EXPLORING THE POTENTIAL OF RENEWABLE ENERGY: EMPIRICAL EVIDENCE FROM DEVELOPING COUNTRIES IN ASIA

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Overview

Climate change has been recognized as one of the threats to world and eventually is a major concern to Asian countries. Recently, United Nations Framework Convention on Climate Change held in Paris in 2015 aimed at achieving universal agreement on climate change to maintain global warming below 2 ℃. All signatory countries pledge to limit global temperatures. With this background, studying the potential of renewable energy consumption in enhancing environmental quality within Environmental Kuznets curve (EKC) is both relevant and timely. By better comprehending the potential factors affecting the carbon dioxide emissions, those countries can design a strategic plan to reduce the rate of global warming and climate change, while stimulating economic development and promoting energy from eco-friendly resources. In addition, this study investigates causal relationships between CO2 emissions, GDP per capita, squared of GDP per capita, electricity consumption from fossil and electricity consumption from renewables. In order to determine the factors that influence the CO2 emissions, this study will apply the Fully Modified Ordinary Least Squares (FMOLS), Dynamic Ordinary Least Squares (DOLS) and Johansen and Juselius and Vector Error Correction Method (VECM) during the period from 1980 till 2014.

Methods

The data used in this study are transformed into the natural logarithm in order to interpret the coefficient estimates as the elasticities of the response variable. CO2 emissions as proxy for environmental quality with respect to the independent variables, while independent variables, GDP per capita as proxy for low economic growth, squared of GDP per capita as proxy for high economic growth, FOSS is electricity consumption from fossil based as proxy for energy consumption from conventional sources and RE is electricity consumption from renewable sources as proxy for energy consumption from renewable sources. This study selected 13 countries in Asia based on availability of data extracted from World Development Indicator and Energy Information Administration including Bangladesh, China, India, Iran, Indonesia, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka and Thailand with the estimation model as follows:

$$lnCO_{it} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP2_{it} + \beta_3 lnFOSS_{it} + \beta_4 lnRE_{it} + \mu_{it} \quad (1)$$

where i and t stands for country and the time; while μ denotes normally distributed error term; $\beta_1, \beta_2 \beta_3$and β_4 are the coefficient estimates on the selected variables, respectively. This study uses the FMOLS and the DOLS estimators in order to show long-run coefficient estimates of the CO2 emissions, GDP per capita, squared of GDP per capita, squared of GDP per capita, energy consumption from conventional sources and energy consumption from renewables.

Results

Table 1 of panel unit root tests of LLC, Breitung, IPS and PP reports the results of panel unit root statistics tests at the level and after first difference. The p-values of variables of CO, GDP, GDP2, FOSS and RE accept the null hypothesis of unit root at level. The four unit root tests reject the null hypothesis of non-stationary at 1% level of significance, after the first difference.

Table 1 Panel unit root tests

Variables	Levels				1st diff.			
	Common unit root		Individual unit root		Common unit root		Individual unit root	
	LLC	Breitung	IPS	PP	LLC	Breitung	IPS	PP
CO	-0.0112	0.4446	-0.1289	28.4697	-6.0320***	-3.7566***	-8.2963***	534.725***
GDP	-1.1480	3.1186	0.7920	15.9335	-7.4969***	-7.1933***	-8.3948***	287.127***
GDP2	-0.6391	3.1128	2.0139	13.0426	-7.2895***	-6.6663***	-8.2410***	221.423***
FOSS	-0.1241	0.2816	-1.2245	25.8391	-2.7839***	-2.1876***	-6.2549***	158.052***
RE	0.2471	-1.7336**	06781	35.6593	-6.1007***	-5.8214***	-6.1410***	183.304***

*, **, *** indicates significant at 0.10, 0.05 and 0.01 level.

Table 2 presents the results of Pedroni co-integration tests (Pedroni, 2004, 2001) and order to ensure the accuracy and reliability of this result, the Kao co-integration test developed by (Kao, 1999) is implied.

Table 2 Results from Pedroni co-integration test

	Statistic	Weighted statistic		Statistic		Statistic
Pedroni					Kao	
Alternative hypothesis: common AR coefs. (within-dimension)			Alternative hypothesis: individual AR coefs. (between-dimension)		ADF	-2.200**
Panel v-Statistic	-0.4752	-1.3229	Group rho-Statistic	2.0459		
Panel rho-Statistic	-0.2501	0.7128	Group PP-Statistic	-3.2104***		
Panel PP-Statistic	-3.5092***	-2.8625***	Group ADF-Statistic	-2.3043**		
Panel ADF-Statistic	-2.1334**	-1.8634**				

*, **, *** indicates significant at 0.10, 0.05 and 0.01 level.

The results from the DOLS and the FMOLS estimators are given in Table 3, respectively. The reported coefficients are statistically significant at different level of significance. The magnitude of every coefficients of the FMOLS is the same as the DOLS.

Table 3 FMOLS and DOLS long-run estimates

Variables	Coefficients	Prob.	Variables	Coefficients	Prob.
FMOLS long-run estimates			DOLS long-run estimates		
GDP	1.0049***	0.0000	GDP	1.3764***	0.0019
GDP2	-0.0376***	0.0003	GDP2	-0.0475*	0.0956
FOSS	0.3871***	0.0000	FOSS	0.3649***	0.0000
RE	-0.0124	0.2138	RE	-0.0393	0.2705

*, **, *** indicates significant at 0.10, 0.05 and 0.01 level.

Dependent variable	Short-run					Long-run ECT
	ΔCO	ΔGDP	ΔGDP2	ΔFOSS	ΔRE	
ΔCO	-	4.6421* (0.0982)	4.3295 (0.1148)	1.4765 (0.4779)	0.6527 (0.7216)	-0.0057 [-1.4845]
ΔGDP	1.9793*** (0.0001)	-	18.3972*** (0.0001)	1.8432 (0.3979)	33.8165*** (0.0000)	-0.0028 [-1.0050]
ΔGDP2	18.5718*** (0.0001)	10.6030*** (0.0050)	-	2.1809 (0.3361)	33.0174*** (0.0000)	-0.0597 [-1.3759]
ΔFOSS	5.9402* (0.0513)	0.4678 (0.7914)	0.9738 (0.6145)	-	7.2585** (0.0265)	-0.0053 [0.0039]
ΔRE	4.9454* (0.0844)	3.7839 (0.1508)	3.6812 (0.1587)	4.2598 (0.1188)	-	-0.0060 [-1.1358]

Table 4 Results of VECM Granger causality test

Notes: Figures in parentheses ( ) and brackets [] are p-values and t-statistics. *, **, *** indicates significant at 0.10, 0.05 and 0.01 level.

Table 4 reported that bidirectional causality between GDP per capita and CO2 emissions in the short-run. Other than that, results from VECM Granger causality shows that the unidirectional causality running from RE to GDP per capita, squared of GDP per capita and electricity consumption from fossil fuels, and CO2 emissions to electricity consumption from fossil fuels and electricity consumption from renewables. However, there is no causality between any series in the long-run.

Conclusions

From empirical findings, economic growth and environmental quality affect each other in the short-run. Meanwhile, Granger causality tests show that extensively use of cleaner energy has helped to improve economic growth and affect the used of energy from conventional sources. In addition, we also found that CO2 emissions is influenced by the energy consumption from both sources. The empirical findings from FMOLS and DOLS long-run estimates show that GDP and squared of GDP is positively and negatively significant on CO2 emissions which suggesting an inverted U-shaped of Environmental Kuznets curve in developing countries in Asia is supported. As expected, extensive use of electricity from fossil increases CO2 emissions. However, electricity consumption from renewable sources was insignificant in explaining CO2 emissions in the long-run. Therefore, evidence from long-run estimates suggests that selected developing Asia countries should invest more on renewable energy projects and create policies and regulations to increase its consumption.