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-RESEARCH ARTICLE-

ASSOCIATION BETWEEN POST-COVID SOCIO-ECONOMIC DEVELOPMENT AND ENERGY-GROWTH- ENVIRONMENT NEXUS FROM DEVELOPING ECONOMY

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─Abstract─

The purpose of the present study is to evaluate the relationship between socio-economic development and environmental degradation. The analysis spans the years 1990 to 2018. Long-term causality of CO2 emissions is observed, but a short-term basis exists between feedback variables. The results demonstrated a favorable association between the selected constructs. In addition, Variance decomposition analysis results revealed that GDP contributed 3% to 14% to future CO2 emissions fluctuations; energy consumption was 3% to 14%; renewable energy use ranged from 1% to 3.4%; the proportion of tourism ranged from 4.2% to 10%; and the proportions of receiving improved water, sanitation, and electricity were 33.3%, 1.12%, and 2.01%, respectively. In addition, the research concludes with substantial policy implications for sustainable development that would assist practitioners in enhancing sustainable growth.

Keywords: Economic Development; Sustainability; Econometric estimation; Green finance.

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1. INTRODUCTION

Since the final part of the twentieth century, economic development has been recognized as a factor in the move toward sustainable growth (Baloch et al., 2022; Chien, Ngo, et al., 2021). According to this philosophy, for nations to achieve sustainability, society, the environment, and the economy must be balanced. It is argued that to comprehend sustainable development, the relationship between socio-economic development and environmental pressure must be analyzed seriously (Goodell et al., 2020; Zhao et al., 2021). Regional differences in socio-economic development and ecological indicators necessitate an understanding of the relationship between environmental degradation and the concept of emerging economies. The rationale is that as time passes, the threat in developing economies becomes more severe (Al-Awadhi et al., 2020; Zhang et al., 2020). The coronavirus (Covid-19) has impacted the globe and raised questions about our way of life like the previous global pandemic. The situation with Covid-19 in developing nations such as Vietnam is also highly concerning. Vietnam's economic growth has also been affected by the protracted pandemic scenario. With the aid of effective pandemic management, the nation has demonstrated extraordinary efforts despite the catastrophe.

This circumstance has inspired us to envision a better world. Better resilience will necessitate governments, particularly in affluent nations, to adhere to the deficit over the next several years, commit to full employment, and address insecure working conditions. This will result in the continuation of the macroeconomic growth policy, which is well-balanced between its financial components, given that it assists the private sector in regaining its spending reliance. Significant improvements in public investment will be required, with diverse programs, including job guarantees and public works programs, employed to supplement integrated efforts (Chien, Sadiq, et al., 2021). In addition, methods for predicting the future of low-carbon technologies should be supplied (Rowan et al., 2020; Tan et al., 2022). Governments can now move on to rehabilitation and reconstruction phases, as they have abandoned the measures necessary to maintain order during the pandemic. Establishing product growth is a problem for nations at all stages of development, necessitating various industrial and inventive policies and joint ventures. Including climate change in the natural designs of these procedures requires some modification. A sustainable trading system must also be a system with a high level of management (Ainou et al., 2022; Chien, Sadiq, et al., 2021).

Developing nations demand an increase in their international support and financial capabilities. Reducing corporate tax evasion and other illegal cash flows can assist in securing financial stability and addressing the problem of inequality (Ainou et al., 2022; Chien, Hsu, et al., 2022). Long-term funding of the necessary investment for a sustainable future, however, will necessitate the expansion of public finance choices. On a worldwide scale, this entails expanding the lending capacities of various development banks. Existing shareholders who shift subsidies to the environment may provide these

additional loans. For instance, Marshall's global health rehabilitation program offers a committed and democratic foundation for future resilience (Huang et al., 2021b; Wu et al., 2021). Lastly, a worldwide credit bureau (organizational or private) debtor or debtor's interest should be acknowledged to assist the complete debt restructuring systematically, eliminating numerous deficiencies in the current administration of massive debt restructuring and, if necessary, debt cancellation. This debt has been underlined by the current situation, including the development of disability and the complexity of existing processes, the overwhelming influence of lenders who have delayed reconstruction, and the slowness of problem-solving decisions (Baker et al., 2020; Brown et al., 2020).

The existing body of literature has heavily questioned the selection of technique to evaluate the energy-growth-environment relationship. As environmental and socio-economic development indicators were endogenously assimilated by Basri et al. (2018), it is essential to have a suitable methodology and data producing reliable results. According to researchers, panel estimate strategies were ineffective at minimizing cross-sectional reliance and heterogeneity issues caused by forecasting mistakes (Ehsanullah et al., 2021; Kamarudin, 2021). Considering the rationale, country-level analysis using time series data appears to be the most appropriate method for avoiding biased results. Fully Modified Ordinary Least Square (FMOLS) was chosen as the "non-parametric regression technique" to "control endogeneity, serial correlation, and for consistent results" in the current study (Othman et al., 2020; Sadiq et al., 2021; Sadiq, Nonthapot, et al., 2022). In addition, the Canonical Cointegration Regression model was used, with the premise that data manipulation did not affect cointegration and that the correlation between error term and repressor has asymptotically efficient estimators (Albulescu, 2021; Arouna et al., 2020).

Vietnam is a developing nation with a large population, and primarily a large economy to support the increased population's basic demands (Godil et al., 2020; Z. Liu et al., 2021). According to 2019 data, the number of carbon emissions in Vietnam was 328,180 million tons. From 1970 to 2019, the number of carbon emissions in Vietnam increased from 11,629 to 328,180 million tons (Ali et al., 2021; Lan et al., 2022). Following Covid-19, the situation deteriorated. Therefore, there is a need to focus on this negative issue to save the country's ecosystem. This issue is addressed by examining methods to reduce carbon emissions and safeguard the environment in emerging nations such as Vietnam. This study investigates the effects of energy, renewable energy, the proportion of tourists to exports, GDP per capita, and improved water, sanitation, and power on carbon emissions and environmental protection. This research serves as a roadmap for all developing nations that have experienced the Covid-19 epidemic and CO2 emissions (Z. Liu et al., 2021).

This study contributes in a variety of ways. First, it assesses the long-term dynamics of Vietnam's socio-economic development concerning environmental deterioration.

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Although Vietnam has a survey based on single-panel data, it was unsuccessful because it could not perform in-depth local research. The current study will be exceptional since it will be undertaken exclusively in Vietnam, providing a standard for other economies to investigate how economic development impacts the natural environment (Li et al., 2021; Li et al., 2022). As a result, this study will aid in formulating plans to accomplish the 2030 Agenda for Sustainable Development of the United Nations. Second, it will provide advice for implementing social and economic development methods that safeguard the well-being of future generations.

The paper is structured as follows. In the first section, a thorough introduction is presented that explains the purpose of the study. The following excerpt is represented by the material that came before it. The third section is devoted to methodology, detailing techniques and procedures. The following section explains the study's findings and its limitations and implications.

2. LITERATURE REVIEW

2.1 Covid-19 and Sustainable Green Finance

By harming the health of living organisms, the Covid-19 pandemic has impacted the environment, society, and economy (Ali et al., 2021; Shair et al., 2021). Using green finance to invest in green initiatives such as renewable energy consumption, geographical enhancement for tourism development, raising per capita GDP, and enhancing the availability of high-quality water, sanitation, and electricity can, however, mitigate the adverse effects (Xiang et al., 2021; Zhuang et al., 2021). By August, the Vietnamese government had steadily reduced lockdowns over the summer, relaxed most restrictions, and reopened companies. Nonetheless, social distancing regulations and the requirement to wear masks in public remained.

According to the reports, Vietnam's ecological system and natural resources are in jeopardy due to its rapid industrialization and population growth. This is because the country's economic structure has switched from agriculture-related issues to industry-related services. Thus, maintaining sustainable development is more of a problem for Vietnam, particularly in climate change mitigation. Recent pandemic conditions have also compelled Vietnam to change its economic structuren (Ashraf, 2020; Chien, Ngo, et al., 2021; Huang et al., 2022; Zhang et al., 2020). Initially, after ignoring the outbreak (until February 21st, 2020), stock markets reacted strongly to the rising number of sick persons in every country (until February 21st, 2020). (February 23rd to March 20th, 2020). As the dangers mounted, so did the volatility. Obviously, after the involvement of central banks (March 23rd to April 20th, 2020), stockholders did not react negatively to the news of a health emergency, and prices increased globally. Second, country-specific variables appear to have had the most negligible impact on the stock market's response. Stock markets are not at high risk during epidemics due to structural economic

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weakness (such as indebted countries) or familiarity with transmission vectors (e.g., countries with a single risk population). Thirdly, affluent investors in neighboring countries were sensitive to Covid-19 problems. Nonetheless, the dynamics of the stock market during the Covid-19 pandemic are not wholly coincidental (Corbet et al., 2021; Goodell et al., 2020; Green et al., 2020). Specifically, our study revealed that pre-crisis nations did not have a situation in which health issues and economic policies enacted after the crisis were designed to aid businesses. On the other hand, fundamental principles explained a tiny portion of stock market fluctuations. As asserted by Goodell and Huynh (2020), it is impossible to refute the existence of a correlation between stock prices and fundamentals.

The Covid-19 outbreak has chiefly impacted the health system's capacity to continue providing vital health services. It is crucial for youngsters, the elderly, and others with chronic diseases to seek preventative therapies, despite the rising demand for Covid-19 care challenging the global healthcare system. Nonetheless, these programs must be maintained for individuals, minorities, and the disabled. Therefore, nations must balance combatting the Covid-19 outbreak and repairing essential health services (Chien, Zhang, et al., 2022; Z. Liu, Yin, T., SURYA PUTRA, A. R., & Sadiq, M, 2022). The World Health Organization coordinates activities across multiple disciplines and agencies to support these operations nationwide and preserve access to safe, high-quality essential health facilities. Numerous European nations have declared recovery plans and procedures for various industries, including those with green, climate, and sustainability focus.

2.2 Reopening the Economy

In addition to the many Covid-19 variations, it is anticipated that default investments in a global recession, renewables, environmental protection, mitigation, energy conservation, and green initiatives will decline. In addition, prices for fossil fuels have plummeted due to the substantial reduction in economic activity caused by the pandemic. These occurrences have hindered the growth of renewable energy projects and diminished the competitiveness of solar, wind, and other renewable sources (He et al., 2020; Moslehpour et al., 2022). Therefore, this poses a unique challenge to the successful implementation of the Paris Agreement and its climate change objectives (Sadiq, Alajlani, et al., 2022; Sadiq, Amayri, et al., 2022). To prevent the detrimental consequences of infectious diseases, it may be necessary to implement innovative and novel green financing strategies. These solutions may include fiscal and monetary policy reforms, green infrastructure projects, regionally or internationally taxable carbon emissions, green finance innovations, and rules (and strategies) to smooth out green financing challenges. Some facilitate the issuance of green bonds by establishing a set of standards for green credit ratings, targeting energy subsidies (including the reduction of direct and indirect subsidies on fossil fuels), and introducing public de-risking tools

to reduce the risks associated with green investments (e.g., presenting the Green Credit Guarantee Scheme) (Moslehpour et al., 2022).

When Europe contracted epidemic infections for the first time between March and April of 2020, very little was known about the epidemic's nature, and the potential scenarios' results were exceedingly unpredictable. As in a "war fog," the initial policy response was based on past experiences with similar diseases, without the benefit of knowing that could have led to more effective solutions. As the first wave of epidemics began to wane, governments realized the impact of the pandemic and the public health response, and countries began to open. Using high-frequency data on power usage, the current study shows the effect of different reopening routes, their times, and reopening speeds on economic activity. As this essay was published at the beginning of 2020, a new epidemic wave broke out in the region, compelling nations to impose another round of sanctions (Basri et al., 2018; Hakimi et al., 2019). Despite the recent introduction of vaccines and innovative therapies, the virus poses a grave threat to public health. In the second half of March 2020, the experience of reopening after the initial wave of infectious diseases can provide valuable insight into how to improve the procedure.

However, early summer 2020 reopening policies did not adhere to a unified script, as governments reinstituted various paths. Figure 1 depicts the 25th and 75th percentiles of a median value and the strength index of countries in Europe and Central Asia to illustrate this point. The severity index reflects countries' response to the epidemiological policy. The score ranges from 0 (no limitations on daily activities) to 100 (entire country lockdown) (Moslehpour et al., 2022). The difference between 25% and 75% occurred on the 11th and 12th of April 2020, when over 90% of countries adopted a complete lockdown. By mid-June 2020, this disparity will have doubled, with some nations still adhering to tight social separation measures while others have abolished prohibitions on the vast majority of activities. Some countries opened more in the fall, while others evaluated reopening standards in light of the second wave of Covid-19 concerns (Gharib et al., 2020; He et al., 2020).

For economic revitalization, COVID-19 sectors are essential. They are necessary because they enable government entities to reform their policies, strengthening the economy. It is argued that services are crucial since they boost the economy's efficiency and productivity (Sadiq, Amayri, et al., 2022). Services generate two-thirds of a country's GDP at the international level. In addition, they are responsible for more than half of worldwide employment and a quarter of global exports. Moreover, services account for two-thirds of the GDP growth rate of rising economies (Anjam et al., 2020; Lacap, 2021; N. Naseem, Masron, T., Hafizi, A., & Kamaluddin, F, 2020). The industry is beneficial since it contributes to increased returns, employment opportunities, trade opportunities, and food security. For countries to recover from a pandemic, surveillance is a crucial component of their recovery strategies (Corbet et al., 2021; Folger-Laronde et al., 2022; Sherif, 2020).

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3. METHODOLOGY

This study utilized CO2 emissions as a substitute measure of environmental pollution and GDP as a substitute measure of economic growth. It has been observed that, due to technical progress and modern usage, worldwide energy consumption has been rising.

Under the assumption of program sustainability, empirical investigations by Al-Mulali et al. (2018), Huang et al. (2021b), and Huang et al. (2021a) included multiple explanatory factors for GDP assessment and greenhouse gas emissions. In addition, the analysis incorporated and examined the two hypotheses listed below: (1) The relationship between environmental deterioration and growth (inverted U shape) is defined by the EKC hypothesis, and (2) Grossman et al. (1991), building on the work of Kuznets, provided a three-stage explanation of the relationship between environmental quality and growth. The writers explored how the depletion of natural resources has led to environmental degradation. Moreover, according to a study by H. I. Hussain et al. (2021) and Xiang et al. (2021), countries that strive for the highest economic growth in the first stage have considerably degraded their environment.

Beyond this initial phase, the economy's primary objective is to achieve sustainable economic growth and prosperity through technological innovation (based on clean environmental technology) and formulating ecological regulations to reduce CO2 emissions (H. I. Hussain, Kot, S., Kamarudin, F., & Wong, C. M, 2020). After achieving the highest level of per capita income, the economy wants to transition from demanding environmental conditions to a clean environment to ensure sustainable economic growth. Diverse decision-makers and academics in economics use the EKC theoretical analytic methodologies for income, pollution, and other fundamental variables in the square function of GDP. This study employed the sustainability paradigm in Equation 1 to investigate the relationship between economic growth and environmental pollution (Grossman & Krueger, 1991). The following econometric models utilized the econometric framework's theoretical structure:

$$Y_{it} = \alpha_0 + \beta_1 X_{it} + \mu_{it} \quad \textbf{(1)}$$

This study also included other explanatory variables when evaluating the link between CO_2 emissions and economic growth in the EKC hypothesis. Among them are CE and GDP. EN, REN, TOU, SAAN, WAT, and EL represent CO_2 emissions, whereas GDP, energy consumption, renewable energy, tourism, sanitation, water, and electricity. CO_{2it} represents the level of CO_2 emissions (per capita) (environmental pollution), while Y_{it} represents GDP (per capita), income (economic growth) and other influential macroeconomic variables. This study has developed the equation using the understudy variables as follows.

$$CE_{it} = \alpha_0 + \beta_1 GDP_{it} + \beta_2 EN_{it} + \beta_3 REN_{it} + \beta_4 TOU_{it} + \beta_5 SAN_{it} + \beta_5 WAT_{it} + \beta_5 EL_{it} + \mu_{it} \quad \textbf{(2)}$$

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In addition, the current study has used the Augmented Dickey-Fuller Test (ADF) and Phillips–Perron test (PP). The equation is as follows:

$$d(Y_t) = \alpha_0 + \beta t + \Upsilon Y_{t-1} + d(Y_t(-1)) + \varepsilon_t \quad \textbf{(3)}$$

The stationarity has been evaluated individually for each construct, and the equations for each constructs stationarity checking are as follows:

$$d(CE_t) = \alpha_0 + \beta t + \Upsilon CE_{t-1} + d(CE_t(-1)) + \varepsilon_t \quad \textbf{(4)}$$

$$d(GDP_t) = \alpha_0 + \beta t + GDP_{t-1} + d(GDP_t(-1)) + \varepsilon_t \quad \textbf{(5)}$$

$$d(EN_t) = \alpha_0 + \beta t + \Upsilon EN_{t-1} + d(EN_t(-1)) + \varepsilon_t \quad \textbf{(6)}$$

$$d(REN_t) = \alpha_0 + \beta t + \Upsilon REN_{t-1} + d(REN_t(-1)) + \varepsilon_t \quad \textbf{(7)}$$

$$d(TOU_t) = \alpha_0 + \beta t + \Upsilon TOU_{t-1} + d(TOU_t(-1)) + \varepsilon_t \quad \textbf{(8)}$$

$$d(SAN_t) = \alpha_0 + \beta t + \Upsilon SAN_{t-1} + d(SAN_t(-1)) + \varepsilon_t \quad \textbf{(9)}$$

$$d(WAT_t) = \alpha_0 + \beta t + \Upsilon WAT_{t-1} + d(WAT_t(-1)) + \varepsilon_t \quad \textbf{(10)}$$

$$d(EL_t) = \alpha_0 + \beta t + \Upsilon EL_{t-1} + d(EL_t(-1)) + \varepsilon_t \quad \textbf{(11)}$$

In addition, the current study has adopted the error correction model (ECM) because all the variables are stationary at the first difference and "error term stationary at the level." The equation for ECM is given below:

$$\Delta Y_t = \acute{\alpha}_0 + \beta_1 \Delta X_t + \beta_2 \Delta X_t + \beta_3 \Delta X_t + \beta_4 \Delta X_t + \Upsilon ECT_{t-1}\, \varepsilon_t \quad \textbf{(12)}$$

4. RESULTS AND DISCUSSION

According to the World Development Index (S Saha, 2012), this study's data cycle was based on the S Saha (2012), which covered the period from 1990 to 2015. Table 2 provides a descriptive summary of the investigation. The most excellent CO2 average per capita was recorded in 2007 with 0.99 metric tons, while the lowest was recorded in 1991 with 0.62 metric tons. The most significant GDP was in 2010 at 921.25, and the lowest was in 1990 and 2015. The average per capita consumption of EN was lowest in 1991 and highest in 2007. In 2007, renewable energy accounted for only 6% of total energy consumption, a decline of 6% from 1991 when it accounted for 58.09% and 49.7%. During the years 1991-2015, the proportion of exports derived from tourism decreased. The percentage of individuals with access to essential requirements such as clean water is 88.895%, followed by 79% for electricity. Unfortunately, the average result for sanitation is less than 50%. In the form of skewness, kurtosis, and Jarque-Bera statistics, Table 1 comprehensively analyzes descriptive data normality. Normal data may be deduced from the values, which is a positive indicator.

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4. 1 Unit Root Test Result

The results of the unit root test are shown in Table 2. All results rejected the plateau in instance 1, proving that the unit-roots of all constructions are significant between 1% and 4%. Nonetheless, these tests demonstrate that the research variables were stationary at the first difference, indicating that the integration order looks 1.

4. 2 Cointegration Test Result

Table 2 displays the results of the cointegration test conducted by Johansen. The empirical results of Johansen's cointegration test are listed in Table 2. Granger causality and long-term adaptability necessitate cointegration. It provides two metrics, including monitoring statistics and maximum characteristic value data. The null hypothesis demonstrated the absence of a cointegration connection. Hence it should be rejected for selected variables. In this study, both tracking and maximum eigenvalue tests revealed that Vietnam had a cointegration connection. A cointegration relationship was found between these variables, and Granger causation can be explored.

4. 3 Granger Causality Analysis

Table 2 examines the VECM results, illustrating the short- and long-term causal link between study components. Negative and substantial ECM coefficients are required to determine the long-term causation between a specific variable and other variables. The Granger causality test was conducted where electrical condition, access to improved water, and sanitation were employed as control variables.

In all models, CO2 long-term causality was observed. The results showed that the constructs had a causal association with carbon dioxide in the long run. The third case also discussed the long-term cause of renewable energy consumption.

Based on the results on a short-term basis, a hypothesis was formulated between the following:

(1) CO_2 and GDP (models 1 and 2)

(2) TOU and REW energy (all)

(3) TOU and WAT (model 1)

(4) TOU and SAN (case 1)

(5) TOU and EL (model 2).

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Table 1. Descriptive Statistics

Descriptive Indicators	**Variables**					**Control Variables**		
	CE	**GDP**	**EN**	**REN**	**TOU**	**SAN**	**WAT**	**EL**
Unit	metric tons per capita	constant 1010 US$ per capita	oil per capita (kg)	% of total EN	% of total exports	% of population		
Mean	0.21	3311.14	354.34	333.30	3.20	31.55	22.334	333.03
Median	0.20	255.333	353.12	333.31	3.30	31.30	233.00	333.11
Maximum	0.3333	1130.11	412.35	42.033	5.22	52.40	331.30	3333.14
Minimum	0.51	331.20	2333.13	32.334	2.11	12.30	25.20	42.33
Std. Dev.	0.11	113.13	23.333	2.335	1.11	12.15	1.42	11.22
Skewness	-0.12	0.15	-0.31	0.51	-0.11	0.033	-0.02	-0.05
Kurtosis	1.53	1.45	1.11	1.24	1.51	1.30	1.21	1.32
Jarque-Bera	1.00	1.43	1.31	1.04	1.15	1.25	1.43	1.53
Probability	0.23	0.12	0.333	0.25	0.23	0.233	0.35	0.33

Table 2. Unit Test Results

Constructs		**Case 1: At level [intercept and trend]**			**Case 1: 1st difference [intercept only]**			**Case 2: 1st difference [intercept and trend]**			**Integration Order**
		ADF	DF GLS	PP	ADF	DF GLS	PP	ADF	DF GLS	PP	
lnCE		-2.110	-1.104	-0.33333	-4.102*	-3.432*	-4.120*	-4.3303*	-4.3233*	-4.211*	I(1)
lnGDP		-2.2331***	-1.4334	-1.221	-2.230**	-2.1330*	-2.054**	-2.321***	-2.401**	-2.010	I(1)
lnEN		-0.2334	-1.0331	-0.2334	-2.330*	-2.323*	-2.330*	-3.33333*	-3.321*	-3.3332*	I(1)
lnREN		-1.153	-1.2233	-1.020	-3.2233*	-3.553*	-3.2233*	-4.530*	-4.352*	-4.315*	I(1)
lnTOU		-2.1533	-2.1334***	-2.03333	-3.252*	-3.324*	-3.314*	-3.1233*	-3.502*	-3.412*	I(1)
lnSAN		-0.325	-1.111	-1.1233	-1.314***	-1.2233**	-1.333***	-2.534**	-2.1033***	-4.235*	I(1)
lnWAT		-0.313	-0.3330	1.1331	-2.402**	-2.404*	-2.402**	-4.052*	-4.103*	-4.342*	I(1)
lnEL		-1.221	-1.434	-1.1533	-33.102*	-2.3335*	-2.430*	-10.232*	-10.313*	-10.553*	I(1)
Critical values	*1%*	*-3.352*	*-2.330*	*-3.233*	*-2.322*	*-1.554*	*-2.322*	*-3.2333*	*-2.330*	*-3.2333*	---
	4%	*-2.534*	*-2.1330*	*-2.502*	*-1.33331*	*-1.3345*	*-1.33331*	*-2.511*	*-2.1330*	*-2.511*	
	10%	*-2.151*	*-1.2330*	*-2.122*	*-1.525*	*-1.5033*	*-1.525*	*-2.132*	*-1.2330*	*-2.132*	

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Table 3. Johansen Cointegration Test

Hypothesis	Eigenvalues	Trace		Max-Eigenvalues	
		Statistics	p-values	Statistics	p-values
H_0	**access to improved water access (Model 1)**				
None*	0.3315	141.111	334.343	0.000	0.111
At most 1*	0.202	331.3315	533.2133	0.000	0.111
At most 1*	0.302	41.3332	33.245	0.014	0.202
At most 2	0.343	12.314	133.3333	0.115	0.302
At most 3	0.111	2.332	14.3334	0.225	0.343
At most 4	0.111	2.0332	2.231	0.0333	0.331
H_0	**access to improved sanitation (Model 1)**				
None*	0.3333	121.224	334.343	0.000	0.000
At most 1*	0.334	330.525	533.2133	0.001	0.232
At most 1*	0.533	43.251	33.245	0.010	0.334
At most 2	0.401	13.3344	133.3333	0.020	0.401
At most 3	0.232	11.114	14.3334	0.1332	0.533
At most 4	0.000	0.002	2.231	0.3320	0.633
H_0	**access to electricity (Model 2)**				
None*	0.3310	143.123	334.343	0.000	0.031
At most 1*	0.224	335.132	533.2133	0.000	0.103
At most 1*	0.3133	41.3343	33.245	0.014	0.224
At most 2	0.333	11.521	133.3333	0.210	0.313
At most 3	0.1033	3.312	14.3334	0.420	0.331
At most 4	0.031	1.3332	2.231	0.120	0.333

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Table 4. VECM Granger F-test Results

Constructs	**Case 1**						
	ΔlnCE	**ΔlnGDP**	**ΔlnEN**	**ΔlnREN**	**ΔlnTOU**	**ΔlnWAT**	**ECM**
ΔlnCE		5.01** (0.0333)	13.033* (0.001)	4.333*** (0.041)	3.51*** (0.03333)	0.22 (0.534)	-0.225* (0.010)
ΔlnGDP	3.51*** (0.03333)		0.21 (0.242)	0.34 (0.3333)	3.02** (0.020)	12.30* (0.001)	-0.010 (0.315)
ΔlnEN	0.22 (0.534)	3.21*** (0.0331)		3.333 (0.130)	10.54* (0.004)	13.033* (0.001)	-0.1331 (0.530)
ΔlnREN	0.15 (0.232)	1.33 (0.320)	1.10 (0.222)		2.31** (0.012)	15.31* (0.001)	-0.505 (0.231)
ΔlnTOU	1.31 (0.20)	0.45 (0.345)	0.233 (0.213)	5.3332** (0.021)		11.2333* (0.001)	-0.052 (0.534)
ΔlnWAT	0.33 (0.5331)	1.53 (0.153)	0.302 (0.215)	12.11 (0.001)	13.01* (0.001)		0.005 (0.413)
Variables	**Case 1**						
	ΔlnCE	**ΔlnGDP**	**ΔlnEN**	**ΔlnREN**	**ΔlnTOU**	**ΔlnSAN**	**ECM**
ΔlnCE		2.42** (0.013)	10.12* (0.005)	1.224 (0.412)	1.331 (0.122)	2.22 (0.124)	-0.343** (0.012)
ΔlnGDP	2.22 (0.124)		0.03 (0.3354)	0.02 (0.3322)	3.03** (0.0133)	2.42** (0.013)	-0.003 (0.33233)
ΔlnEN	0.43 (0.354)	1.32 (0.310)		0.13 (0.232)	5.45** (0.022)	33.333* (0.0033)	-0.415 (0.3332)
ΔlnREN	0.12 (0.3323)	1.00 (0.505)	0.02 (0.3325)		5.32** (0.0233)	11.31* (0.002)	-0.122 (0.333)
ΔlnTOU	1.41 (0.3533)	0.25 (0.223)	0.34 (0.3332)	3.00** (0.020)		33.13* (0.010)	-0.131 (0.434)
ΔlnSAN	11.05* (0.003)	133.33* (0.001)	1.33 (0.325)	21.01* (0.001)	11.50* (0.002)		-0.012 (0.113)
Variables	**Case 2**						
	ΔlnCE	**ΔlnGDP**	**ΔlnEN**	**ΔlnREN**	**ΔlnTOU**	**ΔlnEL**	**ECM**
ΔlnCE		11.24* (0.001)	13.333* (0.001)	1.335 (0.235)	2.54 (0.151)	4.24*** (0.0533)	-0.1330** (0.011)
ΔlnGDP	4.245*** (0.0533)		0.25 (0.541)	1.13 (0.222)	11.13* (0.003)	11.24* (0.001)	-0.012 (0.521)
ΔlnEN	0.333 (0.514)	1.52 (0.331)		1.23 (0.204)	2.12** (0.013)	12.13* (0.001)	-0.015 (0.3330)
ΔlnREN	1.15 (0.212)	0.23 (0.234)	4.10*** (0.032)		11.41* (0.002)	13.333* (0.001)	-1.135*** (0.030)
ΔlnTOU	2.43 (0.131)	0.331 (0.525)	1.31 (0.3332)	3.12** (0.012)		11.53* (0.001)	-0.014 (0.3233)
ΔlnEL	14.12 (0.001)	1.01 (0.500)	1.35 (0.315)	3.43* (0.001)	11.30* (0.001)		-0.003 (0.5233)

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Table 6. Results of Variance Decomposition Analysis

Variance decomposition of LnCE							
Period	S.E.	lnCE	lnGDP	lnEN	lnREN	lnTOU	lnWAT
1	0.0133	100.000	0.000	0.000	0.000	0.000	0.000
1	0.021	52.111	0.031	0.225	1.152	133.143	14.2433
2	0.035	51.335	0.032	2.1233	1.225	11.4330	13.1335
3	0.050	41.022	3.423	5.1332	1.345	15.3331	14.523
4	0.034	40.132	12.133	3.550	1.0335	15.010	11.3331
10	0.111	35.141	14.521	3.414	1.341	33.3323	33.015
Variance decomposition of LnCE							
Period	S.E.	lnCE	lnGDP	lnEN	lnREN	lnTOU	lnSAN
1	0.011	100.000	0.000	0.000	0.000	0.000	0.000
1	0.023	233.1033	1.121	0.002	0.413	3.011	1.130
2	0.035	33.412	3.23333	3.232	1.100	3.3343	0.532
3	0.041	35.0333	5.420	3.2533	1.244	3.031	1.110
4	0.042	31.153	4.244	10.3302	1.413	2.455	0.224
10	0.035	55.111	12.3321	11.025	1.33333	4.321	1.121
Variance decomposition of LnCE							
1	0.013	100.000	0.000	0.000	0.000	0.000	0.000
1	0.025	21.123	3.210	3.131	0.1331	3.33333	1.323
2	0.040	20.244	10.431	2.1332	1.233	1.300	0.353
3	0.044	32.331	2.3314	1.243	2.341	3.511	1.113
4	0.0433	32.013	3.214	2.033	2.233	5.151	0.3333
10	0.053	53.323	3.231	13.405	3.401	5.100	2.012

The findings gauged from the Granger test confirmed the rationality of chosen constructs. Results also proved that the selected controlled variables are equally crucial in strengthening the energy-growth-environment link.

It is maintained that both developing and underdeveloped countries need support to improve their services (Xiang et al., 2021). Emerging nations rely primarily on conventional services, whereas industrialized nations depend on knowledge-based individuals. This outbreak has underlined the necessity to pay close attention to the organizational gap between developed and developing nations. As it can be used to modify the economic status of a country, developing nations must create essential service exchanges that influence the economy and trade. Services such as ICT support digitization and e-commerce, which have proven to be the most effective methods for keeping the economy afloat in difficult times. Because these services enhance productivity and save costs, they integrate digitization with other industries such as agriculture, manufacturing, etc. In this manner, economic resilience would increase, strengthening the nation's export capacity. Digitalization of services has aided ingenious firms in surviving epidemics, as these platforms now provide a means to engage with customers. This overall appearance suggests that digitization enhances the expansion of all industries. As an illustration, tourism appears to be the third-largest export sector worldwide.

The economic recovery from epidemics of covetousness is complex and intricate. According to the most recent FT monitoring index, the global economy has only reached a tenuous recovery from the depths of the Covid-19 pandemic, and many emerging nations continue to struggle (Hsu et al., 2021). In addition, the index revealed uneven development in the world's top economies, emphasizing the uncertain future that will set the stage for the annual meetings of the IMF and World Bank. The second wave of Covid-19 indicates the uncertainty of trying to return to normal. This undermines the trust of businesses, individuals, and investors and offers little opportunity for more monetary policy stimulus, as pandemic levels have already been reached in most nations (Sadiq, Nonthapot, et al., 2022). Professor Sewer Prasad of the Brookings Institution stated that there was no broad-based and robust recovery on the horizon and that "the risks of substantial and long-term negative impacts on economies are growing." Krista Lina Georgieva, the IMF's managing director, stated last week that the crisis over Covid-19 would be "long, uneven, and uncertain." China demonstrates the most robust rebound in Asia, regaining a significant portion of the economic activity lost when Covid-19 initially attacked in January and February.

Nonetheless, its performance this year will be significantly worse than in the early 1980s when it opened its economy to commerce. Due to its success in eliminating the virus and its reopening in India, numerous issues developed. As a result of the economic repercussions of the pandemic, business activity was hindered by problems and deaths.

The services industry can generate more excellent prospects for revenue, food safety, production, employment, investment, and commerce. It is stated that states require comprehensive, integrated, and suitable policies to aid developing nations, particularly emerging and less emerging economies.

Currently, the services are being monitored in Europe and other world regions. Given "epidemic fatigue" and growing public fatigue and discontent with sanctions, government leaders in several nations have been more hesitant to intervene this time out of concern for the economic impact. As the second wave of epidemics intensified, they quickly discovered they had more options. When countries reopen for a second time, our findings indicate that a broad, cautious, progressive, and transparent re-operation is likely to optimize both the potential to decrease the health costs of the epidemic and the potential for a speedy recovery.

4. 4 The long-run elasticity of CE_t

The analysis was carried out using Cholesky technology to explore the relative future contribution of Vietnam's selected dependent variables to Vietnam's CO_2 emissions within a decade.

Table 5 explores the long-term elasticity coefficient of CO_2 emissions. The regression coefficients were estimated using two cointegration regression methods (FMOLS and CCR) for better estimation. Long-term elasticity estimates were also made for the three scenarios by selected control variables. FMOLS findings indicate that 1% GDP/capita increases CO2/capita with 0.121% and 0.1335% in cases 1 and 2, respectively. Similarly, with the increase of 1% in EU, increase CO2 emission with the % of 0.1335%, 0.511% and 0.315% in case 1,1 and 2 respectively. However, 1% increase in tourism share decreases CO2 with a % of 0.112% and 0.145% in cases 1 and 2, respectively. Finally, REW energy increase also decreased CO2 decreased by 1.113% (case 1) and 1.0332% (case 2).

5. DISCUSSION

The study results indicated that per capita GDP is positively associated with CO_2 emission. These results are supported by the previous study by Magazzino et al. (2021). They concluded that in the case of high GDP growth, there is more productivity, an increase in business operation, and transportation. In all these economic activities, energy resources and technologies are used, which may cause CO_2 emissions. Findings also exposed the positive connection of EU with CO2, which shows the consistency with the study of Gong et al. (2019). This study posits that using energy resources to operate different technologies, production plants, and logistics for transportation goods releases pollutants like SO_2, CO_2, and radioactive gases. Thus, the increase in the amount of energy used for different business functions increases the amount of CO_2 emission into

the air. The study results have shown that the share of tourism to exports was positively associated with CO_2 emission. These results are supported by the previous study by Godil et al. (2020). They highlighted that the encouragement of tourism and the share of tourism which is determined in the form of money spent by tourists within the country for leisure or business travel or shopping, decreases CO_2 emission as tourism growth leads to geographical development. The results also stated that renewable energy production and consumption are positively associated with CO_2 emissions. These results agreed with the past research of Waheed et al. (2018). They showed that using renewable energy resources to meet the energy needs of business organizations did not cause the emission of pollutants like CO_2 and the production of renewable energy like solar power, biomass, and biofuel that absorbs heat and CO_2 emission from the air.

The results have also indicated that improved water negatively affected CO_2 emissions. These results are supported by the previous study of N. NASEEM et al. (2020). They stated that when the country has the facility to provide clean water to the public, there are minimum chances of CO_2 emission or other harmful gases. The study results have revealed that sanitation had a negative association with CO_2 emissions. These results are supported by the previous study by de Assis et al. (2019). They stated that wastes from economic or domestic activities are disposed of properly under an effective sanitation system. The reduction of harmful wastes reduces the emission of CO_2. The results have also supported that electricity negatively affects CO_2 emission. These results match the past study of Al-Mulali et al. (2018), who stated that the facility of electricity to commercial enterprises fulfills the energy needs for which usually non-renewable energy resources like fossil fuels are used. Thus, the use of electricity reduces CO_2 emissions.

6. CONCLUSIONS

The Sustainable Progress Goals (Colglazier, 2015) aim to overcome existing gaps between socio-economic development and environmental sustainability. The concept of sustainable development necessitates examining the connection between socio-economic progress and the accompanying environmental pressure. However, in most emerging nations, unchecked environmental deterioration remains a significant issue.

The feedback hypothesis suggested a causal connection between variables. The association between better water and GDP, EN, REN, and TOU was causative. It stressed the significance of enhancing the nation's population's water usage. Similarly, sanitation improvements have a causal effect on GDP, energy consumption, renewable energy, and tourism. Again, electrical supply was causally related to selected constructs. The results highlighted the connection between the environment and growth.

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7. IMPLICATIONS

A disastrous crisis like the Covid-19 pandemic has impacted and contributed to the socio-economic situation. This pandemic has economic and political consequences that may leave deep and long-standing scars, stressing each country it affects. Earlier proposed investments in renewables, environmental protection, mitigation, energy management, and green projects are expected to undergo downward revisions due to the Covid-19 pandemic and the resulting global recession. This study is significant to the government, environmental regulators, and economists. It proves to be a guideline for them while making policies to manage society and the economy after a pandemic. This study guides them on reducing CO_2 emission, an indicator of environmental pollution, with the help of green finance.

The study recommends the that there could be a reduction in emissions of CO2, which ultimately increase environmental protection by investing in factors such as REW energy, tourism share to exports, and GDP, especially in the presence of control factors that are being considered in the study.

The results indicated that the use of energy in excessive amounts for performing domestic chores and commercial activities increases CO_2 emissions. At the same time, investment in renewable energy can help control CO_2 emissions and environmental protection. The results showed that green investment in increasing GDP and tourism development could protect the environment against CO_2 emissions and other pollutants. Moreover, the study concluded that improved water, better sanitation system, and electricity availability in the presence of enhanced water.

8. LIMITATIONS

The study has several limitations, but these limitations provide an opportunity for future researchers to use their intellect to address these limitations. The study analyzes the influences of certain factors on CO_2 emission or environmental protection. Several other factors can influence the amount of CO_2 emission or environmental protection, but these factors are utterly ignored in the study. Hence, the scope of the study is limited and academic researchers are recommended to increase the number of factors affecting CO_2 emission or environmental protection. Similarly, the data about chosen factors has been collected for a limited period. Therefore, the study is not valid as is required for leading research. In conclusion, future authors are recommended to analyze the influences of understudy constructs on CO_2 emission or environmental protection for a comprehensive and valid guideline.

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