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The Impact of Renewable Energy Investment on Economic Growth

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Abstract:
The study aimed to define and assess the impact of renewable energy on economic growth. This included the use of panel data for 18 different countries during the period of 2008-2015. The FMOLS econometric technicality was used to estimate the relevant relations between the independent variables, namely; renewable energy, capital, labor and trade openness and the dependent variable, real GDP per capita. The study found that renewable energy affects economic growth positively, however, the elasticity was highly inelastic. Also, the study found positive and significant relationships between economic growth and the other three independent variables with inelastic elasticities.
The study concluded that countries should be encouraged to invest in renewable energy and gradually decrease their dependence on conventional energy. Furthermore, it highly recommended to remove all obstacles facing the development of renewable energy.

Key words:
economic growth, renewable energy, GDP per capita, FMOLS, capital, labor, trade openness.
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INTRODUCTION

The problem of environmental pollution resulting from the exploitation of fossil energy and the increasing demand for fossil energy, especially in the major industrial countries is the most responsible factor for pollution problems. As a result of its consumption of large quantities ofgas and coal, the countries have led to search for alternative sources of traditional energy that can secure the energy supplies. On the other hand, the need of environmental protection has opened up the field for the promotion and investment of clean renewable energies in the form of solar and wind energy along with hydropower and biomass energy. The energy sector holds vital importance as a source of national income in many countries. The availability of various energy sources is the main artery of the world economy and modern economic life cannot be sustained without these sources considering them the backbone of economic life. This study describes the effect of investing in renewable energy on achieving economic growth, especially as the increasing need for energy and reliance on the sources that are threatened with depletion. This led to the search for renewable sources of energy such as the sun, wind, tides and bio-energy to achieve the desired economic growth.

What is the renewable energy

The renewable energy is that collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat. (Ellabban, Omar; Abu-Rub, Haitham; Blaabjerg, Frede (2014). Renewable energy often provides energy in four important areas: electricity generation, air and water heating / cooling, transportation, and rural (off-grid) energy services.Renewables Global Status Report 2010.The types of renewable energy Renewable Energy Types Nada Kh. M. A. Alrikabi (2014).

- ✓ Solar Energy: solar energy has the greatest potential for providing clean, safe, and reliable power. The solar energy falling on the Earths continents is more than 200 times the total annual commercial energy currently being used by humans.
- ✓ Wind Energy: wind ultimately driven by atmospheric air, is just another way of collecting Energy. The sun also heats the atmosphere, which produces wind. It works during the wet season; on rainy and cloudy days.
- ✓ Biomass Energy: biomass is the most important source for energy productions supplied by agriculture. Effective harnessing of bio-energy can energize entire rural milieu in a country like India where nature offers various types of biomass.
- ✓ Tidal Power oceans cover two thirds of the Earth's surface. This water is avast reservoir of renewable energy. India is mostlysurrounded by the ocean.
- ✓ Geothermal Energy: geothermal energy is the heat from the Earth. It's clean and sustainable. Resources of geothermal energy range from the shallow

ground to hot water and hot rock found a few environmental awareness. And a few investments in the field of renewable energy.

Economic growth

Can be defined as the increase in the inflation-adjusted market value of the goods and services produced by an economy over time. It is conventionally measured as the percent rate of increase in real gross domestic product, or real GDP. IMF, October 2012. Growth is usually calculated in real terms - i.e., inflation-adjusted terms – to eliminate the distorting effect of inflation on the price of goods produced. Measurement of economic growth uses national income accounting.[5] Since economic growth is measured as the annual percent change of gross domestic product (GDP), it has all the advantages and drawbacks of that measure. The economic growth rates of nations are commonly compared using the ratio of the GDP to population or per-capita income. Bjork, Gordon J. (1999).

Methodology of the study:

This research is based upon a standard analysis method used to analyze and interpret data where the inductive approach will be used to review previous studies, previous theoretical literature and research, books, and literary journals related to the subject matter of the study. Forthe analytical side, econometric techniques will be used to test the impact of renewable energy investment on economic growth with annual data for the period 2015-2008for 18 countriesthe data was chosen from the data of world bank, the 18 countries were chosen because their data are appropriate in terms of the volume of renewable energy production compared to their total energy production, the volume of production from renewable energy for the 18 countries represents more than 10% of its total energy production.

For the analytical study, the following variables are selected: Real GDP per Capita; Renewable Energy Investment Index; CapitalThe standard model of the study is based on previous studies and economic theory as follows:

$$G= \alpha_o + \beta_1 R+ \beta_2 K+ \beta_3 T+ \beta_4 L+\mathcal{E}_t \ldots\ldots (1)$$

Where:

- ✓ (G) is defined as real GDP per Capita
- ✓ (R)Independent variable that expresses the proportion of energy production from renewable sources tothe total production of energy
- ✓ (K) change capital accumulation.
- ✓ (T) stands for trade openness.
- ✓ (L) the size of the workforce.
- ✓ $\beta_1,\beta_2,\beta_3,\beta_4$Parameters of independent variables
- ✓ $\mathcal{E}_t$:error term.

The relevant data will be obtained from publications and reports issued to a group of countries, mainly from the World Bank data base for the period (2008-2015 the data will be processed through the following tests:

✓ (The Unit Root Test): tests the stationarityof the variables.
✓Cointegration Test: tests the stability of the variables and reveals if they are cointegrated together.
✓Running the econometric model, which will be one of these methods:OLS, ARDL, FMOLS, VECM)

LITERATURE REVIEW:

Renewable energy is defined as the energy present in nature thatcannot be depleted.In other words, it is the energy derived from natural resources unable to be implemented, i.e., energy generated from an inexhaustible natural source, available everywhere on earth's surface, and easily transformed to workable shape .One of the most important features of renewable energy is that it is eternal and environmentally friendly unlike the non-renewableenergy. These are located in stocks in the land that can be used only after human intervention to remove them. Furthermore, renewable energy sources are totally different from petroleum wealth as their remains do not pollute the environment as they do when the oil burns. (FrohatHadda2012).

The paper study the dynamics of renewable energies in Arab countries using statistical tools, through an analysis of the international approach to renewable energies as an alternative to traditional energies, by dividing them into oil and non-oil countries the paper analyzed and compared between them by using econometric tools to predict the international trend and the orientation of Arab states, both oil and non-oil, to renewable energies. It estimated standard models to analyze how renewable energies affecting growth rates. (Zerzarlayachi and Medahi Mouhamed 2016) Solar Energy and Sustainable Development Volume 5 No (1)2016 Scientific journal published by the Center for Research and Studies on Solar Energy

Fossil fuels can cause considerable damage, burning fossil fuels raises the level of CO2 Biogas, Wind Power, Optical Power, Biofuels, Geothermal Power and Small Water Power. Thus, the future depends on nuclear and renewable energy. The expansion of production technologies based on nuclear energy and renewable energy would significantly reduce future gas emissions, thereby reducing environmental damage. Renewable energy is sometimes a strategic decision vital for countries with limited and dependent on other countries energy imports. (Šimelytė&Dudzevičiūtė, 2017)

The article studies the relationship among renewable energy consumption, carbon dioxide (CO2) emissions, and GDP by using panel data for 24 Asian countries between 1990 and 2012. The paper use cointegration test, the VECM, and the Granger causality test, the study found that a long-run equilibrium exists among renewable energy consumption, carbon emission, and GDP. CO2 emissions have a positive effect on renewable energy consumption in the Philippines, Pakistan, China, Iraq, Yemen, and Saudi Arabia. Increase in 1% in GDP will increase renewable energy by 0.64%. Renewable energy is significantly determined by GDP in India, Sri Lanka, the Philippines, Thailand, Turkey, Malaysia, Jordan, United Arab Emirates, Saudi Arabia, and Mongolia. A unidirectional causality runs from GDP to CO2 emissions, and two bi directional causal relationships were found between CO2 emissions and renewable energy consumption and between renewable energy consumption and GDP. (Wen-Cheng Lu (2017)

On the other hand, the current presence of energy sources has become a motive for integrating and coordinating efforts to enhance the country's position in the world market, especially in light of the emergence of global crises, their effects and their negative effects on the economies of countries. In addition, renewable energy plays an important and essential role in the economies of the countries, so the issue of energy has been studied and discussed because of the high prices and its used as a weapon by the Arab countries during the same period when the world realized the fact that energy sources and technologies are not possessed. This is especially the case after the balance of payments has been affected by this price increase, which has led them to reconsider their policy depending on their advanced technology and substantial financial resources. These countries have succeeded in consuming their energy and developing anddiversifying alternative energy sources in an attempt to cope with their increasing demand on energy (KamilKaygusuzaAbdullahKaygusuzb2002). Renewable energy and sustainable development in TurkeyVolume 25, Issue 3 Pages 341-497 (March 2002)

The concept of economic growth refers to a rise in gross domestic product (GDP) or gross national income, leading to an increase inreal per capita income over time. In other words, economic growth is an increase in the amount of goods and services that an individual receives through spending their national income. The economic growth of any country is also deliberate on the rate of continuous increase of population and individual output (Acemoglu, 2012).

Economic growth can be achieved only by surpassing the rate of growth above the rate of population growth. Economic growth is an increase in the income of a particular country measured by GDP growth. In addition, increased capital,

technological progress and improved education are among the main reasons for economic growth. Economic growth is achieved through economic plans and appropriate solutions that contribute to the improvement of the economic level of the country, the attention and training of workers and employees, and the provision of all instruments, financial information and financial technology means to improve and increase local production, national income and spread economic awareness.

For economic progress of any nation, generalized production of energy is very important but due to the current situation of growth in population, price hikes of energy, environmental issues and lagged economic growth, which requires enhanced amount of power generation being produced from conventional resources which are dying out. Even the power generation is shifting towards renewable resources which are nature based are producing energy security and reducing the detriments of global warming and hazardous change in climate. This study shows a link between renewable energy production and economic growth of European Union (EU) under the period of 2003-2014. As estimated amount of renewable energy into total production is only 15% and the its share in transport sector is 03% which are below the proposed estimates of 20% and 10% respectively (EU directive 2009/28/EC). By evaluating board information fixed-impacts relapse models, the outcomes offer support for a positive impact of sustainable power source in general, just as by type, to name some are hydropower, geothermal vitality, wind power and sun-based vitality on GDP per capita.Daniel Stefan Armeanu, GeorgetaVintilăand S¸ tefan Cristian Gherghina (2017).and others Georgeta SOAVA, Anca MEHEDINTU, Mihaela STERPU, Mircea RADUTEANU,(2018) ,Teresa Grijo´ • Isabel(2016), Imran Hanif

These studies are related to the objectives set by EU based on the strategy of Europe 2020 which aimed at reduction in non-renewable energy production and consumption to get a reliable source of energy based on renewable systems. To increase the efficiency of production must put positive aspects on demand of energy per capita unit of GDP for economy and enhance green production of energy by reducing hazardous gas emissions, so that a long-standing liability on traditional energy resources can be reduced. (Marius-CorneliuMarinaş, Marin Dinu, Aura-Gabriela Socol, Cristian Socol, 2018).

As indicated by Fangan, increment of sustainable power source utilization by 1% drives a development of GDP by 0.120%, GDP per capita by 0.162%, per capita yearly pay of rural family units by 0.444% and per capita yearly pay of urban families by 0.368% (Fang 2011).Bölük and Mert demonstrated that the ozone depleting substance outflows in EU nations are decreased by around 1/2 for every unit of sustainable power source expended over fossil energy consumption (Energy 2014). (Bölük & Mert, 2014).

This study also describes the link between non-consistent energy usage, growth in economy and emission of carbon dioxide in given five appearing economic sectors Brazil, Russia, China, India and South Africa (BRICS) during the period 1992-2019. This was demonstrated in a neo-classical aggregate production and stochastic Impacts by Regression on Population, Affluence and Technology (STIRPAT) modelling framework.

The research applied the strong unit root, cointegration and quite a while ago run flexibility estimation strategies like Pooled Mean Group and differenced board summed up strategy of moments for exact exercise. Having distinguished the board heterogeneity and cross-sectional reliance, the cointegration tests archived the proof of a long run relationship among the different factors that affects the overall production. In the long run, capital, work and non-sustainable power source utilization are found to influence the monetary development in a positive manner. Despite what might be expected, the effect of sustainable power source utilization on the financial development is discovered to be certain however factually irrelevant. In addition, the population, per-capita income and non-renewable power source utilization are found to build the discharges while sustainable power source utilization diminishes them. Hence, alongside an appropriate emissions controls, BRICS nations should structure and execute viable help strategies in order to guarantee the monetary development along with ecological maintainability (Javed Ahmad Bhat 2018)

Measures of economic growth

Among the most important measures of economic growth (Bose et al., 2007) are:
1. "We are very concerned about the situation in the region," Bose said. As their increase or decrease may lead to positive or negative results, it should be noted that the increase is detrimental only to a situation that is lower than the population growth rate.

2. Expected gross national income: A number of economists have suggested that growth is measured based on expected rather than actual income, especially in countries with a large number of crippling potential resources.

3. Average per capita: It is one of the most widely used and true criteria for many economists. Nevertheless, the methods of measuring and counting face many problems in developing countries, which makes comparisons between societies inaccurate, given that there is a difference in the bases and methods of measurement and estimation, such as those based on the total population It is based only on the working population where
The rate of economic growth for two periods is:

GDP = Real per capita income for the t period - real per capita income for the t-1 period / real per capita income for the t-1 period.

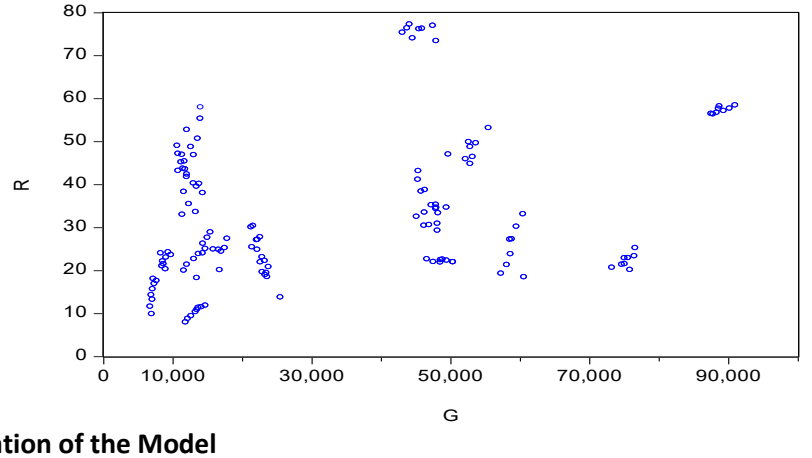
Descriptive Analysis:

Table (1) shows the descriptive statistics for research variables, with average GDP reaching 33606.86 at a standard deviation of 2426.73, while average capital accumulation was 92.700 billion dollars at a standard deviation of 12.7 billion dollars, average labor force was 10049610 at a standard deviation of 21881556, while average renewable energy production was 33.1 at a standard deviation of 16.535. Finally, the average trade openness~~is~~ was 93.82 with a standard deviation of 33.53.

	G	K	L	R	T
Mean	33606.86	92700000000	10049610	33.10656	93.82777
Median	22702.28	52100000000	3147848	27.40984	89.54126
Maximum	90917.5	517000000000	102000000	77.34468	170.4283
Minimum	6709.527	1920000000	187696	8.01054	22.10598
Std. Dev.	24326.73	127000000000	21881556	16.53579	33.53982
Observations	144	144	144	144	144

Table 1: Research Variables Descriptive Statistics

Figure (1) shows the relationship between GDP per Capita (G) and Renewable Energy production(R)



Estimation of the Model

To perform a standard analysis of the impact of renewable energy investment on GDP growth, the stationarity of time series representing study variables must be identified. The Panel Datais organizedto cover the period from 2008 to 2015, for 18 countries.

Stationary Test:

As shown in table 2 all the variables, except L, are stationary.

Table 2 Stationary Test (Source: From the researcher work on E-Views)

Variables	Exogenous variable	Method	T statistic	Prob	Decision in level 5%	Decision in first difference 5%
G	intercept	Levin, Lin & Chu t*	-8	0	stationary	
		Breitung t-stat	-	-		
		Im, Pesaran and Shin W-stat	-1	0.24		
		ADF - Fisher Chi-square	49	0.07		
		PP - Fisher Chi-square	57	0.01		
T	intercept	*Chu t&Levin, Lin	-27	0	stationary	
		Breitung t-stat	-	-		
		Im, Pesaran and Shin W-stat	-13	0		
		ADF - Fisher Chi-square	171	0		
		PP - Fisher Chi-square	74	0		

L	no no &intercept trend	*Chu t&Levin, Lin	-5.3	0	non stationary	stationary
		Breitung t-stat	-	-		
		Im, Pesaran and Shin W-stat	-	-		
		ADF - Fisher Chi-square	70	0		
		PP - Fisher Chi-square	98	0		
K	intercept	*Chu t&Levin, Lin	-5.2	0	stationary	
		Breitung t-stat	-	-		
		Im, Pesaran and Shin W-stat	-1.3	0.1		
		ADF - Fisher Chi-square	56	0.02		
		PP - Fisher Chi-square	81	0		
R	intercept	*Chu t&Levin, Lin	-6.6	0	stationary	
		Breitung t-stat	-0.6	0.27		
		Im, Pesaran and Shin W-stat	-0.5	0.32		
		ADF - Fisher Chi-square	57	0.01		
		PP - Fisher Chi-square	82	0		

Cointegration Test:

The next step is to test the stability of the variables and therefore there is a possibility that these variables can have a Long-term trend. This can be verified by testing the interrelationships of integration. These variables are used by the Johansen Fisher Panel Cointegration Test shown in table (3):

Table 3 Johansen Fisher Panel Cointegration

Pedroni Residual Cointegration Test				
Prob.	Weighted Statistic	Prob.	Statistic	
0.9871	-2.229	0.4223	0.195954	Panel v-Statistic

1	4.450001	0.9999	3.732059	Panel rho-Statistic
0	-5.92343	0	-4.98591	Panel PP-Statistic
0.0356	-1.80372	0.0015	-2.97638	Panel ADF-Statistic
		1	6.611063	Group rho-Statistic
		0	-7.96076	Group PP-Statistic
		0.015	-4.03581	Group ADF-Statistic

Table 4 shows the common integrity test for the time segment data where the corresponding statistical significance of 6 out of 11 partial tests is shown in this type of tests are less than 0.05 and therefore reject the nulhypothesis that there is no common integration Among the variables studied, the alternative hypothesis that there is common integration is not overstated.

Model estimation using FMOLS:

FMOLS are superior to the OLS for many reasons:

(1). OLS is found to be a super-cointegration module, but the t-figures are found to be stationery without I (0) term to be normal in approximation. In the availability of a large finite sample bias convergence of OLS, it is found to be cointegrated even in lower finite examples.

(2). OLS approximation can be affected by serial connection, heteroskedasticity from the time when different dynamics are taken out by residual interference even by valid and related outcomes. Therefore, one can see that "t" statistics for the estimates OLS estimates are useless (3) FMOLS take care of endogeneity by adding the leads & lags.

The model is estimated in the logarithmic form as follows:

$$lnG = \beta_1 lnRt + \beta_2 lnKt + \beta_3 lnTt + \beta_4 lnLt + \varepsilon t .$$

Table 4Model estimation usingFMOLS a methodology

Variable	Coefficient	Std. Error	t-Statistic	Prob.
K01	0.270168	0.019140	14.11549	0.0000
L01	0.185380	0.030688	6.040729	0.0000
R01	0.141699	0.043395	3.265344	0.0014
T01	0.079430	0.020414	3.890984	0.0002

From table4,it can be concludedthat there is a long- term correlation between GDP per capita and investment in renewable energy, that is statistically significant. Similarly,we can also note a long- term correlation between GDPand the changing capital accumulation that is also statistically significant. We can

observe a long- term correlation between GDPand labor change is statistically important, and finally a correlation betweentrade openness and GDPalso proves to bestatistically significant.

The estimated equationcan be expressed as follows:

$$lnG = \beta_1 lnRt + \beta_2 lnKt + \beta_3 lnTt + \beta_4 lnLt + \varepsilon t$$

1. β_1:Represent the elasticity of production to renewable energyan increase in renewable energy of 1% increases in GDP per capita by 0.14%.
2. β_2 : Represent the elasticity of production to capital formation, an increase in fixed capital formation of 1% increases in GDP per capita by 0.27%.
3. β_3 : Represent the elasticity of production to trade opennessan increase in trade openness of 1% increases in GDP per capita by 0.079%.
4. β_4 : Represent the elasticity of production to workforcean increase in workforce of 1% increases GDP per capita by 0.0185%.
5. εt : Represent error term.

1.1 2.6 CausalityTest:

Table No: 5 Wald Test

The Wald Test is described in the following table:

Test Statistic	Value	df	Probability
F-sstatistic	23995.96	(4, 122)	0.0000
Chi-ssquare	95983.84	4	0.0000

Null Hypothesisis: C(1)=C(2)=C(3)=C(4)=0 Null Hypothesis Summary HypothesisSummary:

Normalized Restriction(= 0)	Value	Std.Err.
C(1)	0.270168	0.019140
C(2)	0.185380	0.030688
C(3)	0.141699	0.043395
C(4)	0.079430	0.020414

From table5, it can benoted that the value of PROB is less than 0.05 and therefore the relationship between the combined independent variables and the dependent variable is a long -term and causality relationship.

CONCLUSION:

The problem of the depletion of conventional energy sources and environmental pollution can disrupt the ecosystem and the economic system, given the direct link between energy and economic issues affecting economic growth, energy sources are the backbone of life and the engine of industrial progress in particular, and economic progress in general

1. Investment in renewable energy has a positive effect on GDP growth, which is statistically significant at the 5% level. However, it is highly inelastic (0.14) %.
2. There is a statistically significant positive effect between growth in per capita GDP and growth in fixed capital formation; thus, an increase in fixed capital formation of 1% increases GDP per capita by 0.27%, consistent with economic theory and previous studies.
3. A positive, statistically significant relationship between growth in GDP and growth in the laborforce; Thus, a 1% increase in the labor force increases per capita GDP by 0.1853%, and is consistent with economic theory and past studies.
4. There is a statistically significant positive relationship between growth in per capita GDP and growth in the labor force; thus, a 1% increase in the labor force increases per capita GDP by 0.1853%, and is consistent with economic theory and past studies.
5. Trade openness is statistically significant. A statistically significant positive relationship between growth between GDP per capita and trade openness of 0.0794% is consistent with economic theory but is statistically non-controversial.

RECOMMENDATIONS:

1. Because of the positive relationship between investment and economic growth It is very important to increase the investment in renewable energy.
2. Support and increase investment in research centers, especially those concerned with renewable energy research.
3. Supporting legislation that supports encouraging investment in renewable energy by giving investors the necessary facilities to invest in this field
   Trying to remove obstacles that negatively affect investment in renewable energy, especially technological constraints, through intensive cooperation with developed countries in the field of renewable energy

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