

DID COVID-19 CHALLENGE THE VOLATILITY OF THE SUSTAINABLE STOCK MARKET? AN EXAMINATION OF ASIAN MARKET

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ABSTRACT

The coronavirus outbreak at the end of 2019 hit many aspects of the financial sector, especially the stock market. This research examines the impacts of the COVID-19 pandemic, exchange rates, gold price, and the Brent oil price on the volatility of the Sustainable Stock Market in Asia. A quantitative research method is applied using average monthly panel data from March 2020 to April 2022, covering the COVID-19 pandemic period. We employed panel regressions and applied Feasible Generalized Least Square (FGLS) in the analysis, which also serves as a robustness check. This study contributes to the literature by examining the variables significantly impacting sustainable investing, particularly in the sustainable stock market. Empirical results find that COVID-19, gold price and the exchange rate have negatively affected sustainable stock market volatility, while the Brent oil price has a positive impact on the volatility of the sustainable stock market. This study's recommendations infer that both investors and managers should consider the increase of COVID-19 cases and frequency-varying exchange rates to the USD on the Asian sustainable stock market volatility.

Keywords: sustainable stock market; COVID-19 pandemic; Feasible Generalized Least Square (FGLS); stock market volatility; Asian market

INTRODUCTION

Economic activities experienced a significant downturn during the COVID-19 outbreak. Many sectors were affected (Megits et al., 2020; Ismayilzade et al., 2021), including financial markets (Kristanti et al., 2022). The spread of the virus also harmed investors, causing rapid short time losses. Ever since the pandemic struck the global economy, it constantly has been in the news on both traditional and social media outlets around the globe. Given that stock investors may be highly sensitive to such news and information during times of stress, the abundance of news on the coronavirus may have impacted investor sentiment. Akhtaruzzaman et al. (2022) explored ESG investments during the pandemic. They found that the COVID-19 media coverage index (MCI) made ESG leader indices in developed and developing stock markets more volatile. Especially during a crisis, media has a greater impact on market returns than in normal times. This impact may become enormous when, as was the case for COVID-19, the crisis grows at an exponential rate. In addition, their study tried to figure out the net transmitters and net receivers of crisis-related information and concluded that the US was the most affected country. Dong et al. (2022) used the TVP-VAR technique and Quantile-on-Quantile Regression (QQR) to assess the influence of COVID-19 on volatility connectivity across global stock sectors. Using dynamic total connectedness analysis, they discovered a substantial increase in total connectedness across global equity sectors following the emergence of COVID-19. The empirical results of Quantile-on-Quantile Regression (QQR) showed the various features of the ten stock sectors' responses to the increasing severity levels of the COVID-19 epidemic.

Following the WHO declaration that COVID is a pandemic, global stock indices experienced a sharp decline. Even though the impacts of the shocks were only ephemeral, the coronavirus epidemic induced a large decrease in the skewness and total market price of risk. (Aslam et al., 2020; Cristofaro et al., 2021; Delis et al., 2021). The largest decreases occurred in March and April 2020. Ahmad et al. (2021) investigated the issue in the US, UK, and Europe stock markets. The influence of the coronavirus attack on the number of black swan, a concept used to describe unexpected and unpredictable events, events became obvious in March. Except for a

few sectors, investors had limited investment prospects in the US, UK, and Europe until the end of March 2020 owing to black swan events. The research additionally presented evidence of both panic purchasing and selling. Given the inherent characteristics of the pandemic, it is reasonable to anticipate enduring political, environmental, economic, and social (ESG) ramifications (Akhtaruzzaman et al., 2022; Pavlova and de Boyrie, 2022). Pavlova and de Boyrie (2022) examined whether sustainable investments performed better during the pandemic. By focusing on exchange-traded funds (ETFs), they discovered that higher sustainability ratings based on environmental, social, and governance (ESG) factors did not serve as a safeguard against financial losses during the crisis. However, these companies did not perform worse than the market. Small, medium, and large-sized stock returns were significantly and negatively affected by coronavirus fear in Australia. This consequently led to a return drift in the stock market (Naidu and Ranjeeni, 2021). The findings of previous studies would have benefited investors in comprehending the advantages of investment diversification as well as protection strategies in the light of changing stock market dynamics during the pandemic (Aloui et al., 2022; Aslam et al., 2020; Chkili et al., 2021; Song et al., 2021; Zaheer et al., 2022).

Sustainable investment research has been and continues to be very rare. To achieve the sustainable development goals, support for sustainable investment is necessary to build and develop each country's economy while also paying attention to the climate and social and economic growth. It is assumed that renewable investing will positively affect the planet's economy (Darsono et al., 2022; Tseng et al., 2019; Nguyen et al., 2020). Amidst the COVID-19 pandemic, a correction was observed in all financial sectors. Several studies have examined the effects of the COVID-19 pandemic on the sustainable stock market both during and following the pandemic, but there are few studies on this topic now (Broadstock et al., 2021; Demers et al., 2021; Pavlova and de Boyrie, 2022; Rubbaniy et al., 2021; Takahashi and Yamada, 2021). An early study by Ramelli and Wagner (2020) indicated that the primary drivers of stock market volatility are high levels of corporate debt and liquidity challenges, which aligns with prior scholarly investigations. Due to Shariah screening criteria, Islamic equities are

believed to be less vulnerable to market volatility than their conventional equivalents. Other research by Yarovaya et al. (2022) and Mirza et al. (2022) examined the extent to which Islamic equities funds have demonstrated resilience in the face of the COVID-19 pandemic. Recent research has indicated that Islamic funds exhibited greater resilience to the COVID-19 shock compared to their conventional counterparts, resulting in their outperformance during the peak months of the epidemic. The research does not make it obvious whether this result is related to the fund's investing strategy or whether it supports the idea that Islamic equities funds are a safe haven. Therefore, through an analysis of the correlation between COVID-19 cases and sustainable stock market prices across eight Asian nations, including China-Hongkong, India, Indonesia, Japan, Malaysia, the Republic of Korea, Singapore, and Thailand, our research addresses a notable void in contemporary scholarship. Using panel autoregressive distributed lag (ARDL), our empirical results demonstrate that the spread of COVID-19 and exchange rate volatility significantly affect sustainable stock market performance in both the short and long term.

This study makes a noteworthy contribution to the burgeoning body of academic literature concerning the performance of the stock market in the context of the COVID-19 pandemic. Initially, it makes a valuable contribution to the existing body of literature on the influence of non-economic variables by including infectious disease cases like COVID-19 as one of the independent variables. Second, this research adds to the literature on the stock market's responsiveness to COVID-19 for stock market performance by analyzing the Sustainable Stock Indices of eight Asian countries. Finally, this research evaluates the immediate and prolonged impacts of COVID-19 and the exchange rate for group and individual nations using PMG estimates in time-varying, heterogeneous market settings. The paper is structured in the following manner. The second section outlines the sources of data, the third section outlines the methodology employed in the research, and the fourth section presents the empirical findings and subsequent analysis. Final remarks and policy implications are presented in the fifth section.

LITERATURE REVIEW

Thorbecke (2021) examined sectoral stock returns in South Korea to determine the economic impact of the coronavirus outbreak, finding that industries which produced goods and required more highly trained employees saw a rise in their profits. However, service industries and the jobs they provided for people with lower levels of education and training were hit hard. This made things much more unequal in the country than they were before the epidemic. Li et al. (2021c) conducted a comprehensive analysis of the effects of the COVID-19 pandemic on the G20 stock markets from multiple perspectives. Moreover, they applied spatial econometrics techniques to examine the direct and indirect effects of COVID-19 on stock market volatility spillovers using the uniquely constructed "volatility spillover network matrix," thereby capturing the impact of COVID-19 on the volatility spillovers of G20 stock markets. The empirical evidence suggested that the response of stock markets was more pronounced to confirmed and recovered cases of COVID-19, as opposed to death tolls. During the outbreak of the pandemic, the rare earth index, a term shows a set of seventeen valuable metallic elements, exhibited tight dependency on the clean energy, oil index and global stock index, albeit it generally stays a return and volatility receiver throughout the duration (Song et al., 2021).

Few studies have studied the sector-level impact of the coronavirus outbreak, and the majority of these studies have focused on the US. Using endogenous structural break models and factor-augmented event research techniques, Ahmad et al. (2021) analyzed this problem for the US, UK, and European stock markets by finding crucial events. The researchers determined that the impact of the coronavirus outbreak on the frequency of black swan events is evident during the month of March. Moreover, until the end of March 2020, investors were presented with restricted investment alternatives in the United States, United Kingdom, and Europe, with only a handful of industries being an exception. Specifically, they discovered that certain equities in basic needs goods, healthcare, information technology, public utilities, and financial sectors garnered the most priority. The response to the epidemic differed across various industries in the sampled nations. The impacts of the COVID-19 outbreak

and the accompanying imbalance on the risk market price were examined using an equilibrium risk and return model by Delis et al. (2021). The study involved the formulation of moment and equilibrium equations, wherein the skewness price of risk was identified as an additive factor that affects the relationship between variance and expected return. The results indicated that the COVID-19 pandemic caused a profoundly negative response in the skewness and overall risk market price. The COVID-19 crisis exhibited a significantly greater degree of negativity when compared to both the subprime crisis and the October 1987 crisis.

Further, research conducted by Anh and Gan (2020) on the Vietnam stock market verified the adverse influence of the daily escalation of COVID-19 cases on the returns of the stock market. Their research revealed that the Vietnam stock index behaved differently before and during the national shutdown. The COVID-19 pandemic had a significant impact on Vietnam's stock market, with the pre-lockdown phase resulting in a notable decline in stock returns. However, the subsequent lockdown period had a positive effect on overall market performance and various business sectors in Vietnam. The COVID-19 outbreak had a significant impact on the financial industry within the Vietnam stock market. Sharma et al. (2021) examined the temporal and spectral correlation among the count of confirmed COVID-19 cases, climate, foreign exchange rates, and stock market performance in the 15 countries that were most adversely affected by the COVID-19 outbreak. They utilized Wavelet Coherence to investigate the unforeseen pandemic outbreak impacts on temperature, currency rates, and stock market returns. Their findings indicated a cyclical relationship between climate and COVID-19 cases, indicating the climate daily, on average, had a substantial influence on the transmission of COVID-19 in the majority of nations.

Mroua and Trabelsi (2020) explored both the dynamic and causal relationships between currency exchange rates and equity indices. The objective was to ascertain the immediate and prolonged impacts of the US dollar on the primary stock market indices of the BRICS countries, namely Brazil, Russia, India, China, and South Africa. They utilized a new technique that combined the panel GMM model (generalized method of moments) and the panel ARDL

technique (auto-regressive distributed lag). The results demonstrated that currency exchange rate fluctuations had a substantial impact on the historical and current volatility levels of the BRICS equity indexes. Furthermore, based on the panel autoregressive distributed lag (ARDL) estimates, it could be inferred that the fluctuations in currency rates had a significant effect on the immediate and future equity indices of all the BRICS countries. Applying the Ensemble Empirical Mode Decomposition technique, Ijasa et al. (2021) discovered how exchange rates could influence the REITs market. Applying quantile regression, Archer et al. (2022) revealed a significant connection between exchange rates and other variables like gold, cocoa, and oil prices in Ghana. Using the Granger causality in the quantile test and the multiple asymmetric threshold nonlinear ARDL model, Maydybura et al. (2022) investigated the impact of Economic Policy Uncertainty (EPU) on exchange rates in the Emerging Seven (E7) countries. Applying EGARCH modelling, Van Der Westhuizen et al. (2022) found that the stock market had influences on both the price and volatility of the foreign exchange market. Applying the heterogeneous autoregressive realized variance model, Shiba et al. (2022) found that the infectious diseases-related uncertainty index can be used in predicting foreign exchange realized volatility. Employing a quasi-out-of-sample forecasting experiment, Pierdzioch et al. (2022) discovered that the exchange rate possessed a predictive capacity for the subsequent realized volatility. Using the copula-based GARCH model, Tang et al. (2017) observed that the fluctuation of China's inbound tourism demand was not significantly influenced by the volatility of the exchange rate. Employing the GMM estimator and quantile regression, Nguyen et al. (2021) found that exchange rate volatility harms trade openness.

Boateng et al. (2021) conducted a study utilizing quantile regressions to examine the correlation between the oil-implied volatility index and stock returns in African nations that were significant importers and exporters of oil during the COVID-19 pandemic. According to their research, it was suggested that shocks in oil implied volatility could potentially have an asymmetric impact on equities in Africa. The empirical evidence indicated that optimistic shocks in the oil-implied volatility index had a noteworthy impact on the majority of Africa's

capital markets during market slumps. Conversely, adverse shocks appeared to have had a moderate impact on some of Africa's stock markets during mild market conditions in the context of the pandemic.

DATA AND METHODOLOGY

Data

This research collected data from several databases. The sample of sustainable stock market performance data was filtered in accordance with the United Nations Sustainable Stock Exchanges Initiatives (SSE Initiatives, 2010). Panel data for daily stock market returns from March 2020 to April 2022 was used for 8 Asian countries that have Sustainable Stock Indices, such as China – Shanghai (SSECGI), India (NIFTY100 ESG), Indonesia (JKSRI), Japan (JPXNK400), Malaysia (FTF4GBM), Republic of Korea (KRX ESG 150), Singapore (iEdge SG ESG), Thailand (SETTHSI). Data on COVID-19 daily active cases was obtained from John Hopkins University database for 8 Asian countries that were included in this research sample for the same period. The daily exchange rates for 8 Asian countries' currencies to US Dollar were used in this study. The commodities prices as control variables included in this study were the daily Brent oil prices and gold prices. All the stock market data, exchange rates, and commodities prices were collected from Bloomberg. Further, the average daily data of all variables were transformed to monthly data.

The preceding figure presents a time series plot that combines data from the individual COVID-19 average monthly active cases with the movement of the prices of the sustainable stock markets in eight Asian nations over the research period.

Figure 1 demonstrates the fluctuations of the Asian sustainable stock market price movement and COVID-19 active cases for each nation. A declining trend in the China-Shanghai Sustainable Stock Index may be seen from March 2021 to March 2022. This is in contrast to the majority of other nations, where the trend is rising. This decline may be the result of an increase in COVID-19 cases and a global economic recession. The war between Russia and Ukraine also might have affected the uncertainty of economic policy. The monthly active cases of COVID-19 was volatile in some countries such as India, Indonesia, Japan, Malaysia, Singapore, and Thailand from Quartile 1 of 2021 until Quartile 1 of 2022.

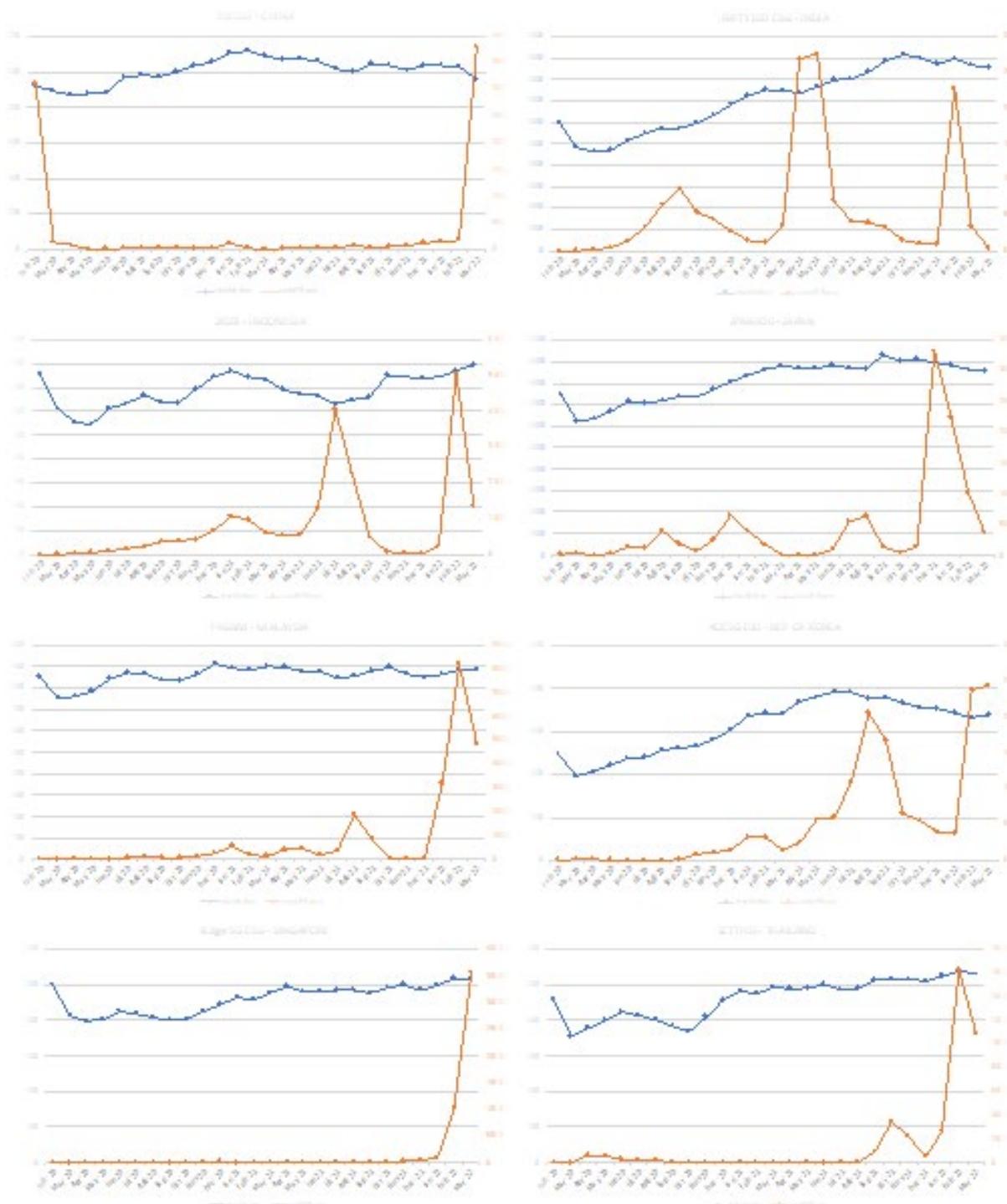


Figure 1. Sustainable Stock Market Prices and COVID-19 Active Cases for 8 Asian Nations

Source: author's work.

Research Method

The present investigation utilized a quantitative research methodology and procures secondary data from diverse databases. In panel data, the proper methods are the FEM (Fixed Effect Model) and REM (Random Effect Model).

The FGLS technique (Feasible Generalized Least Square) was used in case of model defects, including heteroscedasticity and autocorrelation. According to Gujarati et al. (2017), the FEM does not ignore the effects of individuals followed by the Equation 1:

$$Y_{it} = \alpha_i + \beta_1 X_{1it} + \beta_2 X_{2it} \dots + \beta_k X_{kit} + \mu_{it} \quad (1)$$

where $\mu_{it} = \alpha_i + u_{it}$ with i and t shows individual and time, respectively, α_i represents unobserved factors that differ between individuals but do not change over time (identifiable), and u_{it} represents unobservable factors that vary between individuals and change over time. Meanwhile, REM is shown by the Equation 2:

$$Y_{it} = \alpha_i + \beta_1 X_{1it} + \beta_2 X_{2it} \dots + \beta_k X_{kit} + \mu_{it} \quad (2)$$

Substituting α_i as a constant, we treated it as a random variable with a mean of $\bar{\alpha}$. Thus, α_i can be rewritten by $\alpha_{it} = \alpha + \varepsilon_i$ with i from 1 to n . ε_i is a random error term with mean 0 and variance σ^2_{ε} . Thus, Equation 1 is written as:

$$Y_{it} = \alpha_i + \beta_1 X_{1it} + \beta_2 X_{2it} \dots + \beta_k X_{kit} + \mu_{it} = \alpha + \beta_1 X_{1it} + \beta_2 X_{2it} \dots + \beta_k X_{kit} + W_{it} \quad (3)$$

where $W_{it} = \varepsilon_i + \mu_{it}$ in which ε_i is the individual or cross-error components, and μ_{it} the combined time series and cross-error components. Both FEM and REM were tested by the Hausman test to find the fit model. The Hausman test is conducted under H_0 : There is no relationship between the individuals' error terms and the regressors. If the Hausman test's H_0 is rejected, the FEM is the fit model; otherwise, REM is a fit model. Then, the Breusch and Pagan Lagrangian multiplier tests the cross-sectional independence in the residuals. If the Breusch and Pagan Lagrangian test's H_0 is rejected, the REM model has heteroskedasticity.

Next, when performing tests such as heteroskedasticity and autocorrelation, if there is any problem, the FGLS method is applied to handle it. Basically, the FGLS approach does not require the value of the correlation coefficient ρ . Instead, an estimate of ρ is used. The autocorrelation coefficient, denoted as r , represents the correlation between the sample estimates of the residuals e_1, e_2, \dots, e_{n-1} and e_2, e_3, \dots, e_n . Since $E[e_i] = 0$, it follows that

$$r = \frac{\sum_{i=2}^n e_i e_{i-1}}{\sqrt{\sum_{i=1}^{n-1} e_i^2} \sqrt{\sum_{i=2}^n e_i^2}} \quad (4)$$

In the context of autocorrelation, a slightly modified definition will be utilized:

$$r = \frac{\sum_{i=2}^n e_i e_{i-1}}{\sqrt{\sum_{i=1}^{n-1} e_i^2} \sqrt{\sum_{i=2}^n e_i^2}} = \frac{\sum_{i=2}^n e_i e_{i-1}}{\sum_{i=1}^n e_i^2} \quad (5)$$

It is worth noting that the Durbin-Watson coefficient has the potential to be represented as:

$$d = \frac{\sum_{i=2}^n (e_i - e_{i-1})^2}{\sum_{i=1}^n e_i^2} = \frac{\sum_{i=2}^n (e_i^2 + e_{i-1}^2 - 2e_i e_{i-1})}{\sum_{i=1}^n e_i^2} \approx \frac{2\sum_{i=1}^n e_i^2 - 2\sum_{i=2}^n e_i e_{i-1}}{\sum_{i=1}^n e_i^2} \quad (6)$$

and $d \approx 2(1 - r)$. Therefore, the estimation of ρ can be approximated as $r \approx 1 - d/2$.

Research Model

This research employed panel data for eight Asian countries from the daily sustainability indices, the total daily active cases of COVID-19, the exchange rates of the country's currency to USD, and commodities prices as control variables such as the global price of gold and the price of Brent oil from March 2020 to April 2022. The general model of this paper is presented by the following Equation 7:

$$SSMI_{it} = \alpha_i + \beta_1 COVID19_{it} + \beta_2 EXRATES_{2it} + \beta_3 GOLD_{3it} + \beta_4 BOIL_{4it} + \mu_{it} \quad (7)$$

where μ_{it} is a monthly fluctuation of the average of Sustainable Stock Indices of country i at t time, as calculated by $\mu_{it} = Y_{it} - \alpha_i - \beta_1 COVID19_{it} - \beta_2 EXRATES_{2it} - \beta_3 GOLD_{3it} - \beta_4 BOIL_{4it}$. Also, σ_{it} is the monthly volatility of the average of COVID-19 cases of country i at t time, and it is measured by $\sigma_{it} = \sqrt{\frac{1}{n} \sum_{i=1}^n (e_i - \bar{e})^2}$. Meanwhile, $\Delta EXRATES_{it}$ is the monthly change of the average of the exchange rate of country i at t time, measured by $\Delta EXRATES_{it} = EXRATES_{it} - EXRATES_{i,t-1}$. $GOLD_{it}$ and $BOIL_{it}$ are monthly fluctuations of the average of Brent oil prices and gold prices of country i at t time, they are also calculated by $GOLD_{it} = GOLD_{it} - GOLD_{i,t-1}$ and $BOIL_{it} = BOIL_{it} - BOIL_{i,t-1}$, respectively.

EMPIRICAL ANALYSIS AND DISCUSSION

Summary Statistics

Table 1 presents a summary of data pertaining to the mean daily prices of environmentally responsible stock markets across eight distinct countries. Every country saw a good monthly average price from the Sustainable Stock Market Index. All Sustainable Stock Market Index series are negatively skewed, and all are platykurtic, except for Malaysia.

Table 1. Statistics of sustainable stock indices in 8 Asian countries

Index	Country	No.	Min	Max	Mean	Std. Dev	Skew.	Kurt.
SSECGI	China	25	869.42	1115.62	1003.42	70.7	-0.57	-0.46
NIFTY100ESG	India	25	9215.39	18311.6	14223.48	2993.74	-0.27	-1.31
JKSRI	Indonesia	25	273.4	397.519	343.34	34.1	-0.34	-0.75
JPNK400	Japan	25	12409.5	18611.7	16175.64	1823.21	-0.66	-0.85
F4GBM	Malaysia	25	752.84	913.218	859.62	39.73	-1.48	2.10
KOESG150	Rep of Korea	25	986.904	1968.09	1563.46	312.37	-0.43	-1.25
iEdge SG ESG	Singapore	25	793.93	1033.45	918.08	79.28	-0.35	-1.43
SETTHSI	Thailand	25	707.46	1078.14	921.67	111.95	-0.50	-1.11
Total Obs		200						

Source: author's work.

Table 2 presents a summary of statistics of daily active cases of COVID-19 for the eight nations. The COVID-19 monthly average active case frequency was found to be highest in Singapore, with 355,012 cases a month. The

lowest average monthly active case of COVID-19 was in India, with 0.071 cases in a month and a standard deviation of 78,489.35. All the daily case data exhibit positive skewness and leptokurtosis.

Table 2. Summary Statistics of COVID-19 daily active cases

Country	No.	Min	Max	Mean	Std. Deviation	Skewness	Kurtosis
China - Hongkong	25	18.63	3780.33	324.03	922.92	3.423	10.752
India	25	0.071	275571	544483.21	78489.35	2.212	3.941
Indonesia	25	48.63	50645.8	8415.31	12485.5	2.498	6.149
Japan	25	27.53	33121.8	4276.39	7515.48	3.005	9.435
Malaysia	25	8.35	82164.3	8493.38	18743.71	3.093	9.969
Rep of Korea	25	0.78	24490	5457.99	7530.03	1.671	1.699
Singapore	25	26.71	355012	18683.02	71412.38	4.580	21.730
Thailand	25	2.857	16237.4	1511.28	3737.02	3.299	10.915
Total Obs	200						

Source: author's work.

The summary statistics of independent variables, such as the exchange rate of the national currency to USD and the worldwide prices of gold and Brent oil, are presented in Tables 3 and 4 below. The exchange rate of the Singapore Dollar to the US Dollar had the biggest value, with the mean value being 0.735 and the maximum being 0.759, revealing that the Singapore Dollar had a stronger exchange rate

against the US Dollar than the other countries in the study. In contrast, the Indonesian Rupiah was the weakest currency against the US Dollar, with the mean value being 0.00006. The price of a barrel of Brent Oil (BOIL) increased dramatically from its low of USD 19.990 to its high of USD 127.980 and the highest price per troy ounce of gold was 2054.6 US dollars.

Table 3. Summary of local currency to USD exchange rates

Currency	N	Min	Max	Mean
CNY/USD	25	0.139	0.158	0.151
INR/USD	25	0.012	0.013	0.013
IDR/USD	25	0,00006	0,00007	0,00006
JPY/USD	25	0.0077	0.0097	0.0091
MYR/USD	25	0.224	0.249	0.238
KRW/USD	25	0.0007	0.0009	0.0008
SGD/USD	25	0.684	0.759	0.735
THB/USD	25	0.028	0.033	0.031
Total Obs	200			

Source: author's work.

Table 4. Summary of Gold and Brent Oil Prices

Commodity	N	Min	Max	Mean	Std. Deviation	Skewness	Kurtosis
GOLD	25	1477.900	2054.600	1827.747	96.988	-.514	.746
BOIL	25	19.990	127.980	61.545	21.602	.467	.014

Source: author's work.

Empirical results

Table 5 displays the findings of the Pooled OLS, Fixed Effect Model (FEM), and Random Effects Model (REM) for analyzing the impact of COVID-19 cases, currency rates, gold, and Brent oil prices on the sustainable stock market in the Asian

Region across the eight nations. Among these three methods, all of the variables significantly affected the sustainable stock market. COVID-19, gold prices and exchange rates had a negative effect on the Asian sustainable stock market, with a significance level at 5% and 1%.

Table 5. Panel data regression results

Variables	Pooled OLS	FEM	REM
	Coefficient	Coefficient	Coefficient
COVID19	- 0.0001811*** (0.00006)	- 0.000204*** (0.00006)	-0.000181*** (0.00006)
EXRATES	- 0.831372*** (0.19028)	- 0.874149*** (0.19196)	- 0.83137*** (0.19028)
GOLD	- 0.113069*** (0.03946)	- 0.104249** (0.04149)	-0.113069*** (0.03946)
BOIL	0.163025*** (0.021623)	0.160647*** (0.02169)	0.163026*** (0.022162)
Cons	0.003108 (0.00311)	- 0.003209 (0.00309)	0.003108 (0.00307)
Wald Chi-square (F-statistics)	31.88***	32.79***	127.50***
Prob > F	0.0000	0.0000	0.0000
Observations	199	199	199
Groups	8	8	8
R-squared	0.3966	0.3960	0.3966

Note: () is denoted as standard error and ***, **, and * are denoted as significant levels at 1%, 5%, and 10%, respectively.

Source: author's work.

At the same time, Brent oil prices had a positive and significant effect at a 1% significance level.

The overall r-square of Pooled OLS, FEM, and REM were 0.3966, 0.3960, and 0.3966, with the Wald

chi-square 31.88, 32.79, and 127.50, respectively, at a 1% significance level. As a result, we discovered that all independent factors had a considerable impact on the returns of the Sustainable Stock Indices. The findings presented herein are in alignment with the outcomes reported by Dong et al. (2022), Li et al. (2021a), Li and Meng (2022), and Tetteh et al. (2022), who found that historical returns had a significant impact on current returns.

The chi-square value of 6.20 and the associated p-value of 0.184 as presented in Table 6, were obtained from the Hausman test results. The findings suggest that the Random Effect Model (REM) is the optimal model for characterizing the impact of COVID-19, exchange rates, gold, and Brent oil prices on sustainable stock returns. Furthermore, the Breusch and Pagan Lagrange Multiplier test was utilized to examine the presence of heteroscedasticity in the Random Effects Model (REM).

Table 6. Hausman Test Result

Variables	FEM	REM	Difference	Standard Error
COVID19	- 0.00020	- 0.00018	- 0.00002	0.00001
EXRATES	- 0.87415	- 0.83137	- 0.04278	0.02528
GOLD	- 0.10425	- 1.11307	0.00882	0.01280
BOIL	0.16065	0.16303	- 0.00238	0.00166
	Test	Ho: difference in coefficients not systematic		
		Chi-square:	6.20	
		Prob>chi-square:	0.1845	

Source: author's work.

Table 7. Breusch and Pagan Lagrangian Test Results (Correlation matrix of residuals)

	__e1	__e2	__e3	__e4	__e5	__e6	__e7	__e8
__e1	1							
__e2	0.487	1						
__e3	0.163	0.458	1					
__e4	0.231	0.303	-0.150	1				
__e5	0.321	0.268	0.286	0.216	1			
__e6	0.232	0.301	-0.189	0.513	0.007	1		
__e7	-0.071	0.004	0.259	0.048	0.282	0.023	1	
__e8	0.438	0.288	0.099	0.485	0.633	0.424	0.457	1
chi2 (28)					68.416			
Prob > chibar2					0.0000			

Note: Based on 24 complete observations over panel units

Source: author's work.

Table 7 displays the outcomes indicating that the p-value is less than 0.01, specifically 0.00. This result signifies the rejection of the null hypothesis of homoscedasticity; the model exhibited heteroscedasticity. In order to ensure the reliability of the results, the study utilized the feasible generalized least square (FGLS) method to examine the influence of COVID-19, exchange rates, gold, and Brent oil prices on sustainable

stock market returns in eight Asian nations. Table 8 displays the outcomes of the Random Effects obtained from the GLS Robust Model and FGLS Model. Both REM GLS robust model and FGLS results found consistent results with the panel data regressions. COVID-19, gold prices and exchange rates all had negative and significant effects on the Asian sustainable stock market with 5% and 1% significance levels, while Brent

oil prices had positive influences at 5% and 1% significance levels, respectively.

Table 8. Feasible Generalized Least Square (FGLS) Model Results

Variables	Random effects (REM) with robustness	FGLS with autocorrelations and covariances
	Coeff	Coeff
COVID19	- 0.000181*** (0.00003)	- 0.000160*** (0.00005)
EXRATES	- 0.831372*** (0.22852)	- 0.923631*** (0.19764)
GOLD	- 0.113069** (0.04728)	-0.098137** (0.04464)
BOIL	0.163026*** (0.02585)	0.161029*** (0.0921)
Cons	0.00311 (0.00277)	- 0.002130 (0.00270)
Wald Chi-square (F-statistics)	314.12***	159.83***
Prob > F	0.0000	0.0000
Observations	199	191
Groups	8	8
R-squared	0.3966	-

Note: () is denoted as standard error ; ***, **, and * denotes significant levels at 1%, 5%, and 10%, respectively

Source: author's work.

Discussion

The COVID-19 pandemic has badly affected global supply networks and consumer markets, but the national responses to containment measures and the rapid development of prevention vaccines have sparked optimism. Jabeen et al. (2022) anticipated a significant increase and rapid improvement in the performance of global stock markets since April 2020. Similarly, Anh and Gan (2020) discovered a positive correlation between the number of COVID cases and the profit margins of firms listed on the Vietnamese stock index, demonstrating the level of optimism among investors. As a result of their experience with prior pandemics, investors appeared to be optimistic about the immediate response options (restrictions on movement, border lockdown, and free vaccinations) of Asian governments.

The FGLS model results indicate that the volatility of the Asian sustainable stock market was negatively impacted by the COVID-19 cases in the Asian region, with a significance level of 1%. This finding is related to Li et al. (2021b), who found a significant correlation between the

number of confirmed COVID-19 cases and the response of the stock market. The escalation of COVID-19 cases in the Asian region resulted in a detrimental effect on the volatility of the stock market. The business sector and financial services were impacted by the uncertainty policy owing to the rise of COVID-19 cases, lockdown effects, and travel restrictions (Lilis et al., 2022). Further, it brought a domino effect to capital market investors who feared the uncertain market conditions during the pandemic. These conditions showed that the negative trends of the Asian sustainable stock market might have attracted long-term investors to buy sustainable stocks. Thus, the increasing trading volume in sustainable stocks affected the increase of returns in the short term. This finding is related to research by Pavlova and de Boyrie (2022), who found that sustainable investment with high sustainability ratings of ESG did not prevent loss during the pandemic, but the sustainable investment did not fare worse than the market.

However, the increase of COVID-19 active cases caused a decrease in Asian sustainable stock market volatility. Several of the causes that

are listed below may help to explain this phenomenon. First, the restrictions of mass activity, including in factories, caused a slowdown of business activity which raised unemployment. Second, unemployment caused a decrease in purchasing power which affected cash turnover. Third, a decrease in the cash turnover ratio of listed firms in Asian sustainable stock exchanges and uncertainty of COVID-19 policy in the early stage caused investors to hold their investments. This is in line with the results obtained by Aslam et al. (2020), Cristofaro et al. (2021), Delis et al. (2021), and Zaheer et al. (2022), who found a significant drop in stock market prices due to the COVID-19 outbreak. This phenomenon is also associated with Thorbecke (2021), who found that companies with higher skilled workers and produce goods benefited from the pandemic crisis. At the same time, the services sectors employed lower-skilled labor and suffered prior to the outbreak. Additionally, compared with the results of the previous studies focusing on stock market performance and the COVID-19 crisis period, our results support the view that the performance of sustainable stock markets was affected strongly by the COVID-19 crisis (Naeem et al. (2023); Au Yong and Laing, 2021; Díaz et al., 2022; Insaïdoo et al., 2021; Li et al., 2021c; Li and Meng, 2022; Rubbaniy et al., 2021; Zaheer et al., 2022).

The growth of the Asian economy before the COVID-19 pandemic, supported by exports and imports in the industrial and agricultural sectors, caused higher transactions with foreign countries. Since COVID-19 hit the Asian economy, the exchange rate had a negative effect on the Asian sustainable stock market volatility at a 5% significance level. This corroborates the finding of Mroua & Trabelsi (2020), who concluded that the exchange rate had a negative impact on the returns of Indian equity. Changes in the previous day's local currency/USD exchange rate had a negative impact on current stock market returns in eight Asian nations. The negative exchange rate coefficient reveals that the appreciation of eight Asian currencies boosted the value of their Sustainable Stock Indices. It should be mentioned that the appreciation (or depreciation) of each country's native currency versus the USD caused the increase (or fall) in Asian sustainable stock market performance. These results corroborate with the research from Mroua and Trabelsi (2020) and Sharma et al. (2021), who revealed

that the exchange rate had a significant effect on current and past volatility of stock indices.

The FGLS estimation found that the price of Brent oil had a substantial positive influence on the price volatility of the sustainable stock market in the Asian region at the 1% significance level. These results corroborate with the research from Chkili et al. (2021) and Kumar et al. (2022), who found significant correlations between oil prices and stock market returns. The significant effect of Brent oil prices on stock market returns infer that oil is still an important commodity for Asian society, and so the rise or fall in global prices of oil significantly affects the bearish or bullish stock market. Based on the FGLS estimation, the gold price had a negative and significant effect on the volatility of Asian Sustainable Stock Market Indices, indicating that an increment in the gold price decreased the performance of the sustainable stock market index in the eight Asian countries studied. These results are in line with Ghorbel and Jeribi (2021), who confirmed that gold is a safe haven investment during the pandemic of COVID-19, so a shift in investment channels from stock to gold is inevitable.

CONCLUSION

This research investigated both the short- and long-term impacts of COVID-19 average monthly active cases and the exchange rates of local currency to USD and also investigated the impact of commodities prices such as gold and Brent oil on the sustainable stock markets of 8 Asian countries. To achieve the purpose of this study, daily data were collected for the span of time beginning in March 2020 and ending in March 2022, and the panel data regressions with pooled OLS, Fixed Effect Model, and Random Effects Model were applied in the analysis. Furthermore, the random effects from both the GLS robust model and the FGLS model were added to address potential issues that could have arisen during the analysis, thereby serving as a means of ensuring robustness.

This article makes a contribution to the literature, as the analysis was conducted on the variables that greatly influence sustainable investment, notably in the sustainable stock market. Using infectious illness cases like COVID-19, this study contributes further to the current knowledge by considering the influence of non-economic factors. By examining the Sustainable

Stock Indices of 8 Asian countries, this article adds to the existing research on how stock markets reacted to COVID-19. The research findings indicate that the performance of sustainable stock markets in Asia was adversely affected by the COVID-19 pandemic, as evidenced by a statistically significant decrease. In addition, Asian sustainable stock market performance was also affected negatively by the local currency's USD conversion rate and gold price. Further, the performance of the Asia sustainable stocks market was positively and significantly impacted by the Brent oil price. Oil is one of the most in-demand commodities, and its price has been proven to have a negative influence on the returns of environmentally responsible equities traded on Asian markets.

In light of our research findings, this article offers important implications for legislators, investment managers, and investors who are concerned with social and environmental responsibility investment. First, Asian sustainable stock market performance was greatly impacted by active COVID-19 active; the increase in COVID-19 active cases resulted in getting lower returns in Asian sustainable stock markets. On the other hand, the impact of COVID-19 in the short run was not homogeneous across the individual stock market returns in the eight Asian nations investigated in this study. Investment managers and investors have the goal of achieving profits and excess returns from their investments. Nevertheless, they also are concerned with the level of risk that is associated with such investments since high returns are always associated with high levels of risk. Prior to providing suggestions or making any inferences pertaining to the establishment of a sustainable investment portfolio, investment managers are obligated to consistently monitor the daily incidence of COVID-19 cases in Asian nations. This is necessary in order to reduce the likelihood of adverse outcomes.

Sustainable stock markets in nations with lower cases of COVID-19 might be an attractive option for investors who are looking to optimize returns. Additionally, to achieve substantial returns, investment managers and investors ought to take notice of the fluctuation of exchange rates, global gold prices and the price of Brent oil. Hence, in order to entice investors towards sustainable investing, it is imperative that all corporations enlisted in a Sustainable

Stock Market Index possess the ability to mitigate health crisis risks, exhibit exceptional sustainability performance, and provide satisfactory returns to investors. The findings presented in our paper hold potential significance for policymakers in their deliberations concerning the ramifications of the health crisis on sustainable investment. Therefore, the government should establish a plan that minimizes ambiguity when dealing with COVID-19 or other pandemics. The alignment of policies can potentially mitigate the adverse effects of a health emergency on the financial sector, economy, and broader society. Despite the widespread distribution of vaccines across the globe, there remains a sense of uncertainty regarding the conclusion of the COVID-19 pandemic, even after two years since its onset. A coherent approach to economic recovery and healthcare policy would foster investor confidence, thereby promoting sustainable investment from both individual and institutional investors.

There are various drawbacks to this study. For example, it examines the impacts on the returns of sustainable stock indices without taking both uncertainties and turbulence into consideration. This approach, however, limits the variables considered to only one degree of linkage and has not taken a higher number of long-run correlations into consideration. Finally, despite our best efforts, the number of nations and datasets included in this analysis is restricted due to the accessible data. Thus, future research could further study the impacts on returns of a sustainable stock market by including both uncertainties and turbulence, examine the issue through the utilization of models that facilitate a greater quantity of enduring connections, and conduct an investigation utilizing a dataset containing relevant information with a longer time horizon. Further study could also investigate all possible implications of different types of health crises on different forms of sustainable investment.

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