THE DYNAMIC EFFECTS OF RENEWABLE ENERGY ON ECONOMIC GROWTH: THE CASE OF CHINA

Majed S. Almozaini

Abstract

This paper estimates the possible effects of renewable energy consumption on the economic growth of the major renewable energy-consuming country in the world, China. As the top renewable energy-consuming country, this paper uses China to explain the growth process between 1990 and 2019. Using time-series analysis techniques, this study uses estimations and tests results from the different cointegration methods used in China. The results confirm the evidence of long-term dynamics between economic growth and traditional and energy-related inputs. Findings from long-term output elasticities indicate that renewable energy consumption has a significant positive impact on economic output. The findings suggest that governments, energy planners, international cooperation agencies and associated bodies must act together to increase renewable energy investment for low carbon growth in most of these economies.

Keywords: renewable energy; economic growth; CCR-DOLS; cointegration; China

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1.   Introduction

In recent decades, the attention of the world towards the attainment of the Sustainable Development Goals (SDGs) and the worldwide debate on the need to limit the use of fossil fuels has necessitated the utilization of renewable energy as a feasible option for environmentally friendly and inclusive economic growth. The U.S. Energy Information Administration (EIA) defines renewable energy as being energy obtained from naturally replenishing, inexhaustible sources. There are several sources of renewable energy, the major ones being hydropower, solar energy, wind energy, biomass, and geothermal energy. According to the Renewable 2018 Global Status Report (REN21), renewable energy contributed about 70% of the global power generation in 2017. The report also stated, that in the global power sector, there was a revolutionary shift towards the use of renewable energy in the future, though the rate of the transformation is below expectation. This paper will discuss the effects of renewable energy consumption on economic growth using China, the biggest consumer of renewable energy, as an example.

The decade ranging from 2014-2024 has been designated 'the Decade of Sustainable Energy for All' by the United Nations. The attainment of sustainability in energy will create a cleaner environment and energy efficiency using low-carbon renewables and access to electricity will be wider [8]. Globally, renewable energy has been deployed with the overarching goal of helping to address the problems caused by rapid climate change and creating wider access to energy for billions of people living below the poverty line. The International Energy Agency (IEA) projects that the share of electricity generated from renewable energy across the world will increase to 39% by 2050 from 18.3% in 2002. The agency also projects that renewable energy will reduce carbon dioxide production by 50% by 2050, thereby playing a major role in limiting rises in global temperature [5]. In recent years, the growth in the use of renewables has been driven by programs supported by governments through tax credits, subsidies, and other incentives.

Despite there being numerous studies on the energy consumption-economic growth nexus, studies based on renewable energy consumption and economic growth are scarce; however, there is growing concern around the importance of conducting economic research on the impact of renewable energy on sustainable economic development [1]. Generally, the energy consumption-economic growth nexus is analyzed using four hypotheses. The first hypothesis is the growth hypothesis, which states that the consumption of energy is vital for economic growth. According to this hypothesis, any other input, such as labor, capital or technological improvement, cannot be used as a substitute for the role of energy in the production process; therefore, a decrease in energy consumption results in a concomitant reduction in economic growth [27]. The second hypothesis is the conservation hypothesis, which suggests that the economic growth of a country determines its energy consumption, thereby completely differing from the growth hypothesis. The third hypothesis is the feedback hypothesis, which postulates a bi-directional relationship between economic growth and energy consumption where both are interdependent. The fourth hypothesis is the neutrality hypothesis which suggests that economic growth and energy consumption are independent of each other and therefore do not affect each other [24]. In summary, the growth and feedback hypotheses are used to explain the long-term relationship between economic growth and energy consumption, whereas the conservation and neutrality hypotheses are used to explain the short-term relationship between the two.

The study mainly focuses on quantitative research methodology with the objective of addressing the identified issue by considering relevant empirical equations and conducting Bounds F-Test for Cointegration, as well as Dynamic-OLS (DOLS) method of Stock and Watson (1993). Apart from these, the study utilized the Canonical Cointegrating Regression (CCR) of Park (1992) to generate suitable results and thereby address the issue identified by drawing pertinent conclusions. Based on these applicable methods,

it is evident that the study levies utmost attention only on quantitative methodology and data instead of focusing on the qualitative part, thereby affecting the generalizability of the overall collected data. This can be regarded as one of the most fundamental gaps being persistent within the given study. Here, case study approach can be considered to obtain qualitative data to raise the generalizability of the entire information retrieved for the given research. Another gap can be ascertained as the lack of collecting primary data, which could be made possible either by conducting questionnaire survey or semi-structured interview with the respective individuals, such as the business professionals being attached with one of the top renewable energy-consuming nations of this modern commercial world, i.e. China.

The aim of the given study is to estimate the probable effects of the consumption of renewal energy on the economic growth of China. It acts as one of the chief renewable energy-consuming nations in the entire world, and investigates its developmental procedure between the period of 1990 and 2019. Based on these aims, the below hypotheses have been framed for the given study:

Based on Bounds F-Test for Cointegration, the below hypotheses have been framed for the given study:

- Null Hypothesis (H0): There does not exist a long-term association amid Gross Domestic Product (GDP), Real Gross Fixed Capital Formation (GFCF), Labor Force (LF), Non-Renewable Energy Consumption (NREC) and Renewal Energy Consumption (REC) in China
- Alternative Hypothesis (H1): A long-term connection persists amid GDP, GFCF, LF, NREC and REC in China

The below hypotheses have been certainly framed for the study based on estimating Cointegration Coefficients by using DOLS and CCR:

- Null Hypothesis (H0): LNGFCF, LNLF and LNREC have a positive relationship with LNGDP in China
- Alternative Hypothesis (H1): There does not lay a positive relationship amid LNGFCF, LNLF as well as LNREC and LNGDP in China

2.   Renewable Energy Reviews China

According to Zhang et al., (2017), in 2015, China was named as the largest consumer of energy and emitter of carbon dioxide in the world. China is experiencing speedy modern development and economic growth which increases the demand for energy. In an attempt to satisfy the energy demands and also ensure the environment is kept clean, the government of China introduced measures and regulations to increase the production of renewable energy while reducing the over-dependence on fossil-fuel energy [31]. China has strategized to become the world's superpower in renewable energy by focusing on the utilization of solar power, wind power, hydropower and biomass power, among other forms of renewable energy [12].

Of the massive production and utilization of renewable energy sources in the world, it is worth noting that these technologies are vital for the economic advancement of a nation; in this case, China. Recently, China's renewable sources of energy accounted for over 39% of its total conserved energy resource paradigm [8]. These dynamic energy solutions are actively utilized in powering domestic and commercial facets of the economy.

As of 2016, China was world-leading in underlying technology with over 150,000 patents for renewable energy, which represents 29% of the world total. China was followed by the United States with slightly over 100,000 patents and the European Union and Japan, each with about 75,000 patents [12]. Beijing was also regarded as the leading city for the production of electric vehicles. As per the report, China has positioned itself as the largest global producer, installer and exporter of wind turbines, solar panels

and electric vehicles. China has estimated its solar capacity will reach 50GW by 2050, while some market commentators argue its capacity could reach 100GW by 2050 if following the current growth rate [28]. The National Energy Administration of China has aimed for each province to generate a capacity of 500MW of PV solar modules to enhance the installation to more than 15GW in the country [28]. Consequently, PV module prices have fallen from the 2007 price of 30 Yuan per Watt to 2 Yuan per Watt in 2017. Additionally, as of 2017, the solar power and wind capacity of china increased to 130.06 GW and 168.5 GW respectively. About 5.3% of the electricity supply in China currently comes from renewable sources (Boqiang, 2018).

As per Boqiang (2018), China leads for investment in renewables at 132.6 billion dollars, followed by Europe at 57.4 billion dollars, the United States at 56.9 billion dollars, Japan at 23.4 billion dollars and Germany at 14.6 billion dollars.
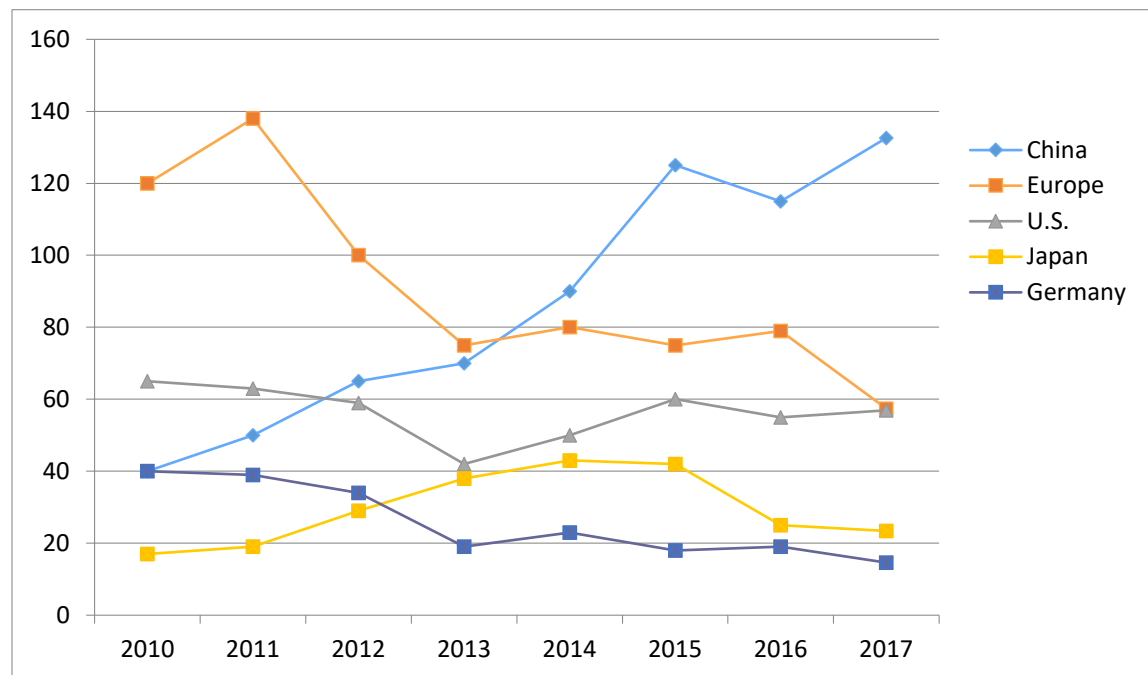

Figure 1. China's investment in renewables is leaving the rest of the world in its wake (2010–2017). Source: Bloomberg New Energy Finance.

63 % of the global solar photovoltaics supply comes from China (Edmond, 2019). The Chinese government put in place an initiative in 2007 that will use the Golden Sun scheme to expand its solar energy production. Following its effort, China has emerged as the leader in the world in the production of solar photovoltaic technology. The world's largest solar companies originate in china. Approximately 820 MW of solar PV come from china. Estimates from the world's intelligence market show China has the capacity to produce 370 GWdc of photovoltaic modules by 2021; this will be more than twice the capacity of the United States (Edmond, 2019). The top 10 countries in the world expected to be leading in the annual installation of PV between 2001 and 2024 include China, with around 369 GWdc by 2024, followed by the United States with 148 GWdc, India with 105 GWdc and Japan with 83 GWdc. Other countries are Germany, Italy, South Korea, France, and Australia with 64 GWdc, 31GWdc, 28 GWdc, 25.8 GWdc, and 25.6GWdc respectively (Edmond, 2019).
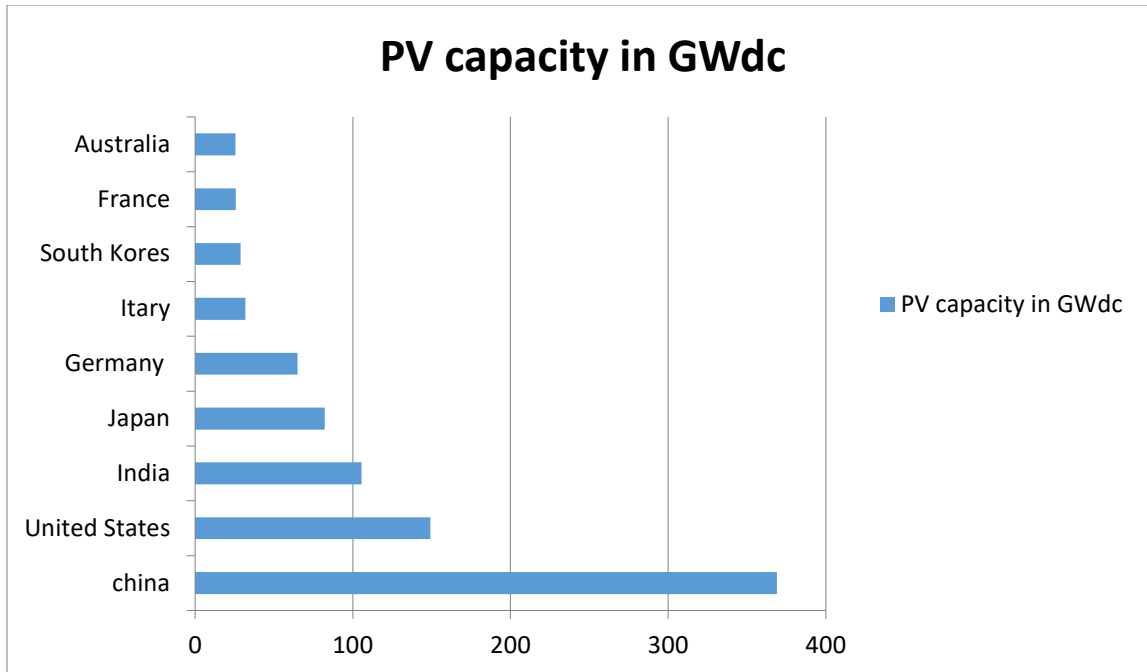
PV capacity in GWdc

Figure 2. Cumulative annual installation of PV between 2001 and 2024 by country (GWdc). Source: Wood Mackenzie Power & Renewables, Global solar PV market outlook

Despite China being the world's largest installer of hydro, wind and solar power, its economic and social developmental needs are growing so rapidly that in 2015, renewable sources made up only 24% of China's electricity generation. However, the proportion of renewable energy production and consumption is gradually increasing per year, with 2017 recording around 37% of the quantity of installed electric power capacity [11]. The increase is expected to continue over time and, by 2024, China is expected to be a global superpower in renewable energy.
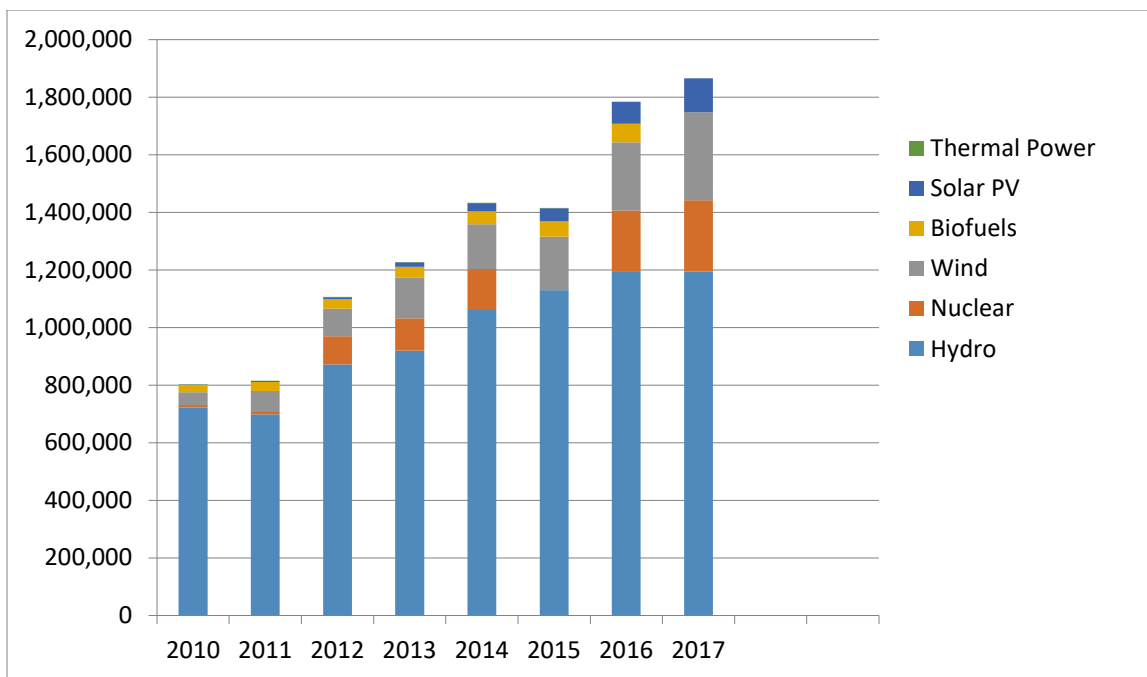
Figure 3. Total production of electricity (GWh) between 2011 and 2017. Source: Brookings.

Literature Review

The past three decades have seen a spectacular increase in the consumption of energy in China to sustain the rapidly growing economy. From 1977 to 2011, the energy consumption in the country rose by 7.3 times while the carbon emissions from energy consumption grew by 6.9 times [19]. By 2011, the carbon dioxide emissions in China accounted for 26.4% of global emissions, leading to rising concerns about the consequences the emissions might have on the socio-economic outlook of China and on the globe. This has led to the country promoting the production and consumption of renewable energy; from 1977 to 2011, the generation of renewable energy grew by 17% [9]; however, renewable energy generation accounted for only 8.8% of the total energy production in 2011. Most of the energy consumed in China is obtained from fossil fuels which are non-renewable and have high levels of pollutants. China has massively invested in the generation and consumption of renewable energy since this reduces carbon dioxide emissions and can be cheaper to produce. The rising consumption of renewable energy in China has led to research on the relationship between economic growth and renewable energy consumption.

There is a positive correlation between China's GDP and electricity production and consumption in the country, where an increase in electricity consumption has a concomitant increase in the GDP. The supply of electricity is, therefore, a vital aspect of the GDP growth of China [22]. The Chinese government has prioritized policies that result in energy efficiency as a means of ensuring a stable power supply to sustain economic growth. The actions of the government are aimed at boosting renewable energy resources through quick and cost-effective measures, including advances in technology, tax rebates and suitable policies [14]. The study by Lin & Moubarak (2014) concluded there was a two-way causal relationship between the consumption of renewable energy and the economic growth of China by analyzing the relationship between the two from 1977 to 2011. In the study, they found a positive impact and contribution to economic growth from the consumption of renewable energy. The Chinese government should enact laws and policies that support the production and consumption of renewable energy as a means of enhancing sustainable economic development and environmental protection [10]. However, there are significant challenges to achieving these goals, including the high cost of generating renewable energies, climate conditions, sufficient management for the maintenance and repair of renewable energy systems and infrastructure challenges.

In brief, this paper discusses the general effects of renewable energy consumption on economic growth, using China as an example since it is the largest consumer of renewable energy in the world. The paper shows a positive correlation between economic growth and the consumption of renewable energy, where an increase in energy consumption shows a respective
increase in economic growth. The Chinese government has heavily invested in the production of renewable energy as a means of enhancing sustainable economic development and the protection of the environment.

3.   Discussion

The table demonstrated hereunder provides a discussion on the comparison of the results of whether Energy Consumption (EC), REC and NREC are positively related to Economic Growth (Y) and vice-versa considering other recent publications. In this regard, the period of 2014-2019 has been duly considered for depicting and discussing the recent publications.

Table 1: Results Comparison with other Recent Publications

Author(s)	Country(s)	Period(s)	Methodology(s)	Finding(s)
Al-mulali et al. (2014)	18 Latin American countries	1980-2010	Panel cointegration test	Y ⇔ REC (long-run) NREC → Y (short-run) Y ⇔ NREC (long-run)
Halkos and Tzeremes (2014)	36 countries	1990-2011	Nonparametric analysis	Based on Growth hypothesis
Ibrahiem (2015)	Egypt	1980-2011	ARDL bounds testing approach	Y ⇔ REC (long-run)
Kumari and Sharma (2016)	India	1974-2014	Cointegration Granger Causality	Y → EC
Atems and Hotaling (2018)	174 countries	1980-2012	The system generalized method of moments (GMM) approach	Positive relationship between Y, renewable electricity generation and non-renewable electricity generation
Al-Mulali et al. (2019)	Gulf Cooperation Council (GCC) member	1980-2014	Panel cointegration test Panel Granger causality test Cross-sectional dependence test	Y → EC (short-run) Y ⇔ EC (long-run) Y == EC (DH)
Aydin (2019)	26 OECD countries	1980-2015	Panel unit root test Dumitrescu-Hurlin (DH) panel causality test Panel frequency domain causality	Y == EC (DH) Y ⇔ REC, NREC (panel frequency)

Source: (Yang & Kim, 2020; pp. 6-7)

The above table offers an in-depth insight into the researches that had been conducted previously on the similar issue of concern, i.e. for estimating the potential impacts of renewable energy consumption on China's economic growth. Besides, the articles covered in the table, when evaluated effectively helped largely in understanding the manner, in which the nations mostly consuming renewable energy throughout the world developed, especially during the years 1990 to 2019. All the articles selected herein were observed to be the quantitative ones, i.e. with the proper use of analytical techniques, mathematical as well as statistical formulae along with logical interpretations. Besides, the time period that was presented in the articles of the table was also observed to be within the ranges (1974) 1980-2015. The findings derived from these articles acted as rational support for presenting a clear understanding of the concerned issue, thereby influencing the progress of the research process of the existing study as well. The research processes of the selected articles also contributed largely to gathering proper information on the methods and analytical tools that can be used for analyzing the data on economic growth. The methods and approaches in the present research were also selected based on the understanding retrieved from the articles mentioned in the above-portrayed table 1.

4. **Data   and   Methodology**

The data were sourced along a simple production function in which traditional inputs, renewable and non-renewable sources of energy, are part of the process of producing goods. For a nation to be competitive in the global market, there is a need for a consistent and effective energy source. These two

different approaches had an influence on the choice of methodology. Further, neo-classical, single-sector aggregate-production systems were utilized in this paper in which capital and energy are considered individually because they are, essentially, separate entities.

GDP$_{it}$ = f (GFCF$_{it}$; LF$_{it}$; REC$_{it}$; NREC$_{it}$)

In this method, i and t describe country and time phase (1990-2019) respectively. In this study, real GDP or output (GDP) in US dollars is used in calculating economic output. When it comes to real gross fixed capital formation (GFCF), the same constant in US dollars was used in place of the growth of capital stock. Available labor force was denoted as (LF) to indicate total labor force.

The source of all the data was the World Development Indicators as prepared and presented by the World Bank; this is an essential tracking tool that is both credible and widely used. For the study to have credibility, the data sources have to be from international bodies that track the variables on a regular basis from an unbiased point of view. When it comes to energy consumption, be it renewable or non-renewable, the data were taken from the US Energy Information Administration (EIA); this is another credible entity that tracks the variables in focus. This source is also home to plenty of information on what is happening worldwide in terms of innovation and renewable energy.

Notably, this is represented through the use of raw data that represent the above variables; for instance, as of 2019, China's GDP was roughly 12 trillion USD while its labor force was roughly 800 million individuals [30]. Given that China largely depends on the utilization of renewable resources, it would be justified to say that the acquisition of new technologies aided China in the advancement of economic metrics.

For this study, the energy sources considered were based on energy consumption, renewable (REC) or non-renewable (NREC). Both of these sources of energy are necessary for progress and production but each has its own dynamics. For the renewable sources, the data were graded based on the electricity consumed in terms of billion Kilowatt hours. Renewable energy comes in many forms but the main aim is to generate energy for electricity. It makes sense to look at the amount produced in order to narrow down the data and avoid having multiple streams, each dedicated to a single type of renewable energy. For the non-renewable sources, the list was derived from coal, natural gas, and oil; for a majority of countries in the world, these are the standard non-renewable sources of energy. Although there are some nations which depend more on one kind than the other, it is assumed that all these sources were used equally. It was necessary to come up with a system that gathered all these fuel sources into a single entity. These were denoted using quadrillion Btu units. In terms of the other variable, GFCF was measured using currency units while labor was presented in numbers. These are standard uses and approaches when it comes to such data and so no assumptions were made.
The equation can be presented as follows:

$$GDP_{it} = GFCF_{it}^{\beta 1i} LF_{it}^{\beta 2i} REC_{it}^{\beta 3i} NREC_{it}^{\beta 4i}$$

The change of the data series into a natural logarithm obviates the issues associated with the dynamic properties of the data series. The logarithmic transformation of the data series is a favored methodology as each subsequent coefficient in a regression equation can be explicated as elasticities. The empirical equation is developed as follows:

$$\ln GDP_{it} = \beta_{1i} \ln GFCF_{it} + \beta_{2i} \ln LF_{it} + \beta_{3i} \ln REC_{it} + \beta_{4i} \ln NREC_{it} + \varphi it$$

In this equation, b1i, b2i, b3i and b4i are elasticities of output with respect to gross fixed capital formation, labor, renewables, and non-renewables, respectively.

As of 2019, China had set itself apart as the leading provider of renewable energy solutions by acquiring over 150,000 patents in the realm of renewable energy solutions, as compared to its competitors such as the US and Russia. As a result, technocrats offer that China, by its own volition as the leading renewable energy provider, will set the pace in terms of the acquisition of similar technologies. Moreover, these dynamic energy solutions are actively utilized in the powering of domestic and commercial facets of the economy. As a result, it is justified to assert that renewable energy sources have a direct impact on China's economy. The purpose of this assignment is to reveal the ways in which renewable energy sources impact China's economy. Ideally, the study will incorporate comparative fiscal and regression tools – namely, the Bound F-Test – to illustrate this aspect.

5. Empirical Results

Bounds F-Test for Cointegration

ARDL model specifications are used to demonstrate relationships in the long-run and dynamic interactions between economic growth, gross fixed capital formation, total labor force, non-renewable energy, and renewable energy using the Autoregressive Distributed Lag (ARDL) cointegration test, popularly known as the bound test. If the F-value is greater than the upper limit of the bound values, we reject the null hypothesis that there is no cointegration between the variables under study. If the F-value is less than the lower limit of the bound value, then we accept the null hypothesis of no cointegration among these variables. Table 2 shows the results of the bound test to examine the presence of a long-term relationship between GDP, GFCF, LF, NREC, and REC in China.

Table 2. Bound test results.

K F-STATISTIC	10% SIGNIFICANCE LEVEL CRITICAL VALUES		5% SIGNIFICANCE LEVEL CRITICAL VALUES		1% SIGNIFICANCE LEVEL F CRITICAL VALUES	
	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
7.703	2.2	3.09	2.56	3.49	3.29	4.37

K represents the number of independent variables; it is important to note that if the assessed F statistics are higher than the upper bound of the critical values, at this point there is cointegration between the series. From the results, we see that the F-statistic falls outside both limits at 10%, 5%, and 1% levels of significance; this means there is strong evidence of a relationship between the dependent variable and all the independent variables, which we know already from previous results.

Estimating cointegration coefficients using DOLS and CCR

This paper estimated elasticities in the long-run using Dynamic-OLS (DOLS) by Stock and Watson (1993) and the Canonical Cointegrating Regression (CCR) by Park (1992). In the case of DOLS, the method

includes the lags for the first difference of the regressors into the model, where the optimal lead-lag truncation is determined based on model selection criteria. In the case of CCR, the method transforms the variables and then selects a canonical regression from the class of models with the same cointegrating regression.

Table 3. Estimation and testing results from the different cointegration methods.

VARIABLES	DOLS		CCR	
	Coefficient	Prob	Coefficient	Prob
LNGFCF	0.191077***	0.0015	0.255853***	0.000
LNLF	2.586007***	0.0002	3.491878***	0.000
LNNREC	-0.211159***	0.0158	-0.341548***	0.000
LNREC	0.475458***	0.000	0.50702***	0.000
R-SQUARED	0.999		0.997	

Notes: DOLS and CCR are the ordinary least square, dynamic and fully modified ordinary least square methods, respectively. * Denotes the significance level at 1%.**

Table 3 shows the experimental results of the two models. The two approaches produce very similar results for each variable in terms of sign and significance; however, in terms of magnitude, they vary slightly. For experimental interpretation, we consider only the results of DOLS and CCR, as these two approaches account for serial correlation and endogeneity that may exist in the model [8].

As seen from the data, the R-squared values are 0.999 and 0.997, which is approximately 1. This result means that the model presented here explains all the variability in the dependent variable. All the variables that determine LNGDP are in this model. Some variables, such as LNGFCF, LNLF and LNREC, have a positive relationship with LNGDP, while LNNREC has a negative relationship.

For the DOLS results, a 1% increase in renewable energy consumption increased output by 0.475%, while a 1% increase in non-renewable energy consumption decreased output by 0.211%. For the CCR results, a 1% increase in renewable energy consumption increased output by 0.507%, while a 1% increase in non-renewable energy consumption decreased output by 0.341%. Each of the variables in the DOLS and CCR estimations are statistically significant at the 1% level. The findings on output elasticities in the long-run suggest that, along with traditional inputs such as capital and labor, both renewable and non-renewable energy played a significant role in the process of economic development in China. Based on these findings, we argue that non-renewable energy consumption plays a bigger role in economic output; therefore, policy advisers need to promote the generation and use of renewable energy to ensure sustainable economic development in the future.

The use of non-renewable energy in China hurts its GDP, as indicated by the negative values of DOLS and CCR coefficients. Non-renewable energy is associated with the release of significant quantities of greenhouse gases [4]. Non-renewable energy has a negative effect on China's GDP because it increases the negative effects on the environment, resulting in a high cost of maintaining and cleaning up the environment, among other costs. China uses large amounts of funds to manufacture and install systems

for the capture and storage of carbon (CCS) and this reduces national revenue. The general set-up of coal mining or crude oil extraction sites is also capital-intensive, meaning the margin between initial investment and returns from the extraction of non-renewable energy is reduced. The extraction and utilization of petroleum products also release significant amounts of greenhouse gases, which further pollute other systems of the environment such as water bodies and the atmosphere [21]. The long-term inhalation of released gases and the consumption of food substances that have been polluted by the gases and rain cause serious health problems among the Chinese population. Poor health reduces labor productivity of the Chinese population, leading to a lower GDP.

The use of renewable energy, on the other hand, reduces the effects on the environment, as well as over-reliance on imported fuels. These changes, in turn, have a positive impact on GDP, as shown by the positive values of DOLS and CCR coefficients. The installation of sites for the generation of renewable energy is capital-intensive, but the operations and maintenance costs are comparatively low [4]. The revenue generated from non-renewable energy is, in all, higher than from non-renewable energy, thus causing an increase in GDP. The generation of renewable energy has a negligible negative impact on the environment and human health [25]. This effect creates a conducive environment for executing economic activities.

6.   Conclusion

This paper succeeds in estimating the probable economic effects of the use of renewable energy in the country that consumes the highest amount of renewable energy, China. Based on China's assumption of the position of the user of the highest amount of energy in the world, it was the country that was used in this study. As of 2015, China had invested approximately $83.3 billion in renewable energy. The US followed with $38.3 billion, while Japan was third with $35.7 billion. As a result of the application of time-series analysis techniques, this study obtained estimations and test results using different cointegration methods in the context of the Chinese economy. Findings from this study re-affirm the dynamics between economic growth and energy-related inputs in the long-run. Data collected on output elasticities in the long-run suggest that the use of renewable sources of energy is directly proportional to economic growth. The findings also reveal that international cooperation agencies, energy planners, governments, and associated bodies need to work collectively to increase investments in renewable sources of energy.

The estimation of elasticities in this paper was carried out using the Canonical Cointegrating Regression (CCR), as presented by Park (1992), and Dynamic-OLS (DOLS), as presented by Stock and Watson (1993). DOLS involved the use of the lags for the initial difference of regressors into the model that entails the optimal lead-lag truncation being reached using a model selection criterion. In the case of CRR, there was a transformation of the variables then selection of a canonical regression from a pool of models with similarity in cointegrating regression.

Based on the overall findings derived for this particular study, the positive values of CCR and DOLS coefficients proved that the GDP of China has benefitted from increased investment in renewable energy. This investment in renewable energy is further encouraged by the positive impact that it imposes on Human Health and Environmental Sustainability. Under this circumstance, Human Health and Environmental Sustainability are directly conducive for economic activities. However, the investment in renewable energy faces various challenges. A few of these challenges fundamentally embraces high costs being involved into renewable energy generation, greater need for sufficient administration for maintenance, climate conditions, maintenance needs of the systems and developed infrastructures to be used for the production of renewable energy.

The results being retrieved for this study also deciphered that there lays the presence of long-term dynamics amid monetary growth and traditional along with energy-related inputs in China, making it quite apparent that REC has a strong positive influence on the nation's financial output. Therefore, based on the entirely obtained results, it can be concluded that the respective government of China and the energy planners must make significant investments on augmenting renewable energy for ensuring low growth of carbon within the nation and thereby maximizing monetary growth at large.

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