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Assessing the role of green economy on sustainable development in developing countries

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A R T I C L E I N F O

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A B S T R A C T

Purpose: Over the last few years, the green economy (GE) notion has been realized as a key tool for achieving sustainable development (SD) in both developing and developed nations. Therefore, the current study tries to investigate the role of GE in achieving SD in developing countries. Through empirically examining the relationship between the GE and three different dependent variables which are GDP per capita, total unemployment rate, and poverty level, using cross-sectional data for 60 developing countries in 2018.
Design/methodology/approach: Applying generalized least square (GLS) approach. The four dimensions of the Global Green Economy Index (GGEI) are the key independent variables that measure the accomplishment of nations in aspects of the global green economy.
Findings: The empirical results showed the existence of a positive statistically significant relationship between the GE and GDP per capita and the level of total unemployment, while there is a negative statistically significant relationship between the GE and the poverty rate in developing countries.
Implication policy: This study recommends that both the private and public sectors continue to endorse and adopt GE in the future for SD, job creation, and poverty alleviation.
The original value of the study: It is the first research for developing countries that explores the relationship between GE and SD using three indicators of SD using a GLS approach according to our information. Also, this study categorized the dataset of the developing countries based on their income level for addressing the heteroskedasticity problem.

1. Introduction

There is no longer any question regarding the fact that environmental conservation and sustainable development have a substantial

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and positive influence on one another. As the world tries to move towards sustainable economic growth, it faces many environmental problems that the world has recognized and has begun to environmental actively pursue to achieve sustainability not only from an economic growth perspective but from an environmental perspective as well.

Within the framework of the main principles of the Rio declaration and Agenda 21, in 1992, the United Nations conference on environment and development issues underlined the national strategies for accomplishing sustainable development [1]. Despite all the efforts spent by many governments all-over the world to accomplish such strategies and also global cooperation to assist those nations, there are still some worries and challenges that many nations confront in terms of ecological sustainability and economic prosperity. Including, the recent fuel, food, and financial crisis, and the impact of climate change, natural depletion, and devastation of ecosystems and biodiversity. Many attempts by the world governments trying to find effective means to help their nations to go out from these related crises, considering into account the biodiversity problems and ecological limits. Hence, there was a need for a new concept that includes all of these issues.

Since its launch in 2008, the Green Economy (GE) concept has attracted considerable global interest, due to its usage as a device for addressing the financial crisis than in 2012 (Rio +20) during the UN conference on sustainable development. Also, the GE concept is widely known by the definition of the UNEP as it indicated the harmonization of three issues: human capital, environment, and social justice [1,2].

The impacts of transition towards a GE have been a controversial issue, as there are some myths about it. First, "there is an inescapable trade-off between environmental sustainability and economic process". Second, the shift to a GE is costly for developing countries as it is a luxury that can be afforded by developed countries only. Third, it can also threat the economic growth of developing countries as the developed one can use it for their interests only at the expense of the developing one [3].

However, according to the report of UNEP in 2011, the projection of the macroeconomic model showed that the transition towards GE would, after a few years, generate more growth, create more jobs and decrease poverty. As in a GE system, growth in income per-capita and employment level must be determined by new private and public green investments which are less dependent on exploiting natural resources and environmental assets, that also reduce carbon emissions, encourage the efficient use of energy and lessen environmental deterioration. So, countries can achieve more sustainable economic growth [4]. Therefore, many developing countries have targeted GE as a new economic growth model to achieve SD, as it contributes to the improvement and development of many sectors, including renewable energy, agriculture, and others. In terms of renewable energy, in light of global development, solar PV power supply is anticipated to become one of the most important international energy supply companies by 2030 and a leading source of energy by 2050. Therefore, China aims to establish a photovoltaic industry with a cumulative total installed capacity of 1050 GW by 2030 [5], since it is among of the leading producers of PV (for solar energy) and also the largest solar PV products exporter as it exports more than 98% of its production. Also, Malaysia is increasing access to energy for the poor in rural areas like Bario Asal which can be considered one of the successful case studies of applying renewable energy in a remote rural area in Malaysia. Moreover, the Egyptian government seeks to generate about 42% of electricity from renewable energy, especially solar energy in 2034/35 [6].

Furthermore, developing the organic agriculture sector in Uganda, by 2003 Uganda turned out to be the 13th world largest country in respect of organic agriculture production, where its organic agricultural production area increased by 60%. Also, the organic agriculture production system, in Uganda, contributed to the decrease of GHG emissions per ha by 64% compared to greenhouse gas emissions from conventional agricultural production [7]. In addition, the GE contributes to the creation of many new investments and sectors such as green technology, green transportation, and green cities in China, India, Egypt, Malaysia, etc., which lead to creating green job opportunities, advancing the economy and minimizing environmental deterioration, adapting and mitigating the impacts of climate warming and other challenges facing developing countries [8–11].

In terms of green jobs, according to the German Development Institute's 2012 Report and UNEP report in 2014 about the impacts of the green economy implementation in Egypt, the waste collection activities will generate an additional 24,000 jobs, sustainable agriculture is expected to produce 8 million additional jobs by 2050, in addition to the jobs provided by recycling, composting, and biofuel development. Also, based on [12], around 3.5 million jobs were created in environmentally-friendly sectors in Bangladesh, and about 800.00 of these jobs could be considered green jobs. In addition, according to Ref. [11] globally, the solar 53 photovoltaic industry contributed to creating 3.37 million jobs in 2017, Asia got around 3 million jobs, which is 88% of the global total. Among Asian countries, China had the largest share with 90% of those PV jobs.

Concerning alleviating poverty and promoting social justice, the GE policies in developing countries have set targets geared toward the poor and vulnerable groups. There are several examples of how cutting fuel subsidies allows money to be shifted to public transit or health care to enhance the level of well-being of the poor. Sustainable certification schemes, eco-labeling programs, and other initiatives in Uganda, Nepal, Egypt, etc. have identified a new source of revenue from agricultural and forestry products. Moreover, China, Malaysia, and other developing countries have adopted climate change adaptation and mitigation programs that directly benefit the poor and vulnerable [13–17].

In addition, the GE concept is hard to be specified, as it has multi-dimensions and definitions, there are also different views on its relationship with SD especially in developing countries, and about how the movement towards GE among countries begins and continues. Thereby, the problem is that there is no specific theory that can determine all the factors that affect this relationship.

Empirical evidence showed that the GE could have different impacts on the economic growth, employment, and poverty level of the countries with the same economic and social level, based on different economic policies and structural adjustments which are adopted during the transition process. That needs to take into account each emerging country's social and economic situation, which assured the difficulty of assessing the impacts of the GE transition [14].

The current study adds to the empirical studies in the field of GE and SD as follows: first, as far as we can tell it is the first study to investigate the relationship between GE and SD using three indicators of SD including, GDP per capita income, total unemployment ratio, and poverty headcount ratio to investigate the impact of GE on economic growth, job creation, and poverty alleviation to achieve sustainable development in 60 developing countries in 2018 and this year is selected based on data availability and generalized least square (GLS) approach is applied. Second, the study categorized the dataset of the developing countries based on their income level for addressing the heteroskedasticity problem. Third, the empirical results and recommendations may be crucial to assist policymakers in these developing countries to trigger the movement towards attaining sustainable development by concentrating on poverty alleviation and its social positive impact.

The remainder of this paper is systematized as follows: following the introduction, Section 2 reviews the existing literature. Section 3 contains methodology and model specification, data source while empirical results are analyzed in Section 4. Finally, the discussion, conclusion, and further recommendations for future researchers are covered in Sections 5 and 6 respectively.

2. Literature review

Based on different studies, the green economy is one of the significant transitions that should be addressed when studying sustainable development and environmental protection. As a consequence, the links between the green economy and sustainable development are a priority for many academics such as those for European nations [18], 32 OECD countries [19], and China [20]. Therefore, this study investigates the relationships between the green economy and sustainable development by focusing on the first and eighth goals of no poverty, decent work, and GDP. For coherence, the literature review is divided into three segments. These segments are the green economy and economic growth nexus. While the second and third segments analyze the green economy-poverty reduction, and green economy -employment level nexuses, respectively. Using the existing and relevant evidence, we discuss each linkage in the segments that follow.

2.1. Green economy & economic growth nexus

Parallel to the green economy ambitions, one of the core goals of sustainable development has been to upsurge economic advancement while maintaining environmental quality. Therefore, there has been substantial discussion concerning the ecological effects of economic growth in recent decades, particularly in developing nations. For countries to build their infrastructure in recent years, economic growth has become increasingly important. Environmental consequences and economic development, thus give a dilemma, for both economists and environmentalists. The main objective of numerous studies has been to determine the causal relationship between economic growth and environmental deterioration, and concluded mixed results. Some research revealed that the protection of the environment is negatively impacted by economic growth, and as a result, economic strength is regarded as a stimulant that causes environmental damage, especially in the early stages of growth when the economy is heavily reliant on oil and gas as referenced for N11 nations [21], for Bangladesh [22], for MENA region [23], for top African suppliers of natural gas [24], for Pakistan [25,26], for Egypt [27,28], for USA and Europe [29], for South Asia [30], and for developing countries [31].

On the other hand, other research indicates that achieving sustainable development can be considered dependent on green economic growth. Increased reliance on environmentally friendly, energy-saving innovations, the spread of environmental knowledge and expertise, the encouragement of sustainable energy generation, and the augmentation of the energy mix by expanding the use of renewable energies could all contribute to green economic growth as mentioned for Seven case studies [32], for G7 countries [33,34], for Africa [35], for top 20 green innovator nations [36], and for BIRCS [37]. Given the development that developing nations have accomplished and are projected to make throughout the next decades, such conclusions are crucial for them. So, it also indicates that the theme investigation is intended to address a research problem in developing economics.

2.2. Green economy & poverty reduction nexus

The initial Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development is to end poverty in all of its dimensions. Target 1 is where the SDGs make their primary mention of eradicating poverty. It is essential to mobilize significant resources from a variety of sources, including improved development cooperation, to provide developing countries, especially the least developed ones, with appropriate and reliable means to carry out programs and policies to combat poverty in all of its ways. The SDGs also aim to establish sound policy frameworks at the national and regional levels in order to ensure that by 2030 all men and women have equal rights to economic resources, including access to basic services, ownership of and control over land and other forms of property, inheritance, natural resources, appropriate new technology, and financial services. As a consequence, various academics aimed at examining the significant role of the green economy to reduce poverty with positive findings. Some investigators showed that the green economy positively affects the income per capita and poverty ratio via green financing, renewables utilization, and green hydrogen such as [3,38–46].

2.3. Green economy & employment level nexus

Scholars have given the green economy a lot of attention because of its consequences, particularly on employment. According to United Nations Environment Program (UNEP), a green economy boosts social justice and generates jobs, demonstrating the positive impact of the green economy on the labor market. The International Labor Organization agrees that the green economy has the potential to generate millions of new jobs. Thus, many studies have investigated the nexus between the green economy and employment levels by investigating the connection between the environmentally-friendly innovation and the creation of new job opportunities, the association between green employment and the green economy that generates new investments with positive results as mentioned in Refs. [47–51].

Contrary to these views there are several studies concluded that despite the positive impacts of a green economy on employment, it can also have some negative impacts, which may mostly affect developing countries. These studies argued that environmental protection is a luxury that only developed countries can afford as conducted in Refs. [52–54]. These findings show that the topic research attempts to address a knowledge gap and is of the highest concern for developing economies. The link between the green economy and employment level as a crucial goal of sustainable development is used in our analysis and this is extremely meaningful when studying this impact in developing countries.

3. Research gap

Publications that examine how a green economy affects sustainable development in the academic world by economic growth, poverty reduction, and employment level for developing nations are insufficient. This literature reviews focus on the one goal of sustainable development; therefore, it is questionable if the green economy may allow rapid these sustainable development goals. The results of the abovementioned empirical studies may suggest that not only are there still few studies on the drivers of sustainable development, but also that there is no sufficient evidence for studies on developing nations in particular. Given the significance of the green economy in developing countries, it seems vital to evaluate these regressors by offering suggestions to decision-makers and developing sufficient policies to achieve sustainable development goals. Our theoretical framework and hypotheses are presented in the following section build on the background literature we studied in this section.

4. Development of the theoretical framework and hypothesis

Many theories have attempted to explain the correlation between ecological damage and economic growth, as well as, green economy theories. Among the more well-known theories include the following ones.

4.1. Correlation between economic growth and environmental harm

From a theoretical point of view, the link between economic progress and the environment has been widely treated. Preserving the environment is considered to be the key issue in the debate on the economic link between the environment and growth. According to the traditional economic theory, there is an accepted trade-off between environmental protection and economic growth [3].

Besides the traditional economic theory, Malthus also tried to study the relationship between environmental resources and population growth. The study stated that incorporating the environmental constraints in the economic model showed that growth in food production simultaneously can no longer support population growth. This may be interpreted as a set of issues about the environment's carrying capacity, which could be traced back to the beginnings of the green economy [55]. Ref. [56] developed the Solow model to include the environmental variable and it's been dubbed "the Green Solow model", which analyzes the impact of technological advancements on the value of a pollutant while assuming a fixed ratio of both labor and capital.

Moreover, the "Limits theory" states that environmental thresholds may be breached in certain cases before the nation reaches the EKC turning point. Many researchers commented on this theory, such as [57], who argue that the risk of minor variations generating destructive harm implies that concentrating primarily on economic progress to meet environmental goals may lead to counter-productive consequences. "For instance, in the light of biodiversity, increased investment in preserving species diversity would not be enough to resurrect endangered species. The limits theory explains the economy-environment relationship in terms of environmental degradation approaching a point beyond which development is badly affected and the economy contracts" (see Fig. 1.1a). Then, there is the additional theory which questions the presence of the turning points, and considers also the possibility that environmental deterioration continues to raise as the countries develop (see Fig. 1.1b). This is identical to the new toxics opinion, as emissions of existing pollutants decrease with more economic progress, but new pollutants that replace them are increasing [58].

Moreover, in 2004 there was a new model that represents a new approach to studying the link between economic progress and ecological degradation within the perspective of global competition which is known as "Race to the Bottom" (see Fig. 1.1c). It shows that international competition is one of the main causes of environmental damage increase. This competition increases up to the point when developed countries have the power to decrease their environmental impact and start to outsource the polluted activities to

Fig. 1. Various forms of the link between environmental damage and economic progress [60].

developing countries. "In the best-case scenario, this model results in a "non-improving situation" [59].

4.2. Correlation between green economy and sustainable development

Following [61], the "Green Concept" not only refers to common ideas about environmental conservation and protection but is used to signal the evolution of a new paradigm established to deal with environmental issues from a developmental perspective. This paved the road for the existence of a new environmental policy, quite different from the old views [62]. According to Ref. [63] the green economy can be considered a modern school of thinking that seeks to "create a new discipline that functions for the good of all humans everywhere, for the earth, the biosphere, nonhuman beings, biodiversity, and all life forms". Ref. [64] believed that the green model can be also considered as a new appropriate strategy for reform programs, formulated to address the global economic crisis.

Moreover, the study asserted that the green economy could manage the economic reform through "greener guidelines", which won't just support the reform itself to be effective but it will also help accomplish the long-term objectives of encouraging sustainable development. According to Ref. [65] the concept of the green economy could be used to refer to any economic theory that integrates any human economic activities into the ecosystem.

Since the green economy is thought to be a crucial element in enhancing sustainable development. Therefore, we investigate the green economy on selected goals of sustainable development in developing nations under the following hypothesis.

Hypothesis 1: Enhancing the green economy leads to expanding economic progress.
Hypothesis 2: Enhancing the green economy leads to poverty alleviation.
Hypothesis 3: Enhancing the green economy leads to increase employment levels

5. Methodology

5.1. Model specification

This study tends to use the generalized least square (GLS) method on cross-section data from 60 developing countries in 2018, to study and measure the GE performance and its impact on SD (economic progress, job creation, and poverty alleviation) in the developing nations. These methods are chosen due to the lack of harmonized time-series data on the global green economy index [3]. The study will use the log transformation for the data to eliminate the heterogeneity across the observation and to ensure that the data will be normally distributed.

The econometric analysis involved regressing the dimensions of sustainable development on green economy indicators and other significant variables as discussed below:

First, the general form of the model,

$$LSD_i = \alpha + \beta_{1i}LLab_i + \beta_{2i}LTR_i + \beta_{3i}LCO_{2i} + \beta_{4i}LGE_i + \varepsilon_i \tag{1}$$

Second, the three sub-models:

$$LGDP_i = \alpha + \gamma_i LLC_i + \gamma_i LES_i + \gamma_i LMI_i + \gamma_i LEN_i + \gamma_i LLab_i + \gamma_i LTR_i + \gamma_i LCO_{2i} + \varepsilon_i \tag{2}$$

$$LUnp_i = \alpha + \delta_i LLC_i + \delta_i LES_i + \delta_i LMI_i + \delta_i LEN_i + \delta_i LLab_i + \delta_i LTR_i + \delta_i LCO_{2i} + \varepsilon_i \tag{3}$$

$$LPov_i = \alpha + \theta_i LLC_i + \theta_i LES_i + \theta_i LMI_i + \theta_i LEN_i + \theta_i LLab_i + \theta_i LTR_i + \theta_i LCO_{2i} + \varepsilon_i \tag{4}$$

where α denotes the constant variable and the dependent variables are LSD_i denotes the sustainable development dimensions such as: $LGDP_i$, $LUnp_i$ and $LPov_i$ which denote the gross domestic product per capita in country i, the total unemployment ratio in country i, and the poverty headcount ratio in country i respectively.

Whereas the control variables are $LLab_i$, LTR_i and LCO_{2i} denote total labor force ratio in country i, trade as a percentage of GDP in country i, carbon emission reduction in country i respectively, and variables of interest are LGE_i denotes the green economy dimensions such as:

LLC_i, LES_i, LMI_i and LEN_i denote the leadership and climate change in country i, the efficiency sectors in country i, the market and investment in country i, and the environment and natural capital in country i respectively, and finally ε_i denotes the error term.

For solving or eliminating the heteroskedasticity problem, which often occurs due to the nature of cross-section data, where observations are all for the same period but are from different entities. So, the study tends to eliminate this problem by using the Robustness test and by removing some insignificant variables, and then checking the model specification by the Ramsey test to be sure no misspecification error can cause an impure heteroskedasticity problem. Furthermore, the study will use another method for addressing the heteroskedasticity problem by categorizing the dataset of developing countries based on their income level. Following the World Bank classification, developing countries are classified as low-income, upper-middle-income, and high-income countries. Based on the availability of the data, the study includes only high and upper-middle-income developing nations, the dummy variable will take 1 if the developing country is an upper-middle-income country and 0 otherwise.

5.2. Generalized least square method (GLS)

One of the big problems that face the cross-sectional analysis is the heteroskedasticity problem, as it is known that the OLS method assumes that the variance of the disturbance is constant across all the observations which is called homoscedasticity. But in real most of the cross-sectional data suffers from heteroskedasticity problems therefore to address this problem it is better to use the GLS method of estimation rather than the OLS.

The GLS will be used when the heteroskedasticity is known, let (X_i) denote all the regressors and assume that:

$$\sigma_i^2 = \text{Var}\ (u_i \setminus x_i) = \sigma^2\ \text{h}(x_i) = \sigma^2 h_i \tag{5}$$

where h (x_i) is some function of the regressors that determines the heteroskedasticity. The equation use x_i to denote all regressors for observation i, and h_i changes with each observation because the regressors change across observations.

First, let's consider the OLS equation:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} \ldots\ldots + \beta_k x_{ik} + u_i \tag{6}$$

Transform the equation containing heteroskedastic errors into one with homoskedastic errors (and fulfills all the other Gauss-Markov assumptions). Since h_i is just a function of x_i, $u_i/\sqrt{h}$ i have a zero expected value conditional on x_i . Further, since Var ($u_i \backslash x_i$) E ($u_i^2 \backslash x_i$) $\sigma^2 h_i$, the variance of $u_i/\sqrt{h}$ i (conditional on x_i) is σ^2:

$$\text{E}\left(\left(u_i \Big/ \sqrt{h}\ \text{i}\right)\hat{2}\right) = \text{E}\left(u_i^2\right) \Big/ h_i = \left(\sigma^2 h_i\right) / h_i = \sigma^2 \tag{7}$$

So now Eq. (6) will be divided on $\sqrt{h}$ i to get

$$y_i^* = \beta_0 x_{i0}^* + \beta_1 x_{i1}^* + \ldots + \beta_k x_{ik}^* + u_i^* \tag{8}$$

where $x_{i0}^* = 1/\sqrt{h}$ i and the other starred variables denote the corresponding original variables divided by $\sqrt{h}$ i. So, it is clear that we can get a new estimator of the β_j that have better efficiency properties than the OLS estimators. These estimators, $\beta_0^*, \beta_1^*, \beta_k^*$, will be distinct from the OLS estimators in the original equation. The β_j^* are examples of GLS estimators. In this case, the GLS estimators are used to account for heteroskedasticity in the disturbance [66].

5.3. Diagnostics check

Assessing a model is a crucial step that follows the estimation process. It helps to verify the quality and validity of the model used in the analysis, as well as ensure that it is not affected by common issues such as inconsistent variance, multicollinearity among the explanatory variables, or non-normality of the error term. It's important to confirm that the model being studied doesn't suffer from any of these problems.

The first step in testing for heteroscedasticity is to conduct a Breusch-Pagan test, which assesses whether there is a difference in variance across the error terms. This involves calculating an F-value and comparing it to the significance level of 5%, as well as examining the null and alternative hypotheses. If the F-test probability value exceeds 5%, the null hypothesis is not rejected, indicating the absence of heteroscedasticity [61]. Prior to conducting the Breusch-Pagan test, the study should present graphs of the model and data to visually detect the presence of heteroscedasticity.

H0: constant variance (homoscedasticity).
H1: non-constant variance (heteroscedasticity).

The second test is the Variance Inflation Factor (VIF), which is used to detect multicollinearity in the model. The VIF assesses how much the variance of a regression coefficient is inflated as a result of multicollinearity. VIF values range from 1 to 10, where a value of 1 indicates no correlation, values between 1 and 5 indicate weak correlation, values between 5 and 9 indicate moderate correlation, and values above 10 indicate high correlation, which is a cause for concern [67].

$$\text{VIF} = \frac{1}{1 - R_i^2}$$

The third test is the Shapiro-Wilk test, which assesses the suitability of the error variable's distribution for a normal distribution. This involves obtaining a probability value and comparing it to the significance level of 5%, as well as examining the null and alternative hypotheses. If the probability value exceeds 5%, the null hypothesis is not rejected, indicating that the data is normally distributed. Otherwise, the null hypothesis is rejected, indicating that the data is not normally distributed [66].

H0: data are normally distributed.
H1: data aren't normally distributed.

5.4. Data source

In this study, the data were selected based on the literature review also the lack of consistent and retrospective data on the green economy has always restricted researchers' ability to study the role of GE in attaining SD and affected the selection of different variables. This study has utilized data from many different sources, using cross-sectional data for 60 developing countries in 2018. First, the SD is represented by the GDP per capita, Total unemployment (% of the total labor force), and Poverty headcount ratio at national poverty lines (% of the population). Second, the GE is represented by the four dimensions of the Global Green Economy Index (GGEI), including Leadership & Climate Change, Efficiency Sectors, Markets, and Investment and Environment. GGEI evaluates the performance of 130 countries for the green economy as well as experts' assessment of this success. Third, the other control variables include trade as a percentage of GDP, total labor force, and CO_2 emission as a percentage of GDP. Data is extracted from different sources, the green economy performance indicators for countries were taken from Dual Citizen LLC, sustainable development dimensions and control variables were taken from the World Bank and CO_2 from the International Energy Agency database.

6. Empirical results

The analysis commences with a preliminary examination of the variables through the use of descriptive statistics and a correlation matrix. Descriptive statistics provide readers with essential statistical information about the data, such as the number of observations (N), minimum and maximum values, mean values, and standard deviations for each variable in the study. Meanwhile, the correlation matrix displays the relationships between all variables, including both the dependent and independent macroeconomic variables (see Table 1).

Table 2 displays the descriptive statistics of the variables, revealing that GDP per capita has the highest value, with a minimum of 275.4296, a maximum of 43004.95, an average of 4867.793, and a standard deviation of 6424.75. Among the dependent variables, unemployment rate has the smallest standard deviation and mean, at 5.56 and 6.57 respectively, while poverty ratio has the smallest minimum value of 0.1. The independent variables exhibit mostly small variances, except for labor force. These results provide robustness and stability to the study model, reducing inconsistencies and variability in the data.

As the above Table 3 of correlation shows, leadership and climate change is insignificantly correlated with efficient sectors and trade while significantly correlated with all other variables, efficient sectors is significantly correlated only with market and investment and labor force, market and investment is also significantly correlated with all other variables except trade and carbon dioxide emission, environment and naturel capital is insignificantly correlated with all other variables except leadership and climate change and market and investment, Labor force is significantly correlated with efficient sectors, market and investment and carbon dioxide emission and insignificantly correlated with all the other variables, trade is insignificantly correlated with all other variables except the carbon dioxide emission variable and carbon dioxide emission is significantly correlated with leadership and climate change, labor force and trade, and insignificantly correlated with all other variables. Despite this, there is a significant correlation between the independent variables and each other but still doesn't cause a multicollinearity problem as they all represent only weak and moderate correlation.

6.1. Cross-sectional regression results

This section starts with the coefficients of estimation of the relation between sustainable development and green economy using GLS estimation. First, Table 4 represents the results of regressing GDP per capita on the independent variables of the study, the GLS shows that the four dimensions of the green economy are positively significant at a different significant level, which indicates a strong positive relationship between the GE and GDP per capita, resembling the findings of [3,19,20,68–71]. Also, the estimation depicts that the labor force is negatively significant at a 5% significant level, which confirms the findings of [55] that the labor force has a negative relation with green economic growth. While, CO_2 and trade are statistically insignificant, which is contrary to the results of [69,72,73] that the CO_2 has a negative relation with the economic growth after moving to the green economy. In addition, the goodness of fit of

Table 1
Descriptions of the variables.

Variables	Symbols	Measurements	Data Source
Dependent variables			
GDP Per capita	GDP	GDP per capita (current US$)	WDI
Unemployment	UNP	(% of the total labor force)	WDI
Poverty headcount ratio at national poverty lines	POV	(% of the population)	WDI
Independent variables			
Leadership & Climate Change	Perf_LC	Dimension 1 of GGEI	Dual citizen
Efficiency Sectors	Perf_ES	Dimension 2 of GGEI	Dual citizen
Markets and investment	Perf_MI	Dimension 3 of GGEI	Dual citizen
Environment	Perf_EN	Dimension 4 of GGEI	Dual citizen
Control Variables			
Labor Force	Lab	Total labor force	WDI
Trade Openness	TR	Trade (% of GDP)	WDI
Carbon emissions	CO_2	CO2 emissions (kt)	IEA

Table 2
Descriptive statistics.

Variables	N	Min.	Max.	Mean	Std. Deviation
GDP	60	275.4296	43004.95	4867.793	6424.75
Unp	60	.273	26.958	6.57985	5.560239
Pov	60	0.1	77.6	21.34333	23.16031
Lab	60	.099276	787.5514	39.80365	119.8076
TR	60	26.35504	187.5212	73.82686	35.86733
CO_2	60	.015	1.574	.4095932	.2881903
Perf_LC	60	.329899	.8272635	.6142435	.1318041
Perf_ES	60	.1956307	.7279886	.4348362	.1158147
Perf_MI	60	.2400209	.7137136	.4155386	.1294791
Perf_EN	60	.1567046	.6662468	.3980222	.1331099

Table 3
Correlation matrix.

Variables	LC	ES	MI	EN	Lab	TR	CO_2
LC	1.0000						
ES	0.0236 (0.8581)	1.0000					
MI	−0.2693 (0.0374)	0.4958 (0.0001)	1.0000				
EN	−0.5372 (0.0000)	0.1433 (0.2748)	0.3125 (0.0150)	1.0000			
Lab	−0.2476 (0.0565)	0.3211 (0.0124)	0.4464 (0.0003)	0.0620 (0.6379)	1.0000		
TR	−0.1758 (0.1792)	−0.1089 (0.4099)	−0.0304 (0.8476)	0.1542 (0.2395)	−0.2257 (0.0830)	1.0000	
CO_2	−0.6263 (0.0000)	−0.0891 (0.5022)	0.1990 (0.1309)	0.1850 (0.1608)	0.2507 (0.0005)	0.3441 (0.0076)	1.0000

Noted: values between brackets represent the probability of a 5% significance level.

Table 4
GGEI and sustainable development (GDP per capita) GLS, the year 2018.

L (GDP) Dep. variable	Coef.	Std. Err.	*t*-test	P > |t|	[95% Conf. Interval]		VIF Ext.
Constant	3.836	0.520	7.37	0.000***	2.792	4.883	
LLC	1.225	0.479	2.56	0.014**	2.187	0.263	1.94
LES	0.699	0.358	1.95	0.057*	−0.020	1.418	1.58
LMI	0.553	0.331	1.67	0.101*	−0.111	1.219	1.71
LEN	1.885	0.265	7.10	0.000***	−1.353	2.418	1.52
LTR	−0.002	0.208	−0.01	0.990	−0.420	0.415	1.61
LLab	−0.141	0.062	−2.27	0.028**	−0.267	−0.016	1.98
LCO2	−0.003	0.140	−0.03	0.979	−0.285	0.277	2.01
Num. of obs = 60 F (7, 52) = 21.79 prob > F = 0.0000							
R-Sq. = 0.7457							
Adj.R-Sq = 0.7115							
Br.P. = 0.571							
Sh.W. = 0.801							

Note: * Significant at 10%; ** Significant at 5%; *** Significant at 1%.

the estimated model can be evaluated by examining the R^2 value, which shows that the model can account for 74% of the variation in the dependent variable, GDP per capita. Also, to test the significance of the model, (F-test) was applied, and it was found that the estimated model was significant at (0.01) significance level, which indicates the significance of the variables jointly in their effect on GDP per capita. The study uses the Breusch Pagan test for Heteroscedasticity and the Shapiro Wilk test for assessing normal distribution of data which equal (0.571 and 0.801), respectively, which are greater than the null hypothesis so the null couldn't be rejected and the data doesn't suffer from Heteroscedasticity and it is normally distributed. Also, the results of the variance inflation factor test (VIF) are all less than 10 which indicate that the model doesn't suffer from multicollinearity problem too.

Second, Table 5 represents the results of regressing the Total unemployment rate on the independent variables of the study, the GLS shows that the environment and natural capital are the only significant independent variables among the GE dimensions at a 5% significant level, which indicates a positive relationship between the GE and the unemployment level as when the LC and EN increase by one unit the unemployment will increase by 0.951 and 0.757, respectively. This is the opposite of the findings of [48,74,75] who stated that there is a strong positive relationship between environment-friendly innovation and job creation, while this finding is in line with [76,77] which concluded that the GE harms the employment level. Also, the estimation depicts that the labor force is negatively significant at a 5% significant level, while, CO_2 and trade are statistically insignificant.

In addition, the goodness of fit of the estimated model can be evaluated by examining the R^2 value, which shows that the model can account for 31% of the variation in the dependent variable, Total unemployment. Also, to test the significance of the model, (F-test) was applied, and it was found that the estimated model was significant at (0.01) significance level, which indicates the significance of

Table 5
GGEI and sustainable development (Total Unemp.) GLS, the year 2018.

L (Unp) Dep. variable	Coef.	Std. Er.	*t*-test	P > |t|	[95% Conf. Interval]		VIF
Constant	1.809	0.708	2.55	0.014**	0.388	3.231	
LLC	0.951	0.653	−1.46	0.151*	−2.261	0.358	1.94
LES	−0.421	0.488	−0.86	0.392	−1.401	0.559	1.58
LMI	0.516	0.451	1.14	0.258	−0.389	1.422	1.71
LEN	0.757	0.361	2.09	0.041**	0.031	1.482	1.52
LTR	−0.302	0.283	−1.07	0.291	−0.871	0.266	1.61
LLab	−0.198	0.085	−2.33	0.024**	−0.369	−0.027	1.98
LCO_2	−0.064	0.191	−0.34	0.738	−0.447	0.319	2.01
Num. of obs = 60							
F (7,52) = 3.35 prob > F = 0.0050							
R-Sq. = 0.3110							
Adj.R-Sq = 0.2182							
Br.P. = 0.0434							
Sh.W. = 0.38924							

Note: * Significant at 10%; ** Significant at 5%.

the variables jointly in their effect on Total unemployment. The study uses the Breusch Pagan test for Heteroscedasticity and the Shapiro Wilk test for assessing the normal distribution of data which equals (0.043 and 0.389), respectively. The results of the Breusch Pagan indicate the presence of the Heteroscedasticity problem as its probability is less than 5% so the null hypothesis will be rejected, while the Shapiro Wilk result indicates that data follows a normal distribution. Also, the results of the variance inflation factor test (VIF) are all less than 10 which indicates that the model doesn't suffer from multicollinearity problems too.

Third, Table 6 represents the results of regressing the poverty headcount ratio on the independent variables of the study, the GLS shows that the (market and investment) and (environment and natural capital) are negatively significant at a 1% significant level. These findings are in line with [3,70] who concluded a strong negative relationship between the GE and poverty ratio, while contrary to Ref. [78] who concluded that moving to a green economy will hinder most developing countries, as it will lead to a decrease in GDP and per capita income and an increase in the poverty rate.

In addition, the goodness of fit of the estimated model can be evaluated by examining the R^2 value, which shows that the model can account for 80% of the variation in the dependent variable, Poverty headcount ratio. Also, to test the significance of the model, (F-test) was applied, and it was found that the estimated model was significant at (0.01) significance level, which indicates the significance of the variables jointly in their effect on the poverty level. The study uses the Breusch Pagan test for Heteroscedasticity and the Shapiro Wilk test for assessing the normal distribution of data which equal (0.243 and 0.704), respectively, which are greater than the null hypothesis so the null couldn't be rejected and the data doesn't suffer from Heteroscedasticity and it is normally distributed. Also, the results of the variance inflation factor test (VIF) are all less than 10 which indicates that the model doesn't suffer from a multicollinearity problem too.

6.2. *Robustness results*

After estimating the GLS models, it is evident that the second model has a heterogeneity problem as the results of Breusch Pagan indicate the presence of the heteroscedasticity problem as its probability is less than 5% so the null hypothesis will be rejected. Therefore, to solve this problem, the study used robust estimation after omitting some insignificant variables and then check the effect of those omitting variables on the model specification of the three models by using the Ramsey test at the end the study will use the

Table 6
GGEI and sustainable development (Poverty ratio) GLS, the year 2018.

L (Pov) Dep. variable	Coef.	Std. Er.	*t*-test	P > |t|	[95% Conf. Interval]		VIF
Constant	−0.398	1.480	−0.27	0.789	−3.378	2.581	
LLC	0.746	1.978	0.38	0.708	−3.237	4.729	7.41
LES	−1.056	1.732	−0.61	0.545	−4.543	2.429	3.37
LMI	−2728	0.865	−3.15	0.003***	−4.470	−0.987	6.45
LEN	−3.245	1.245	−2.61	0.012***	−5.751	−0.739	3.39
LTR	0.425	0.638	0.67	0.509	−0.860	1.711	5.39
LLab	0.255	0.195	1.30	0.199*	−0.139	0.649	8.05
LCO2	−0.763	0.683	−1.12	0.270	−2.138	0.611	5.46
Num. of obs = 54 F (7,46) = 27.70 prob > F = 0.0000							
R-Sq. = 0.8083							
Adj.R-Sq = 0.7791							
Br.P. = 0.2438							
Sh.W. = 0.7049							

Note: * Significant at 10%; *** Significant at 1%.

information criteria to compare between the GLS estimation and the robust estimation to choose the best of fit model.

Table 7 shows that there is no big change in the significance level of the variables, especially for the first and the second models with the log (GDP) and log (Unp) as dependent variables, while, for the third model with the log (Pov) as dependent variable the leadership and climate change has had a significant negative impact on the poverty ratio while the market and investment become not significant also the R-Square (55%) become smaller after omitting some unimportant variables. Also, to test the significance of the three models, (F-test) was applied, and it was found that the estimated models were significant at a (0.01) significance level, The Ramsey test was also used to check the model's specification and see whether there was any omitted variable bias. The results of the three models reveal that the null hypothesis (no omitted variables in the model) is not rejected in the three models. Also, the previous results are corrected for heteroskedasticity by using the robust standard error.

Also, to eliminate the heteroskedasticity problem as mentioned before the study will use another method for addressing the heteroskedasticity problem by categorizing the dataset of the developing countries based on their income level. According to the World Bank classification, developing countries are classified as low-income, upper-middle-income, and high-income countries. Based on the availability of the data, the study includes only high and upper-middle-income developing countries, the dummy variable will take 1 if the developing country is an upper-middle-income country and 0 otherwise.

Tables 8–10 show the findings of the GLS estimation for the relationship between sustainable development and green economy in upper-middle-income developing countries according to the World Bank classification. First, Table 8 shows that leadership and climate change, efficient sectors, and environment and natural capital have a significant positive relationship with the GDP per capita in middle-income countries at a different level of significance, which is consistent with the GLS estimation results for the whole developing countries under the study.

In addition, the goodness of fit of the estimated model can be evaluated by examining the R^2 value, which shows that the model can account for 65% of the variation in the dependent variable, GDP per capita. Also, to test the significance of the model, (F-test) was applied, and it was found that the estimated model was significant at (0.01) significance level, which indicates the significance of the variables jointly in their effect on GDP per capita. The study uses the Breusch Pagan test for Heteroscedasticity and the Shapiro Wilk test for assessing the normal distribution of data which equal (0.87 and 0.12), respectively, which are greater than the null hypothesis so the null couldn't be rejected and the data doesn't suffer from Heteroscedasticity and it follows the normal distribution, Also, the results of the variance inflation factor test (VIF) are all less than 10 which indicate that the model doesn't suffer from multicollinearity problem too. All of these results are consistent with the GLS estimation results for the whole developing countries under the study.

Second, Table 9 shows that the environment and natural capital have a significant positive relationship with the total unemployment in the upper middle-income countries at a 5% level of significance, and also represents that the labor force has a significant negative relationship with total unemployment level, which is consistent with the GLS estimation results for the whole developing countries under the study. In addition, the goodness of fit of the estimated model can be evaluated by examining the R^2 value, which shows that the model can account for 37% of the variation in the dependent variable, Total unemployment. Also, to test the significance of the model, (F-test) was applied, and it was found that the estimated model was significant at (0.05) significance level, which indicates the significance of the variables jointly in their effect on the total unemployment level.

The study uses the Breusch Pagan test for Heteroscedasticity and the Shapiro Wilk test for assessing the normal distribution of data which equal (0.39 and 0.66), respectively, which are greater than the null hypothesis so the null couldn't be rejected and the data doesn't suffer from Heteroscedasticity and it follows the normal distribution, Also, the results of the variance inflation factor test (VIF) are all less than 10 which indicate that the model doesn't suffer from multicollinearity problem too. The Heteroscedasticity problem was eliminated after categorizing the developing countries according to their income level to achieve homogeneous variance across the observed data.

Third, Table 10 shows that leadership and climate change and market and investment have a significant negative relationship while the efficiency sectors have a significant positive relationship with the poverty headcount ratio in the middle-income countries at a 1% level of significance, also the estimation depicts that the trade is negatively significant at 10% level of significance.

In addition, the goodness of fit of the estimated model can be evaluated by examining the R^2 value, which shows that the model can account for 63% of the variation in the dependent variable, poverty headcount ratio. Also, to test the significance of the model, (F-test)

Table 7
Robustness estimation of the three models.

Variable	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
Constant	3.829	0.000***	1.040	0.001***	−0.823	0.179
LLC	1.226	0.002***	0.787	0.145	−2.905	0.004***
LES	0.716	0.043**	−0.370	0.424	−0.050	0.928
LMI	0.554	0.125	0.408	0.360	0.535	0.465
LEN	1.885	0.000***	0.723	0.036**	−2.297	0.000***
LLab	−0.143	0.003***	−0.163	0.014***		
Num. of obs=	60		60		54	
F = prob > F=	34.09		5.88		14.34	
R-Sq.=	0.0000		0.0002		0.0000	
RESET=	0.7394		0.2844		0.5514	
	0.1796		0.6138		0.4518	

Note: ** Significant at 5%; *** Significant at 1%.

Table 8
GGEI and sustainable development (GDP per capita) GLS, Upper middle income.

L (GDP) Dep. variable	Coef.	Std. Er.	*t*-test	P > |t|	[95% Conf. Interval]		VIF
Constant	3.652	0.570	6.40	0.000***	2.492	4.811	
LLC	0.935	0.455	2.05	0.048**	1.861	0.010	1.86
LES	0.659	0.341	1.93	0.062*	−0.034	1.353	1.49
LMI	0.423	0.330	1.28	0.208	−0.247	1.095	1.61
LEN	1.569	0.285	5.50	0.000***	0.989	2.148	1.26
LTR	0.058	0.246	0.24	0.813	−0.441	0.559	2.48
LLab	−0.095	0.065	−1.45	0.155	−0.228	0.037	2.88
LCO_2	−0.100	0.167	−0.60	0.555	−0.440	0.240	2.85
Num. of obs = 43 F (7,35) = 9.59 prob > F = 0.0000							
R-Sq. = 0.6573							
Adj.R-Sq = 0.5888							
Br.P. = 0.8734							
Sh.W. = 0.12866							

Note: * Significant at 10%; ** Significant at 5%; *** Significant at 1%.

Table 9
GGEI and sustainable development (Total Unemp.) GLS, Upper middle income.

L (Unp) Dep. variable	Coef.	Std. Er.	*t*-test	P>|t|	[95% Conf. Interval]		VIF
Constant	2.148	0.910	2.36	0.024**	70.299	3.997	
LLC	−0.957	0.719	−1.33	0.192	−2.418	0.502	1.86
LES	−0.097	0.559	−0.17	0.863	−1.232	1.037	1.48
LMI	−0.155	0.534	0.29	0.773	−0.929	1.240	1.64
LEN	1.054	0.458	2.30	0.028**	0.122	1.986	1.29
LTR	−0.445	0.390	−1.14	0.262	−1.238	0.347	2.35
LLab	−0.222	0.104	−2.22	0.033**	−0.444	−0.020	2.75
LCO2	−0.072	0.255	−0.28	0.778	−0.590	0.445	2.71
Num. of obs = 43 F (7,35) = 2.96 prob > F = 0.0151							
R-Sq. = 0.3720							
Adj.R-Sq = 0.2464							
Br.P. = 0.3920							
Sh.W. = 0.66165							

Note: ** Significant at 5%.

Table 10
GGEI and sustainable development (Poverty ratio) GLS, Upper middle income.

L (Pov) Dep.varia	Coef.	Std.Er.	*t*-test	P>|t|	[95% Conf. Interval]		VIF
Constant	0.206	1.196	0.17	0.864	−2.230	2.642	
LLC	6.998	1.119	6.25	0.000***	4.717	9.278	2.85
LES	−3.003	0.844	−3.56	0.001***	−4.723	−1.284	5.67
LMI	3.332	1.129	2.95	0.006***	1.030	5.633	2.85
LEN	0.454	0.727	0.62	0.537	−1.027	1.935	2.45
LTR	−1.197	0.630	−1.90	0.067*	−2.482	0.087	1.73
LLab	−0.117	0.180	−0.65	0.520	−0.486	0.251	3.16
LCO2	0.149	0.447	0.34	0.740	−0.763	1.062	3.11
Num. of obs = 38							
F (5,32) = 10.96 prob > F = 0.0000							
R-Sq. = 0.6314							
Adj.R-Sq = 0.5738							
Br.P. = 0.5891							
Sh.W. = 0.11456							

Note: * Significant at 10%; *** Significant at 1%.

was applied, and it was found that the estimated model was significant at (0.01) significance level, which indicates the significance of the variables jointly in their effect on poverty headcount ratio. The study uses the Breusch Pagan test for Heteroscedasticity and the Shapiro Wilk test for assessing the normal distribution of data which equal (0.58 and 0.11), respectively, which are greater than the null hypothesis so the null couldn't be rejected and the data doesn't suffer from Heteroscedasticity and it follows the normal distribution. Also, the results of the variance inflation factor test (VIF) are all less than 10 which indicate that the model doesn't suffer from multicollinearity problem too. All of these results are consistent with the GLS estimation results for the whole developing countries under the study.

7. Discussion

Table (10) and Figure (2) summarize the findings of the GLS approach. The estimation findings demonstrate that GE positively impacts the GDP and the employment level while having a negative relationship with the poverty rate in developing countries.

The positive coefficient of GE means that it increases economic progress; demonstrating that green economic growth can be considered necessary for achieving sustainable development. Green economic growth may result from increased reliance on environmentally friendly, cost-effective innovations, the promotion of sustainable energy production, and the diversification of the energy mix by boosting the adoption of renewable energy. This may be with the findings by Refs. [35,37]. It is crucial to mention that among the four main dimensions of GGEI, leadership, and climate change, efficient sectors and environment and natural capital are the ones that positively affect income per capita. Leadership and climate change include all policies and regulations helping developing countries move towards a green economy without hurting their economic growth [79–81]. The other important dimension of the GE to GDP per capita is the efficient sectors, which consist of public and private sectors such as energy, tourism, green transportation, and green building, all of these new green sectors will boost the country's economy as well as the average per capita income [82,83].

The positive influence of the GE on employment may be attributed to several factors associated with a green economy that fosters an equitable society and establishes occupations, highlighting its positive impact on the workforce sector and this is in line with [49,50,84,85]. Moreover, concerning the environmental dimension with natural capital, it stands to logic that nations with high-quality natural resources have an advanced level of economic development, which corresponds to the input factors of the production function, among which are natural resources. Hence, an appropriate environment and natural capital will lead to a better economy. In addition, the conclusion about the green economy's effect on unemployment remains ambiguous, since the findings indicate that only one component of the green economy has a noticeable positive influence on unemployment. Since the green economy has an indirect impact on jobs by economic output, it does not directly influence employment. Jobs will rise as productivity increases, and unemployment will fall. However, this secondary impact is minimal and is not driven exclusively by GE. And these results parallel ILO reports that conducted the green economy has the potential to create millions of new employments [86,87].

Additionally, promoting GE leads to eradicating poverty, resulting in sustainable development. This major negative linking exists because the upsurge in development cooperation resulted in the appropriate and reliable means to execute programs and policies, which drives to overcome poverty in all of its forms. This connection is the line with many studies that concluded that to reduce poverty and promote sustainable development, attempts have been made to implement green economy strategies. Furthermore, the GE reduces the poverty rate in every country based on its national criteria, by this way the higher the environmental quality, the lower the poverty level in a given country. Among the key dimensions of GGEI, two dimensions greatly affect the poverty rate. First, the Market and investment have a negative relationship with the poverty level as the advance of green investment will increase per capita GDP as well as the standard of living of people in the country. By raising the standard of economic life, the number of people whose income is below the poverty line for each country will decrease. Second, the environment and natural capital also have a negative relationship with poverty as environmental conservation and sustainable use of natural resources will contribute to securing the per capita share of good food and safe drinking water and thus reducing malnutrition rates, which will lead directly to reduce poverty rates in developing countries [39,40,44,45,88].

8. Conclusion and policy recommendations

The importance of the GE concept emerged not as an alternative to SD, but as a specific and direct approach and an essential tool for achieving SD. Moving towards a GE has the potential to achieve economic growth and poverty eradication on an unprecedented scale, quickly and effectively. This potential derives from two simultaneous changes. First, our society and the risks we face have profoundly shifted due to a shifting playing field. These shifts necessitate a radical rethinking of our economic strategy, and second, there is an increasing recognition that natural resources are the foundation of our physical infrastructure and must be managed as a primary source of prosperity and well-being. Therefore, countries are currently racing to exploit their potential available natural resources and renewable energy, especially in light of the global trend towards attention to environmental issues to reduce ecological degradation and damage to biodiversity, in addition to acid rain and a marked increase in temperatures due to the rise of GHG that cause change Climate and portend disastrous consequences. As a result, GE can be seen as a new economic paradigm and a key factor in economic development, job creation, and poverty reduction for all countries worldwide, particularly emerging ones.

In light of this, the results showed that GE positively affects the average per capita income of GDP and the level of total unemployment, while negatively affecting the poverty rate in developing countries, which implies that the green economy is a major engine to achieving sustainable development by promoting economic growth, creating new jobs opportunities and reducing poverty across developing countries.

So, the significance of a green economy should be clarified by developing country administrations by unifying its definition, tools of measurement, and data set used in the calculation, improving institutions and policies to promote public and private sectors investing in green sectors, encouraging scientific research and development initiatives and technological innovation. By allocating a large portion of public expenditures for scientific R&D in the field of green economy, designing special programs to raise the quality of labor based on intensive training on advanced technologies for the various green sectors, and raising their skills. Also, issuing and developing policies for the transition towards a GE to encourage public spending and foreign direct investment to generate new economic sectors and investment opportunities that contribute to increasing job creation potentials, especially for the poor and vulnerable groups is considered a crucial step.

Encouraging the establishment of the national green financial system, which provides some new financial tools such as green

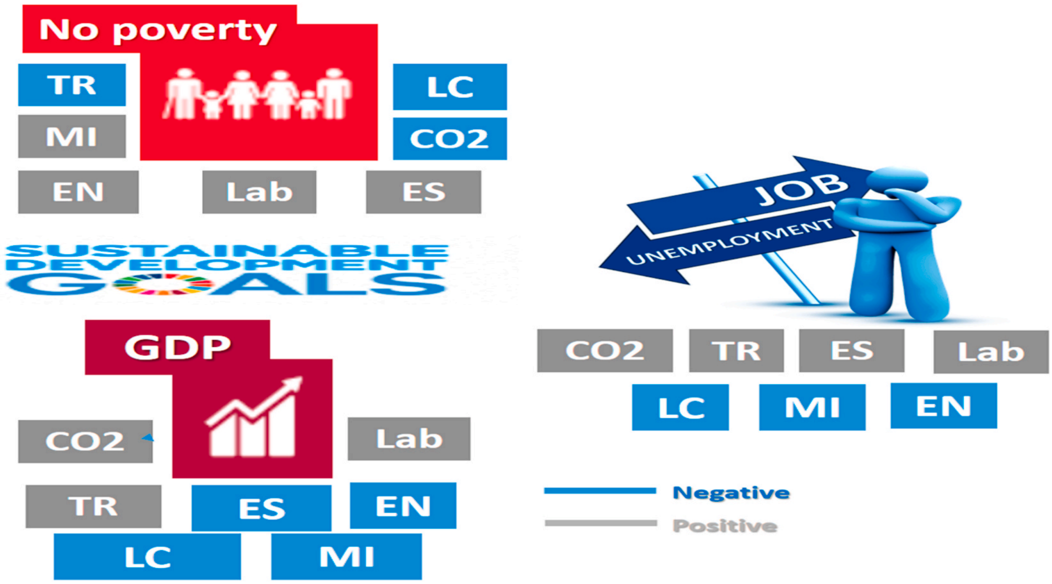

Fig. 2. Empirical Results for the study variables.

securities, green insurance, and green credit to meet the demand for sustainable green financing for green transition is crucial. Moreover, promoting new investments in the renewable energy sectors, in particular, wind and solar energy, and the use of renewable energy must be institutionalized in all fields, as renewable energy products lack this character, so the consumer may use these products without the existence of a mechanism responsible for regulating his rights and duties towards the product. Accordingly, the authorities and ministries concerned with renewable energy must provide that institutional character to ensure a wider use and spread of renewable energy in developing countries.

Green policies must integrate environmental, social, and economic considerations, to assure a fair distribution of wealth, and to ensure that different segments of the population have equal opportunities. Furthermore, encouraging the private sector to invest in green sectors through the use of economic incentives such as procurement policies, differential pricing, and taxes to promote renewable technologies and financing mechanisms, as well as encouraging the use of renewable energy technologies through reducing tariffs on equipment and components, as well as, eliminating or reducing fossil fuel subsidies.

We focused on the linkages between the green economy and sustainable development by targeting the social and economic dimensions associated with the first and eighth goals named; no poverty, decent work, and GDP applying the emerging economies. However, for future studies, we suggest that the study's framework expand by including other goals for sustainable development in the analysis, and suggest including developed and developing countries for comparing and acquiring additional conclusions.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

List of abbreviations

ARDL Autoregressive Distributed Lag
CO_2 Carbon
ILO International Labour Organization
GAM Growth Accounting Method
GE Green Economy
GGEI Global Green Economy Index
GLS Generalized Least Square
GDP Gross Domestic Product
GTFP Green Total Factor Productivity
OECD Organization for Economic Co-operation and Development
OIC Organization of Islamic Countries
OLS Ordinary Least Square
SD Sustainable Development
TFP Total Factor Productivity

UN United Nations
UNEP United Nations Environment Programme
VIF Variance Inflation Factor

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