Level	1st Diff.	Level	1st Diff.
REI	−3.689**	−6.9459***	−3.635**	−16.704***	0.1558**	0.0321***
CMEU	−2.049**	−19.805***	−2.0614	−19.801***	0.5113***	0.0514***
CMUK	−2.146	−13.296***	−6.6547***	−19.673***	0.4634**	0.0681**
CMUS	−1.935	−19.086***	−1.9465	−19.086***	0.4920**	0.0199***
IMEU	−2.336	−19.479***	−2.3472	−19.473***	0.5165**	0.0550***
IMUK	−11.42***	−33.909***	−15.039***	−19.379***	0.4592***	0.1418*
IMUS	−1.953	−19.315***	−1.8598	−19.350***	0.5262**	0.0205***

***, **, * indicate 1%, 5% and 10% significance level, respectively. ADF, PP and KPSS are the empirical statistics of the Augmented Dickey–Fuller (1979), and the Phillips-Perron (1988) unit root tests, and the Kwiatkowski et al. (1992) stationarity test, respectively. The critical values of the KPSS unit root tests at 5% significance level are 0.463 and 0.146, respectively

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + \mu_t \quad (1)$$

were β^+ and β^- are long-term parameters of *kx1* vector of regressors x_t, decomposed as:

$$x_t = x_0 + x_t^+ + x_t^- \quad (2)$$

where x_t^+ and x_t^- are the partial sums of positive or negative changes in x_t as follows:

$$x_t^+ = \sum_{j=1}^{t} \Delta x_j^+ = \sum_{j=1}^{t} \max(\Delta x_j, 0) \quad (3)$$

$$x_t^- = \sum_{j=1}^{t} \Delta x_j^- = \sum_{j=1}^{t} \min(\Delta x_j, 0) \quad (4)$$

4.2. Nonlinear ARDL-Error Correction Model

The NARDL (p,q) from Eq.(2), in the form of an asymmetric error correction model (ECM) (Raza et al., 2016) can be presented as follows:

$$\Delta y_t = \rho y_{t-1} + \theta^+ x_{t-1}^+ + \theta^- x_{t-1}^- + \sum_{j=1}^{p-1} \varphi_j \Delta y_{t-j} + \sum_{j=0}^{p} (\pi_j^+ \Delta x_{t-j}^+ + \pi_j^- \Delta x_{j-t}^-) + \varepsilon_t \quad (5)$$

where $\theta^+ = -\rho\beta^+$ and $\theta^- = -\rho\beta^-$. In a nonlinear framework, the first two steps to ascertain cointegration between the variables are the same as in linear ARDL bound testing procedure i.e. estimation Eq. (5) using OLS and conduction of the joint null ($\rho = \theta^+ = \theta^- = 0$) hypothesis test of no asymmetric relationship. However, in NARDL, the Wald test is used to examine the long-run ($\theta^+ = \theta^-$) and short-run ($\pi^+ = \pi^-$) asymmetries in the relationship.

Finally, the asymmetric cumulative dynamic multiplier effects of a unit change in $x_t^+ \, and \, x_t^-$ on y_t can be calculated as follows:

$$v_h^+ = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{\partial x_t^+}, v_h^- = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{\partial x_t^-}, h = 0,1,2,\ldots. \quad (6)$$

whereas h = ∞, the $v_h^+ \to \beta^+$ and $v_h^- \to \beta^-$. A mentioned above β^+ and β^- are the asymmetric long-run coefficients and here can be examined as $\beta^+ = -\theta^+/\rho$ and $\beta^- = -\theta^-/\rho$, respectively.

5. EMPIRICAL RESULTS AND DISCUSSION

Throughout this section, the empirical results from model estimation will be exhaustively discussed. As mentioned in our introduction, our main objective is to examine asymmetric effects of green energy investment on stock markets: the case of U.S, Europe and UK conventional and Islamic stock markets. We employ Nonlinear ARDL model to examine long-run and short-run asymmetric effects green energy investment Islamic and conventional stock markets. For the NARDL method, we obtain the asymmetric cumulative dynamic multiplier effects of of selected variables under study, as well as the characteristics of symmetry or asymmetry in the short and long term. Finally, we apply the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) of the recursive residuals to test the robustness (Brown et. al, 1975).

After confirmation of cointegration among the variables, we proceed with the results of long-run and short-run asymmentric impact of green energy investment on conventional and Islamic stock markets. The results summarized in the following panel of Table 3 shows that green energy invesment siginicant positive impacts conventional stock markets of U.S and EU for long-run. However, green energy invesment insiginicant positive and negative effects on both conventional and Islamic stock markets in UK.

The short-run dynamics are reported in the lower panel of Table 4. Our findings summarized the short-run coefficients of renewable energy investment have a significant positive affect on Islamic stock markets for the selected U.S, UK and EU markets. Likewise,

Table 3: Long-run coefficient estimates of the NARDL-VECM model

Market	Variable	Coefficient	Probability
United States	LCMUS_POS	0.959060	0.0693
	LCMUS_NEG	2.261814	0.1752
	LIMUS_POS	0.265135	0.1891
	LIMUS_NEG	−1.606312	0.1542
United Kingdom	LCMUK_POS	2.195495	0.1512
	LCMUK_NEG	−0.484511	0.6787
	LIMUK_POS	−0.102494	0.9031
	LIMUK_NEG	−0.671920	0.3797
European Union	LCMEU_POS	2.808979	0.0421
	LCMEU_NEG	−1.460800	0.1544
	LIMEU_POS	1.039456	0.1297
	LIMEU_NEG	−0.769997	0.4089
	C	8.162677	0.0000

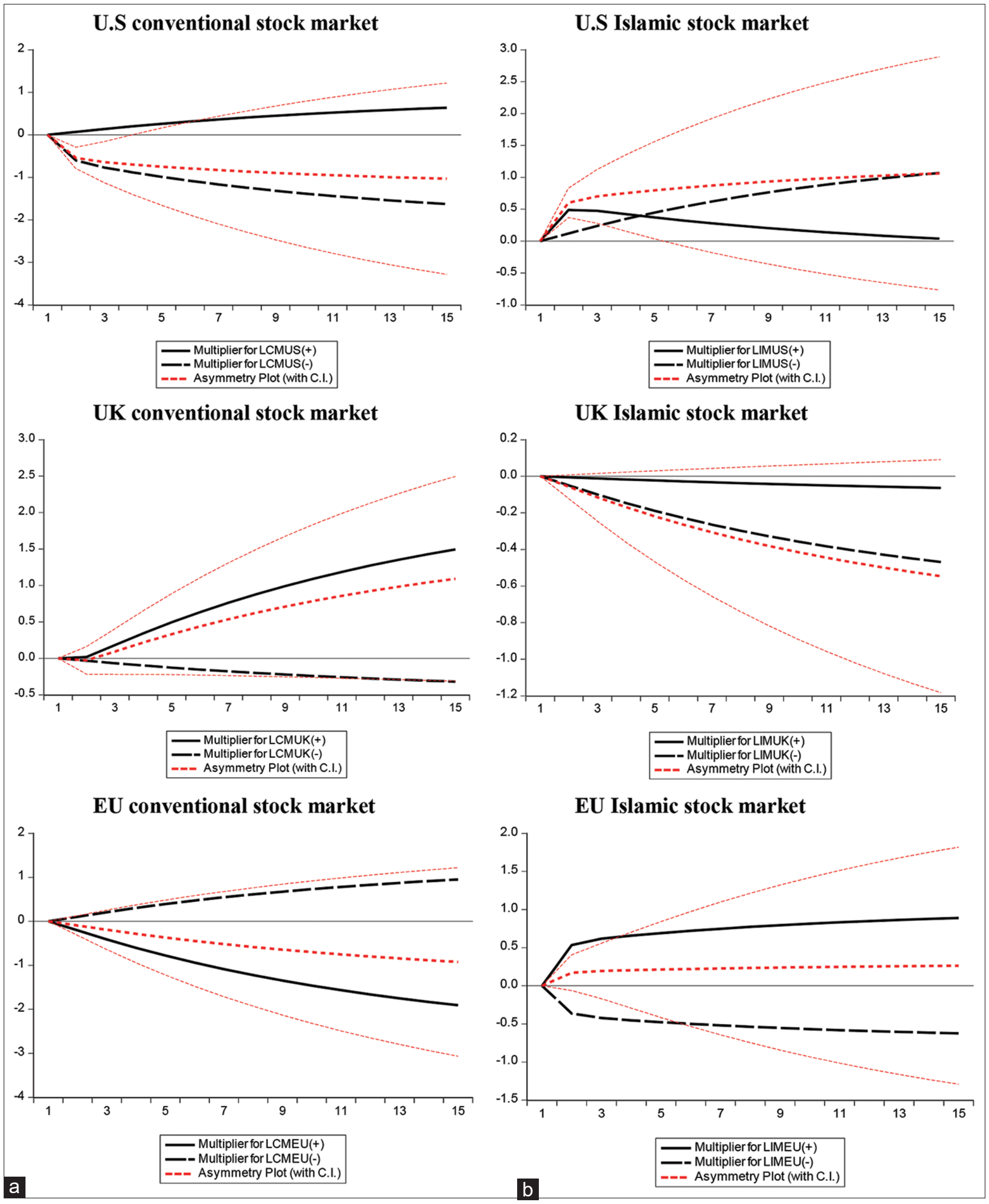
Here, Here, LCMEU, LCMUK, LCMUS, LIMEU, LIMUK and IMUS represent conventional and Islamic stock markets, respectively

Table 4: Short-run coefficient estimates of the NARDL-VECM model

Market	Variable	Coefficient	Probability
	C	**−0.000170**	**0.8155**
United States	DLIMUS_POS	0.524229	0.0974
	DLIMUS_NEG	–0.212911	0.4616
	DLCMUS_POS	0.011052	0.9751
	DLCMUS_NEG	0.704877	0.0294
United Kingdom	DLIMUK_POS	–0.066376	0.0453
	DLIMUK_NEG	0.051203	0.5573
	DLCMUK_POS	0.146617	0.0516
	DLCMUK_NEG	0.026325	0.8912
European Union	DLIMEU_POS	0.829956	0.0003
	DLIMEU_NEG	0.257719	0.1208
	DLCMEU_POS	–0.535534	0.0549
	DLCMEU_NEG	0.028858	0.8984
	ECT(–1)	–0.070676	0.0000

Here, Here, LCMEU, LCMUK, LCMUS, LIMEU, LIMUK and IMUS represent conventional and Islamic stock markets, respectively

Figure 2: (a and b)Multiple plots that are showing the cumulative effect of green energy investment on conventional and long-run and short-run asymmetries. Note: Blackline shows the positive and black(dotted)line is negative impact while red lines show asymmetry and confidence (upper and lower) bands



EU conventional stock market has a significat positive effects of short-run. Change in green energy investment have a negatively insignificant impacts on Islamic and conventional markets of E.U and UK. Indeed, short-run coeffficients of green energy investment negatively on U.S conventional stock market.

Furthermore, the dynamic asymmetric relationship between selected variables are further enriched by plotting the multipliers effects. These multipliers (Figure 2) show the cumulative effect of green energy investment on Islamic and conventional stock markets long-run and short-run asymmetries. The linear combinations of multiple plots corresponding to the positive (black line) and negative (dashed black line) changes are presented through asymmetry curves.

The overall long-run and short-run asymmetries in the positive and negative is presented through dashed red lines and corresponding upper and lower bounds of asymmetry (at 95% confidence level) are plotted using dotted red lines. The dynamic multipliers show that green energy investment (Figure 2) has a negative impact on the conventional stock markets of the US and EU in the short run. However, the UK conventional stock market has a positive effect in the short run. Likewise, green energy investment has positively significant effects on US and EU Islamic markets in the long run. The UK Islamic market has negative effects in the short-run, respectively. In sum, Figure 2 also approves nonlinearity and model parameters stability, which shows that the NARDL model is appropriate for selected varibales under study.

6. CONCLUSION AND POLICY RECOMMENDATION

In the wake of the global financial crisis and post-pandemic, the need has emerged for consideration of many facets of the existing financial system. Among other developments, this has also led to a renewal of interest in the Islamic capital market. In essence, Islamic capital markets attempt to provide financial products and instruments that are consistent with certain principles such as social responsibility, ethical and moral values, and sustainability. As mentioned above, some empirical studies have examined the influence of green energy investment on Islamic and conventional stock markets of the US, UK, and EU. There is a gap in research pertaining to the relationship between selected variables. The study covers this gap by focusing on renewable energy investments that have largely been ignored in prior research. The Nonlinear Autoregressive Distributed Lagged model (NARDL), which is suitable to examine long-run and short-run relationships between variables has been employed in this study to establish the asymmetric impact of renewable energy investment on conventional and Islamic stock markets.

Our empirical results confirmed a strong asymmetric co-integration relationship among selected variables under study. In conclusion, we summarized that the green energy investment adjustment is running towards the long- and short-run steady increment regarding positive and negative shocks in conventional and Islamic stock markets. These indicate the inequality effect of long- and short-term covariates on green investment in various lengths of time. What we understand about the shocks of the green energy investment on conventional stock markets in US and EU markets are positively asymmetric in the long run; the UK has an insignificant effect in the long run. Importantly, green energy investment positively has significant effects on conventional and Islamic stock markets in the US. UK and EU (except the conventional stock market of the US). The increase in green energy investment may result in an increase in the cost of energy generation, which reduces the renewable energy production firm's profitability and finally decreases the stock market prices in the short-run.

These findings have important implications for the portfolio diversification and hedging decisions of environmentally concerned investors. In fact, investors should consider the presence of extreme tail dependence between green investment and stock markets an important factor in making more informed and rational choices. From a managerial perspective, our results offer more knowledge about the factors that influence the performance of green energy companies. Thus, managers can make better business decisions with regard to investments, and the performance of the company can be enhanced. This study also supports policymakers in articulating policies that seek to avoid the contagion risk stemming from volatile asset classes. They should remain observant of the impact of extreme downside movements in equity and renewable energy, Islamic, and conventional stock markets and intervene when necessary to ensure financial stability.

We recommend that future research extend this study by using the VECM and the Cobb-Douglas production mechanism through the nonlinear ARDL models to examine policy thresholds and critical masses at which renewable energy investment could increase effects on green economic growth without negative effects on the environment.

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