Renewable Energy and Economic Growth in “Next Eleven” Emerging Markets

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1 Introduction

So many nations have had fast economic expansion during the last four decades, mainly due to industrialization. The expansion of economic activity in both developed and developing nations has given rise to two major worries: first, the rapid depletion of non-renewable energy sources due to their constant consumption; and second, the effects of global warming brought on by the emissions of greenhouse gases like carbon dioxide (CO2) and methane. Due to these energy issues, renewable energy is now receiving a lot of attention.

The international community has gradually realized that such development is not sustainable over the long term. Against this background, the 1997 Kyoto Protocol served as an avenue where attempts were made to cut the proportion of emissions caused by fossil fuels. The pact required the industrialized nations to cut greenhouse gas emissions, namely, CO2 emissions. As a result, many industrialized and developing nations began to rely more on renewable energy and less on fossil fuels [1].

In 2013, it was projected that 19.1% of the final energy consumed worldwide came from renewable sources. Wind, solar PV, and hydropower have been driving the recent expansion of the electrical industry. The capacity for heating is expanding steadily, while the output of biofuels for transportation has lately increased after a decline in 2011–2012. According to the International Energy Agency’s (IEA) most

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optimistic scenario, renewable energy sources would account for 39% of power output by 2050, up from 18.3% in 2002. All these point to the growing consumption of renewable energy in order to yield a more sustainable environment and healthy living. However, the question of whether this trend will help fuel economic growth is becoming more and more pressing as there is a rise in the production and use of renewable energy in the overall energy mix.

There is, nevertheless, a lack of consensus on the mechanics of the link between renewable energy and economic growth. While some studies revealed that renewable energy promotes economic growth, others revealed that it hinders economic growth and others revealed no link between them. Looked at from another angle, the direction of causation between renewable energy and economic growth is mainly vague. An argument may support that improvement in economic growth leads to more renewable energy consumption, while another may support the other way round. Moreover, the emerging markets (most especially the countries categorized as "Next Eleven" emerging markets), which are now in the quest for economic prosperity more than ever, have received less attention in the investigation of the relationship between renewable energy and economic growth, leaving unanswered the question of how the increased use of renewable energy in this economies relates to their economic growth.

On this note, the key question raised is, what is the direction of causal relationship between renewable energy consumption and economic growth and how does the renewable energy promote economic growth in "Next Eleven" emerging markets?

In addition to this introduction section that highlights the policy problem and aims of the chapter, the second section provides the literature review and policy context, the third section highlights the hypothesis development, the fourth section gives details of the methodology and data, the fifth section presents the findings, and the sixth section provides the required policy recommendations.

2 Literature Review

2.1 The Impact of Renewable Energy Consumption on Economic Growth

Research on the renewable energy-economic growth nexus has gained attention from different climes of the world. Different researchers across the globe have explored the relationship between renewable energy and economic growth. The reason for this burgeoning attention given to this area of research might be attributed to the global campaign against fossil fuels and the need to contextualize the intertwined relationship between different energy sources and economic indicators.

Despite the numerous studies conducted along this line, there still needs to be a consensus on findings in the existing literature. Empirical findings from this discourse can be divided into two major schools of thought. The first and most prominent school opines that there is a relationship between renewable energy consumption and economic growth. (See, e.g., [2–17]).

The above school of thought which is undoubtedly the strongest in terms of empirical backing has three hypotheses within it: the feedback, conservation, and the growth hypothesis. The feedback hypothesis suggests a bi-directional causality between renewable energy consumption and economic growth, this implies that there is interdependence between the two constructs. Many studies have supported, including the work of [5], when they studied the impact of renewable energy on carbon emissions and economic growth in 15 major renewable energy-consuming countries. The authors of [4] also support the feedback hypothesis when they examined the impact of renewable and non-renewable energy consumption on economic growth using the Middle East and North Africa Net Oil Exporting Countries as a case study. The authors of [17] also found the feedback hypothesis to be valid in their study. The authors of [18] examined the heterogeneous impacts of energy efficiency, renewable energy consumption, and other factors on the economic growth of Brazil, Russia, India, China, and South Africa (BRICS) for 1990–2014 and the results also supported the feedback hypothesis.

The growth hypothesis suggests a uni-directional causality running from energy consumption to economic growth. This hypothesis has been supported by [3]. The authors of [11] also supported the growth hypothesis when they studied the effect of renewable energy consumption on economic growth across 38 renewable-energy-consuming nations covering the timeline of 1990–2018. The study adopted dynamic ordinary least squares (DOLS), fully modified ordinary least squares (FMOLS), and heterogeneous non-causality approaches.

Lastly, the conservation hypothesis suggests a uni-directional causality running from economic growth to renewable energy consumption. This hypothesis was supported by the work of [12] when they found a causality running from economic growth to renewable energy consumption among the 5 South Asian countries investigated. The study examined the long-run equilibrium relationship by adopting panel Fully Modified Ordinary Least Squares and panel Dynamic Ordinary Least Squares estimation techniques. The work of [19] has also supported the conservation hypothesis in the case of the Czech Republic.

The second school of thought opines that there is no relationship between renewable energy consumption and economic growth. This group supports the neutrality hypothesis, which is the fourth hypothesis found in the literature. This school reports that none of these constructs exert any effect on one another and they are independent totality. Even though this school of thought is the weakest due to the few studies that backed it, some studies have also supported the neutrality hypothesis. [7] studied the association between renewable energy consumption and economic growth in the nine Black Sea and Balkan countries, according to the st;

accordingutrality hypothesis was valid in the case of Turkey. Along this line, the authors of [19] also contributed to this school of thought by supporting the neutrality hypothesis in the case of Cyprus, Estonia, Hungary, Poland, and Slovenia when they investigated the role of renewable energy consumption in economic growth within the EU member countries.

2.2 Renewable Energy Policy in Nigeria

For instance, Nigeria set a target in its Renewable Energy Master Plan (REMP) to increase renewable electricity supply from 13% of total electricity generation in 2015 to 23% in 2025, consequently increasing the consumption of renewable energy to a large volume of total final energy consumption. The plan also includes a target to increase energy from small-hydro and biomass-based power sources from 600 megawatts and 50 megawatts in 2015 to 2000 megawatts and 400 megawatts in 2025, respectively, and also achieve 500 megawatts and 40 megawatts of energy from solar PV and wind energy sources, respectively, by 2025. The REMP also includes a variety of fiscal and market incentives to encourage the development of renewable energy. In the medium term, the strategy calls for a suspension of import taxes on renewable energy technology. Longer term, the strategy recommends the creation of further tax credits, capital incentives, and preferred lending alternatives for renewable energy projects. According to World Bank estimates, Nigeria already had its consumption of renewable energy as 81.4% of total final energy consumption in 2019. Even though this seems to ban outstanding achievement, there is more to how the consumption of renewable energy promoted economic activities in the country and how sustainable is the continuation of such consumption.

2.3 Renewable Energy Policy in Egypt

Egypt is working to increase the supply of electricity generated from renewable sources to 20% by 2022 and 42% by 2035, with wind accounting for 14%, hydropower accounting for 1.98%, photovoltaic (PV) 21.3%, wind accounting for 14%, and concentrating solar power (CSP) accounting for 5.52%. Conventional energy sources account for 57.33%. This plan is now being amended and awaits approval from the Supreme Council for Energy to represent 33% of the energy generated from renewable sources by 2025, 48% by 2030, 55% by 2035, and 61% by 2040. This is seen to be a highly hopeful strategy. The majority of this capacity is projected to be provided by the private sector. According to World Bank estimates, Egypt had its consumption of renewable energy as only 5.3% of total final energy consumption in 2019. This shows a very minimal proportion of total energy consumption being from renewable energy sources and equally shows the country has a relatively long way to go to achieve its sustainable environment plans, despite its abundance of sunny weather and high wind speeds.

2.4 Renewable Energy Policy in Iran

According to Iran's Fifth Five-Year Development Plan, renewable resources must produce 5000 MW of power under green horizon scenarios. There is no scarcity of knowledge in Iran, which is positioned near the zero line (Earth's equator) and has around 300 bright sunny days per year, concerning developing regulations encouraging solar energy. According to recent figures, assuming current growth plans are carried out, the installed capacity of renewable energy systems will reach 2.8 GW by 2030. More than $2800 million in US dollars must be invested over 20 years, from 2010 to 2030. Despite the benefits of using solar energy, such as lowering greenhouse gas emissions, it is crucial to highlight that solar power is 2.5 to 5 times more expensive than electricity generated by existing conventional power sources, such as coal and other sources. According to World Bank estimates, Iran had its consumption of renewable energy as only 0.98% of total final energy consumption in 2019. This shows a very minimal proportion of total energy consumption from renewable energy sources and equally shows the country has a very long way to go to achieve its policy targets on renewable energy, despite having an impressive clear sunny number of days in a year.

2.5 Renewable Energy Policy in Bangladesh

The existing renewable energy policy for Bangladesh has as part of its objectives to scale up contributions of renewable energy both to electricity and to heat energy; scale up contributions of renewable energy to electricity production; develop sustainable energy supplies to substitute indigenous non-renewable energy supplies; enable, encourage, and facilitate both public and private sector investment in renewable energy projects; and harness the potential of renewable energy resources and dissemination of renewable energy technologies in rural, peri-urban, and urban areas. The government has continued to work in line with the policy in order to achieve these objectives. However, the country's renewable energy consumption as a proportion of total final energy consumption has been declining despite government policy to ensure a transition from the use of electricity from non-renewable energy sources to those from renewable energy sources. According to World Bank estimates, Bangladesh had its consumption of renewable energy as about 24.8% of total final energy consumption in 2019 down from 31.9% in 2015 which was also down from about 40.3% in 2010. This shows that the country is retrogressing in terms of renewable energy consumption.

3 Hypothesis Development

On the mechanics of the link between renewable energy and economic growth, there is, nevertheless, a lack of consensus. Some studies revealed that renewable energy promotes economic growth, other studies revealed that it hinders economic growth while a third group revealed that there is no link between them. In other words, the renewable energy- economic growth relationship is largely vague. An argument may support that improvement in economic growth leads to more renewable energy consumption while another argument may support the other way round. Moreover, the emerging markets (most especially the countries categorized as "Next Eleven" emerging markets), which are now in the quest for economic prosperity more than ever, have received less attention in the investigation of the relationship between renewable energy and economic growth, leaving unanswered the question of how the increased use of renewable energy in this economy relates to their economic growth.

On this note, this study tested the following stated research hypotheses for a clear understanding of the impact of renewable energy consumption on economic growth in "Next Eleven" emerging markets.

H1: There is a causal relationship flowing from renewable energy consumption to economic growth in "Next Eleven" emerging markets.

H2: There is a causal relationship flowing from economic growth to renewable energy consumption in "Next Eleven" emerging markets.

H3: Renewable energy promotes economic growth in "Next Eleven" emerging markets.

4 Methodology and Data

The study focuses on the "Next Eleven" emerging economies, which are a set of emerging markets comprised of two countries in Africa (Nigeria and Egypt), one country each in Central America, Europe, and Middle-East (Mexico, Turkey, and Iran, respectively), and six countries in Asia (Vietnam, South Korea, Philippines, Pakistan, Bangladesh, and Indonesia). The term "Next Eleven" was coined out by Goldman Sachs, referring to these countries which have potentials of rivaling the advanced economies. The choice of these countries rests on the increase in their renewable energy consumption in recent years, which has signaled a shift in their traditional energy consumption mix and opening up a potential of further enhancing their economies.

Secondary data was used in this study, covering a period between 1990 and 2019. The data was sourced from Word Development Indicators (WDI). The choice of the sample period stems from data availability from the secondary source. The data were collected for variables such as real GDP (RGDP), which was used to proxy economic growth, and gross fixed capital formation (GFCF), total labor force (LF), and renewable energy consumption (RE), which are the explanatory variables. The natural logarithm transformation was taken for real GDP, gross fixed capital formation, and total labor force in order to bring down their large values.

In order to examine the causal relationship between renewable energy and economic growth, the Dumitrscu-Hurlin panel Granger causality procedure was employed. Dumitrescu and Hurlin (2012) proposed a test for Granger non-causality for heterogeneous panel based on the individual Wald statistics of Granger non-causality averaged across cross-sectional units. As for the impact of renewable energy on economic growth, the dynamic panel autoregressive distributive lag model was employed to estimate the model. The estimation procedure is capable of controlling for the likely endogeneity in the renewable energy-economic growth nexus. Stata 14 software was used to generate the panel data results for the effect of renewable energy on economic growth. Furthermore, E-views 9 software was employed to generate the time series results.

4.1 Summary of Variables

The panel summary of variables presented in Table 1 shows that real GDP is in billions and its average across the countries in the sample amounted to about US$415 billion. Similarly, gross fixed capital formation has an average of about US$113 billion. Labor force is averagely 42.3 million people among these countries and the proportion of renewable energy of total energy consumption is averagely 31.39%. The time series summary of these variables for each country is presented in Table 2. The summary for Turkey and Vietnam were not presented because of unavailability of data and this also influenced the decision to omit both countries from the panel and time series regression analyses.

4.2 Models

The empirical model to examine the causal relationship that exists between economic growth and renewable energy is presented as follows:

Table 1 Panel summary of variables

Variable	Mean	Std. Dev.	Min	Max
RGDP ($billion)	415.0	345.0	45.1	1640.0
GFCF ($billion)	113.0	183.0	−837.0	922.0
LF (millions of people)	42.3	24.3	14.3	136.0
RE (% of Total final energy consumption)	31.39	26.44	0.44	88.68

Table 2 Time series summary of variables

Country	Variable	Mean	Std. Dev.	Minimum	Maximum
Nigeria	RGDP	292.0	132.0	150.0	500.0
	GFCF	61.0	9.84	48.0	82.0
	LF	46.3	9.05	32.0	62.0
	RE	85.06	2.28	80.64	88.68
Egypt	RGDP	229.0	86.1	120.0	400.0
	GFCF	32.9	17.4	11.0	76.0
	LF	22.9	4.74	16.0	29.0
	RE	7.04	1.50	5.10	9.83
Mexico	RGDP	937.0	197.0	630.0	1300.0
	GFCF	209.0	46.4	130.0	270.0
	LF	42.9	8.17	29.0	57.0
	RE	10.95	1.67	8.97	14.41
Iran	RGDP	323.0	89.3	190.0	460.0
	GFCF	155.0	54.0	60.0	250.0
	LF	20.8	4.06	14.0	27.0
	RE	0.98	0.27	0.44	1.53
South Korea	RGDP	1010.0	386.0	400.0	1600.0
	GFCF	324.0	102.0	150.0	510.0
	LF	24.1	2.82	19.0	29.0
	RE	1.35	0.88	0.44	3.36
The Philippines	RGDP	200.0	86.2	110.0	400.0
	GFCF	39.9	23.5	19.0	100.0
	LF	33.4	7.01	22.0	45.0
	RE	34.94	6.73	26.73	51.96
Pakistan	RGDP	191.0	67.9	100.0	320.0
	GFCF	33.4	8.7	22.0	54.0
	LF	49.0	13.1	30.0	72.0
	RE	49.30	4.22	42.09	58.09
Bangladesh	RGDP	122.0	59.7	53.0	260.0
	GFCF	30.6	21.3	7.8	80.0
	LF	51.7	9.85	35.0	69.0
	RE	50.07	14.69	24.75	73.16
Indonesia	RGDP	563.0	225.0	270.0	1000.0
	GFCF	124.0	455.0	−840.0	920.0
	LF	104.0	17.1	77.0	140.0
	RE	40.49	11.04	19.09	58.60
Turkey	RGDP	556.0	226.0	289.0	997.0
	GFCF	–	–	–	–
	LF	24.4	4.14	19.4	33.4
	RE	17.01	4.54	11.40	24.51
Vietnam	RGDP	143.0	78.4	45.1	314.0
	GFCF	–	–	–	–
	LF	44.8	7.87	32.7	55.8
	RE	48.11	16.90	18.65	76.08

$$\ln\text{RGDP}_t = \alpha + \sum_{k=1}^{K}\beta_k \ln\text{RGDP}_{t-k} + \sum_{k=1}^{K}\gamma_k RE_{t-k} + \varepsilon_t \tag{1}$$

where lnRGDP is the natural log of real GDP and RE is renewable energy. The fundamental tenet is that if previous values of RE have significant impact on lnRGDP despite including past values of lnRGDP in the model, it is then said that RE has causal influence on lnRGDP. Given this equation, it is simple to test for causality using the following null hypothesis in an F-test:

$$H_0 : \gamma_1 = \ldots = \gamma_K = 0 \tag{2}$$

One can infer that causality flows from RE to lnRGDP if the null hypothesis is rejected. Naturally, the RE and lnRGDP variables can be swapped to test for causation in the opposite manner.

The model to examine the impact of renewable energy on economic growth is specified as follows:

$$l\text{nRGDP}_{it} = \alpha_0 + \alpha_1 \ln\text{GFCF}_{it} + \alpha_2 \ln\text{LF}_{it} + \alpha_3 RE_{it} + \varepsilon_{it} \tag{3}$$

where: lnRGDP is the natural log of real GDP; lnGFCF is the natural log of gross fixed capital formation; lnLF is the natural log of total labor force; RE is renewable energy consumption, and ε is the disturbance term. The subscripts (it) indicate observation over a panel of eleven emerging markets. Although, the estimation was done for the countries together in a panel data analysis, a time series analysis was also carried out for each of the countries to verify the overall panel analysis.

5 Empirical Results

First, the study examined the time series properties of the panel data, as well as the time series data, through the unit root test. It further examined the cointegration of the non-stationary series employed in the study. The unit root test and cointegration test results are presented in Tables 3 and 4, respectively. The unit root results suggest that all the variables had unit root and are not stationary. Therefore, the test was conducted on their difference transformations which revealed that each of the variables became stationary after first difference. The result implies that estimation methods like the ordinary least squares would give spurious results in this situation. Therefore, this study resorted to employing the autoregressive distributive lag (ARDL) method in order to ensure the validity of the regression results. Prior to the ARDL results, the cointegration test result is presented. The result of the cointegration test conducted through the Westerlund (2007) error-correction-based test revealed that there is cointegration among the variables. The test shows four statistics and their respective low p-values indicate they are significant and hence guarantee long-run cointegration.

Table 3 Results of panel unit root test

	Fisher-ADF		Fisher-PP	
Variable	stat	*p*-value	stat	*p*-value
lnGDP	−1.599	0.945	−0.627	0.734
ΔlnGDP	9.257	0.000	19.29	0.000
lnGFCF	−2.023	0.978	−1.669	0.952
ΔlnGFCF	29.67	0.000	39.8	0.000
lnLF	−1.197	0.884	0.117	0.453
ΔlnLF	8.581	0.000	19.37	0.000
RE	0.225	0.410	−0.864	0.806
ΔRE	19.66	0.000	36.87	0.000

Note: Δ = difference notation

Table 4 Result of cointegration test

Statistic	Value	*P*-value
Gt	−6.178	0.000
Ga	−8.186	0.000
Pt	−4.852	0.000
Pa	−10.454	0.000

To verify the first and second hypotheses, Table 5 shows from the panel causality test result that a statistic value of −0.821 and *p*-value of 0.411 imply that there is no evidence of causal relationship flowing from renewable energy to economic growth. However, the table shows that there is causality running from economic growth to renewable energy consumption (with statistic value of 9.589 and *p*-value of 0.000). The table also shows that similar results were obtained for most of the countries in the sample individually. For Egypt, South Korea, Pakistan, Bangladesh, and Indonesia, respective statistics of 0.246, 0.010, 0.657, 1.066, and 0.081 and *p*-values of 0.783, 0.989, 0.527, 0.360, and 0.921 for the flow from renewable energy to economic growth and respective statistics of 3.025, 2.576, 5.248, 10.43, and 5.369 and *p*-values of 0.068, 0.097, 0.013, 0.000, and 0.012 for the flow from economic growth to renewable energy imply that there is evidence of causal relationship only flowing from economic growth to renewable energy for these countries.

For Nigeria, Mexico, Iran, and the Philippines, respective statistics of 1.186, 1.953, 2.133, and 0.133 and *p*-values of 0.323, 0.164, 0.141, and 0.875 for the flow from renewable energy to economic growth and respective statistics of 1.847, 0.011, 0.007, and 0.803 and *p*-values of 0.180, 0.988, 0.992, and 0.460 for the flow from economic growth to renewable energy imply that there is no evidence of causal relationship between renewable energy and economic growth for these countries.

The findings from these panel causality tests revealed that causal relationship mainly flows from economic growth to renewable energy consumption and not vice versa. In other words, it is an increase in economic growth that prompts an increase in the consumption of renewable energy in these economies, thereby supporting the conservation hypothesis that economic growth precedes renewable energy consumption. Specifically for individual countries, there is evidence of causal relation

Table 5 Causality test results

Sample	Direction	stat	*p*-value
Panel	RE to lnRGDP	−0.821	0.411
	lnRGDP to RE	9.585***	0.000
Nigeria	RE to lnRGDP	1.186	0.323
	lnRGDP to RE	1.847	0.180
Egypt	RE to lnRGDP	0.246	0.783
	lnRGDP to RE	3.025*	0.068
Mexico	RE to lnRGDP	1.953	0.164
	lnRGDP to RE	0.011	0.988
Iran	RE to lnRGDP	2.133	0.141
	lnRGDP to RE	0.007	0.992
South Korea	RE to lnRGDP	0.010	0.989
	lnRGDP to RE	2.576*	0.097
The Philippines	RE to lnRGDP	0.133	0.875
	lnRGDP to RE	0.803	0.460
Pakistan	RE to lnRGDP	0.657	0.527
	lnRGDP to RE	5.248**	0.013
Bangladesh	RE to lnRGDP	1.066	0.360
	lnRGDP to RE	10.43***	0.000
Indonesia	RE to lnRGDP	0.081	0.921
	lnRGDP to RE	5.369**	0.012

Notes: ***$p < 0.01$; **$p < 0.05$, *$p < 01$

flowing from economic growth to renewable energy consumption in Egypt, South Korea, Pakistan, Bangladesh, and Indonesia but there is no evidence of causal relation in Nigeria, Mexico, Iran, and the Philippines.

Verifying the third hypothesis and examining the impact of renewable energy on economic growth the panel ARDL method was applied to the panel data. The Hausman test was used to select the most preferred estimation procedure between the pooled mean group (PMG) estimator and each of the mean group (MG) and dynamic fixed effects (DFE) estimators. Its results in Table 6 revealed that the statistic of 1.54 for the choice between PMG and MG and the statistic of 0.001 for the choice between PMG and DFE, each with very high *p*-values, provide no evidence to reject the PMG as a better estimator to the other two alternatives. Considering the PMG result, log of gross fixed capital formation shows a significant positive coefficient both in the short and long runs (0.574 and 0.120, respectively). This connotes 1% increase in capital formation leads to an increase of 0.574% and 0.120% in economic growth in the short and long run, respectively. Renewable energy consumption reveals a negative and significant coefficient only in the long run (−0.028). This implies that 1% point increase in renewable energy consumption causes economic growth to decline by about 2.8%.

Therefore, the findings of this study revealed that renewable energy consumption have largely been detrimental to the growth pattern of "Next Eleven" emerging markets. In other words, renewable energy has not promoted economic growth but

Table 6 Results of panel regression for the effect of renewable energy on economic growth

	PMG		MG		DFE	
Variables	Coef.	*z*	Coef.	*z*	Coef.	*z*
Long run estimates						
lnGFCF	0.574***	5.71	0.061	0.06	0.441	1.65
lnLF	0.122	0.47	−0.558	−0.28	0.873	1.51
RE	−0.028***	−3.19	0.005	0.07	−0.021	−1.53
Short run estimates						
EC	−0.013	−0.79	0.072*	1.32	−0.023*	−1.9
ΔlnGFCF	0.120***	3.66	0.145***	7.53	0.089***	7.53
ΔlnLF	0.049	0.48	−0.068	−0.39	0.126	1.08
ΔRE	0.002	0.81	−0.001	−1.13	−0.001	−0.79
Constant	0.169	0.92	0.501	0.72	0.055	0.31
Diagnostic tests						
Hausman test			1.54(0.672)		0.001(0.999)	
Observation	250		250		250	

Notes: ***$p < 0.01$; **$p < 0.05$, *$p < 01$; Hausman test p-value in parentheses
PMG pooled mean group, *MG* mean group, and *DFE* dynamic fixed effects

affected it negatively by causing a decline in it in these economies. Specifically for each of these economies, the findings from results of Tables 7 and 8 revealed that renewable energy consumption causes a decline in economic growth both in the short and long runs in South Korea, but only in the short run in Indonesia and Pakistan. There is no evidence that renewable energy consumption affects economic growth in Nigeria, Egypt, Iran, and the Philippines. However, for Mexico and Bangladesh, there is short-run evidence that renewable energy consumption led to increased economic growth. While the effect was instantaneous in Mexico, the effect was only obvious after two-period lag in Bangladesh.

6 Conclusion

One of the major problems found with the existing renewable energy policies in the “Next Eleven” emerging market economies is the lack of consideration given to how and where the renewable energy sources are being produced. Most of the policies were focused on generating electricity from renewable energy sources at any cost, with very ambitious, if not overambitious, targets. For developing economies in which the production of equipment required to generate renewable energy is very minimal, it invariably becomes very costly to employ such energy efficiently in order to promote economic activities. Most of these countries resort to importing these equipment at very high cost, and in most cases, this high cost can only be affordable to the government and unaffordable to the private entities. One of the major elements to be included in the existing renewable energy policies is a harmony between the countries’ capacity to produce the required equipment for

Table 7 Results of time series regression for the effect of renewable energy on economic growth in selected countries

	Nigeria		Egypt		Mexico		Iran		South Korea	
Variable	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*
Long run estimates										
lnGFCF	−2.354**	−2.622	0.690	1.203	0.651*	1.826	0.202*	1.991	0.615*	2.086
lnLF	4.067***	6.472	0.140	0.098	−0.079	−0.093	1.008***	4.877	1.743	1.575
RE	0.004	0.335	0.012	0.082	0.010	0.339	0.141	1.554	−0.070***	−3.015
Short run estimates										
EC	−0.191***	−4.323	0.032	0.485	−0.160*	−1.846	−0.211***	−2.998	−0.174*	−2.670
D(lnGFCF)	−0.162***	−3.519	0.086***	3.082	0.355***	10.06	0.143***	5.085	0.224***	7.313
D(lnLF)	0.656	1.646	0.189**	2.474	−0.257	−0.814	0.213**	2.394	1.145***	3.584
D(RE)	0.001	0.334	−0.000	−0.083	0.023***	3.820	0.030	1.665	−0.012*	−1.865
C	13.02	1.071	6.467	0.344	12.18	1.479	4.243**	2.141	−18.07	−1.578
Diagnostic test										
Autocorrelation	1.517(0.251)		2.683(0.100)		2.337(0.135)		1.571(0.232)		1.544(0.245)	
F-statistic	1799.5***		6686.4***		1005.9***		730.8***		6346.5***	

Notes: ***$p < 0.01$; **$p < 0.05$, *$p < 01$

Table 8 Results of time series regression for the effect of renewable energy on economic growth in selected countries

	The Philippines		Pakistan		Bangladesh		Indonesia	
Variable	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*	Coefficient	*t*
Long run estimates								
lnGFCF	0.365***	7.613	−1.172	−0.264	−1.492	−0.338	0.007	1.090
lnLF	1.349***	10.95	1.033***	3.477	1.136	0.270	−0.562	−0.234
RE	0.000	0.030	−0.095	−0.335	−0.103	−0.546	−0.034	−1.106
Short run estimates								
EC	−0.249***	−2.905	−0.088	−0.351	−0.037	−0.498	−0.097	−0.886
D(lnGFCF)	0.101***	3.883	0.080*	1.893	0.116	1.168	0.002***	8.548
D(lnLF)	0.336***	2.959	−0.381*	−1.835	0.042	0.488	−1.755***	−4.253
D(RE)	0.000	0.030	−0.008***	−3.983	−0.002	−1.254	−0.011***	−3.823
C	−6.184***	−3.835	41.82	0.340	46.41	0.920	39.37	0.858
Diagnostic test								
Autocorrelation	0.337(0.717)		1.140(0.246)		0.132(0.876)		1.530(0.248)	
F-statistic	4106.0***		4095.1***		14954.6***		1160.7***	

Notes: ***$p < 0.01$; **$p < 0.05$, *$p < 01$
EC error correction

renewable energy and the proposed targets in terms of renewable energy consumption. It examined the causal relationship that exists between renewable energy and economic growth. It also examined the impact of renewable energy on economic growth in "Next Eleven" emerging markets. The study also presents some insights on the renewable energy policies in these countries.

The results revealed that in most of these countries, it is the increase in economic growth that precedes the increase in the consumption of renewable energy. In spite of the causal link, renewable energy has not really improved economic growth in most of these countries, but rather served has a detrimental force to economic growth in countries like South Korea, Indonesia, and Pakistan. Mexico and Bangladesh are the only countries that have experienced improvement in economic growth as a result of their increased consumption of renewable energy. Given this situation, it is recommended here that these economies should set a clear target about renewable energy consumption. Strategies and action plans must therefore be specified on how the goals and targets are met.

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