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The impact of economy, energy and environment factors on Human Development Index in MENA countries

تأثير العوامل الاقتصادية والطاقوية والبيئية على مؤشر التنمية البشرية في بلدان الشرق الأوسط وشمال إفريقيا

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Abstract

We shall perform with the heterogeneous panel cointegration method and Granger causality to investigate the link among the variables of Human Development Index, per capita primary energy consumption, per capita gross domestic product and per capita dioxide carbon emission for six MENA countries over the period of 1992-2016. We found that the sign of per capita (GDP) was positive for FMOLS estimation and negative for DOLS estimation; meanwhile, the coefficient of per capita primary energy consumption was positive and significant for both models. However, the coefficient of per capita dioxide carbon emission was negative for both models.

Keywords: heterogeneous panel cointegration procedure, panel Granger causality, Human Development Index, MENA countries.

الملخص

سوف نقوم بتطبيق الطريقة التكامل المتزامن للبيانات البنال الغير المتجانسة و السببية قرنجر لاختبار العلاقة ما بين المتغيرات المؤشر التنمية الاجتماعية، الاستهلاك الطاقة الكلية على عدد السكان، الناتج الداخلي الخام على عدد السكان، انبعاث الغاز الثاني الأكسيد على عدد السكان و هذا على ستة بلدان من الشرق الأوسط–الشمال افريقيا خلال الفترة 1992–2016. كنتيجة، كان للناتج الداخلي الخام على عدد السكان أثر ايجابي في التقدير FMOLS بينما كان لديه أثر سلبي في التقدير DOLS ، حيث كان للاستهلاك الطاقة الكلية على عدد السكان أثر ايجابي و معنوي في كلى نموذجين التقدير، و لكن انبعاث الغاز الثاني الأكسيد على عدد السكان كان له أثر سلبي في كلى نموذجين التقدير

الكلمات المفتاحية : بتطبيق الطريقة التكامل المتزامن للبيانات البنال الغير المتجانسة ،السببية قرنجر، المؤشر التنمية الاجتماعية، ستة بلدان من الشرق الأوسط–الشمال افريقيا

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1. Introduction

In 1987, the Brundtland Report defined sustainable development as "development that meets the needs of the present without compromising the ability of future generation to meet their own needs" (**UN report of 1987**). This definition of sustainability means that a system's social, economic, and natural capital should be preserved for future generations. This assumes that sustainable development will lead to harmonious socioeconomic development that does not place unacceptably high levels of pressure on resources and the environment (**K. Lei et al. 2012**).

The United Nations have proposed the human development index (HDI), which used the arithmetic mean or geometric mean of the indexes of 3 dimensions – life expectancy, education level, and gross national income (GNI) – to measure human welfare in different countries and different regions (**K. Harttgen and S. Klasen, 2012**). Later, the United Nations General Assembly adopted the Sustainable Development Goals (SDGs), which contain 17 goals including ending poverty and hunger, improving health and education, combating climate change, and protecting forests (**G. Schwerhoff and M. Sy, 2017**).

The main measures of progress and their respective advantages and disadvantages in apprehending the significant contributions to national progress towards sustainable development were studied by several researchers. On the other hand, several researchers found that there is a close connection between primary energy use (especially renewable energy consumption) and sustainable development, the improvement of renewable energy technologies will assist sustainable development and may develop the economic growth and the socio-economic situation for several countries.

Such energy can provide services to meet many basic human needs and there is a direct relationship between the absences of adequate energy and many human well-being indicators such as modern healthcare, education, and communication (the main variables of HDI). A lack of access to energy services dramatically affects and undermines health, limits opportunities for education and development, and can reduce population's potential to rise up out of poverty.

However, several MENA countries are suffering from bad management of their natural resources, political instability and corruption, and which

it will damage the socio-economic situation and several factors of sustainable development. They are also other reason why such countries are struggling with their situation, the informal sector and the complex bureaucratic forms for example are one of problems that impact negatively the economic activity and the well-being of population by reducing the number of employment and wages. Moreover, the MENA countries are characterized by having a lot of the non-transparent organization that limits the information between firms and governments. Consequently, it's important for such countries to continue their economic, financial and institutional reforms to recover their economic growth and to achieve the goals of sustainable development.

In the light of this statement, we shall use econometric tools to examine the energy, economic, and environment factors that may develop the human development index of several MENA countries and to make a decision that can guide them to the sustainable development in the future. This work is divided into 5 sections, introduction, literature review, data and methodology, empirical results, conclusion plus reference and annex.

2. Literature review

Table 01: Literature review about human development index and several variables.

Study	**Period**	2003 - 2015
Z. Zang et al. (2017)	**Data**	The South China See neighbouring countries include China, Cambodia, Vietnam, Thailand, the Philippines, Malaysia, Indonesia, Singapore and Brunei Darussalam
	Variables	Land area per capita, Forest coverage rate, food production index, fresh water per capita, urbanisation rate, mortality of Children under age 5, education investment rate, GNI per capita, car penetration rate, chemical fertilizer utilisation rate, particle emission intensity, Co_2 emission intensity, GDP/national land area, national saving rate, fixed asset investment rate, energy and mineral consumption rate

	Methodology	Evaluation index of human welfare, and indicator system of sustainable development pressures with Delphi method
	Conclusion	The HDI increased steadily, with an average annual growth rate between 0.29% and 2.50%. Singapore, Brunei Darussalam, Malaysia and Thailand were the top 4 countries ranked in descending order, whereas Cambodia always ranked in last place. The sustainable development pressure was very high for these countries. China and Vietnam gradually increased, Singapore gradually declined and for the other countries, they remained in a fluctuant equilibrium state
Study	**Period**	1980-2010 (six five-year intervals).
S.G. Grubaugh (2015)	**Data**	83 countries
	Variables	The growth of GDP per capita, GDP per capita, population, average growth rate of population, fraction of population living in urban areas, exports plus imports (% of GDP), investment (% of GDP), government consumption (% of GDP), average investment price level, life expectancy at birth, index of political right (scale 1 to 7), index of civil liberties (scale of 1 to 7) and minimum kilometre from New York, Rotterdam or Tokyo.
	Methodology	Dynamic panel estimation of Arellano and Bond (1998)
	Conclusion	The initial level of GDP, population, average population growth over the five-year periods and life expectancy are found statistically significant for both models (GDP and HDI). In the HDI growth model, the sign of GDP per capita and population were positive. However, the coefficient of life expectancy and initial GDP were negative.
Study	**Period**	2002
	Data	106 countries
	Variables	Quantities of renewable, non-renewable, purchased resources, Ecological Footprint, Surplus Biocapacity, Wellbeing Index, Environmental Sustainability Index, emergy

P.A. Frugoli et al. (2015)		yield ratio, GDP, GDP per capita, HDI, Democracy Index, Happiness Index and Life Expectancy.
	Methodology	Scatter plots and the Spearman correlation coefficient
	Conclusion	They concluded from correlation coefficient that the GDP is inadequate for monitoring sustainable societal development. Also, none of the indices studies encompass all perspectives needed to guide societies to sustainable development and the combinations of biophysical and socioeconomic indices improve the information provided
Study	**Period**	1985 to 2011
H. Roy et al. (2015)	**Data**	60 countries
	Variables	HDI, energy consumption and new HDI (with recalculation and incorporating the energy index along with other original indexes such as education, health and income)
	Methodology	the procedure of pooled regression, panel cointegration and granger causality
	Conclusion	They found bidirectional causality between HDI and energy consumption. They established for the new HDI that all countries scoring 0.80 are considered to be countries that have achieved “high human development” and all countries scoring below 0.50 are considered to be countries that have achieved “low human development”. Also, they revealed that the development in energy consumption will lead to increase the Human Development Index especially for poorer and developing nations.
Study	**Period**	2006-2012
	Data	102 countries
	Variables	HDI and global competitiveness index which is measured in a scale from 1 to 7
	Methodology	Pearson Correlation analysis and cluster analysis

J. Lonska and V. Boronenko (2015)	**Conclusion**	The countries that have a faster growth of competitiveness have a swift expansion of their human capital develop (Pearson correlation was 0.364 and statistically accepted). The most interesting is that these are not so called "developed" countries that take higher places in the competitiveness rating, but do not show their ability to grow, or it occurs for every year for the "developed" countries which they suffered from sustainably loss of their competitiveness, and the tendency is typical of their human capital development.
Study	**Period**	the 1st was from 1980 to 2010 with 5 years data to analyse long term effects and 2nd was from 2005 to 2010
G. Kazar and A. Kazar (2014)	**Data**	154 countries which was divided into 5 groups (all countries, countries with very high HDI, countries with high HDI, countries with middle HDI, countries with low HDI)
	Variables	HDI and the total renewable electricity net generation value
	Methodology	Long and short-run test and Granger causality
	Conclusion	They found that the variable of renewable electricity is significant for all dataset except for countries with high HDI in the model with long-run test. For the Granger causality, they showed that there's no long-run relationship between RE and HDI for group of very high HDI and low HDI. Meanwhile, there was unidirectional causality running from HDI to RE for group of all countries, and high HDI. However, they found bidirectional causality for countries with middle HDI. For the 2nd period, they found from the short-run test that the group of all countries, middle HDI and low HDI had a significant coefficient for their RE but the other group was insignificant. For Granger causality, they found bidirectional causality for all countries and unidirectional causality for the group of high HDI and which was running from HDI to RE but for the group of

		middle HDI, they found unidirectional relationship running from RE to HDI. However, for the other group they found no causality.
Study	**Period**	1980-2007
K.A. Hafner and D. Mayer-Foulkes (2013)	**Data**	72 countries
	Variables	GDP per capita, HDI, fertility, electricity and energy consumption per capita, domestic credit shares and trade
	Methodology	the procedure of Westerlund (panel cointegration model)
	Conclusion	They confirmed cointegration in the case of electricity for fertility and for HDI. They found with DOLS method that there is no long-run relationship with GDP as the dependent variable. However, they found an evidence of cointegration when energy was used as a proxy for technology or as urbanization with a constant and a trend included in the HDI equation. Relating to DOLS estimation, the coefficients of GDP, domestic credit shares and trade were positive and significant at 1% level, but they were no impact of energy consumption on human development.
Study	**Period**	1988-2008
	Data	15 developing countries
	Variables	HDI, energy consumption per capita, electricity consumption per capita and

N.S. Ouedraogo (2013)		international oil price as proxy of energy price
	Methodology	panel cointegration and Granger causality
	Conclusion	She confirmed for the existence of panel cointegration between variable. In the long-run, the income elasticity had negative and significant coefficient (-0.08) on energy model and a 1% increase in per capita energy consumption may reduce the HDI by 0.08%. Also, the energy price elasticity had a negative and statistically accepted sign (-0.11) and a 1% rise in this variable can decrease the HDI by around 0.11%. For electricity consumption per capita model, the income elasticity had a positive and significant coefficient (0.22) and an increase by 1% in electricity consumption could increase HDI by 0.22%. In the short-run, the energy consumption and energy prices had a statistically positive impact on HDI, whereas electricity consumption is statistically insignificant. Also, It appeared that only energy prices can determine the level of energy consumption not the level of development and neither the level of development nor the energy prices have a statistically significant impact on electricity consumption. Moreover, the energy consumption has a neutral effect on HDI from the joint causality test. In the long-term, the coefficients for energy consumption and the HDI are significant at level of 10% but have a negative effect and the Granger causality showed an evidence of unidirectional causality running from energy consumption to HDI. She said that a growing economy needs to diminish the level of energy consumption as production shifts toward less energy intensive service sectors or an inefficient energy supply.
Study	**Period**	1997-2008
	Data	six European countries
	Variables	Renewable energy and fossil fuel consumption, total population, gross inland renewable energy consumption per capita,

C. Pîrlogea (2012)		energy intensity, Co2 intensity, human development index
	Methodology	a panel data analysis and regression
	Conclusion	The fossil fuel consumption had a negative impact on the variable of HDI for Romania and Bulgaria. However, the positive impact was for countries with very high HDI. The renewable consumption had a positive impact on human development in the case of Poland and Ireland. When she studied the data as an individual variable, the energy consumption, in the most cases, have established a positive relationship with HDI, but when she included the energy intensity variable, the contribution was negative.
Study	**Period**	1975-2008
T.W. Abraham and U.A. Ahmed (2011)	**Data**	Nigeria
	Variables	GDP and HDI
	Methodology	The error correction model
	Conclusion	They found that there is a significant difference between the average growth of the economy and human development index. They showed also that there is a negative and insignificant short-run relationship between (GDP) and (HDI). In the long-run, the coefficient was statistically accepted. This suggest that policies aimed at accelerating growth would have a negative impact on human development in the short-run, but in the long-run, it will be re-established by HDI adjusting upwards or downward to correct the equilibrium error.
Study	**Period**	1975 - 2005
J.K. Steinberger and J.T. Roberts (2010)	**Data**	156 country
	Variables	(HDI), (GDP) per capita, primary energy supply per capita, population, total carbon emission from fossil energy, gas flaring and cement manufacturing
	Methodology	Several regression based on energy and human development, energy and carbon emission
		They showed that for some selected stages of energy consumption, (HDI) will increase

	Conclusion	over time. When HDI is attaining a high level of development, it will decrease the level of energy usage (especially fossil fuel). They demonstrated also that the dropping in the energy and carbon thresholds for growth will not automatically resolve the problem of climate change, energy supply or human development losses and the social and environmental development is only possible if the industrialized nations (which have high use of energy per capita and (co2) emission per capita) will significantly moderate or diminish their consumption and emissions.

Source: Done by the researchers

3. **Data and methodology:**

We shall use the variables of per capita primary energy consumption, per capita dioxide carbon emission, per capita gross domestic product and the human development index over the period of 1992-2016 for the MENA countries of Iran, Kuwait, Saudi Arabia, United Arab Emirates, Algeria and Egypt.

The (HDI) measures the average achievement in a country in three basic dimensions of human development:

- A long and healthy life, as measured by life expectancy at birth;
- Knowledge, as measured by the adult literacy rate (with two-thirds weight) and the combined primary, secondary, and tertiary gross enrolment ratio (with one-third weight);
- A decent standard of living, as measured by gross domestic product (GDP) per capita at PPP (purchasing power parity) in USD.

The primary energy consumption is composed of fossil energy, renewable energy and nuclear energy consumption.

The Gross domestic product is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the product.

The dioxide carbon emission reflects only those through consumption of oil, gas and coal for combustion related activities.

Table 02: **Variables definition**

Variables	**Unites**	**Source of Data**

PEC: per capita Primary energy consumption	Million tonne equivalent of petrol	Bp database (British Petroleum) and International Energy Agency (IEA)
COE: per capita Dioxide carbon emission	Million tonne carbon dioxide	Bp database and Global Carbon Atlas
GDP: per capita Gross domestic product	Constant 2010 US $	World Bank database
HDI: Human development index	Indices on the scale of 0 to 1	UNDP database (United Nation for Development program)

Source: Done by the researchers

The model for this study will be defined as following:

$$HDI_{it} = a_1 PEC_{it} + a_2 GDP_{it} + a_3 COE_{it} + \varepsilon_{it}$$

(HDI_{it}) indicates the sustainable development factor (or socio-economic factor) for specific country (i) at time (t).

(PEC_{it}) designs the variable of primary energy consumption for specific country (i) at time (t).

(GDP_{it}) represents the economic variable that designs the economic growth of countries for specific country (i) at time (t).

(COE_{it}) indicates the environment factor that measures the level of pollution for specific country (i) at time (t).

This research is one of the rare studies that modelling those variables within a panel framework and to examine the impact on indicators of human well-being. We shall apply a heterogeneous panel cointegration to study the dynamic relationship between these variables and which it could demonstrate the role of energy, economic, and environment on human well-being and implant the term of sustainable development. Also, the test for causal relationship between these variables in a panel background is typically led in three steps. First, we should check the order of integration in time series variables. Then, after having recognized the order of integration in the series, the panel cointegration tests are used to investigate the long-run link. Therefore, if the order of integration is found to be one for all variables (1st difference), the next step is to use the cointegration analysis to examine the existence of long-run relationship. And, the last phase is represented by employing dynamic panel causality tests in order to evaluate the long-run direction of causality.

3.1. Panel unit root tests

The panel-based methods proposed by **Levin, Lin and Chu (2002)**, **Im, Pesaran and Shin (2003)**, **Breitung (2000)**, **Hadri (2000)** and

Heteroscedastic consistent test are used in this paper. For each estimation technique, we test for unit roots in the panel by using three types of models (one with constant and trend, one with only constant and one with no constant and no trend).

3.2. Panel cointegration test

We shall develop **Pedroni (1999, 2004)** panel cointegration test that use eleven tests to examine the cointegration relationship and which allow for heterogeneity among individual members of the panel.

3.3. FMOLS and DOLS models

FMOLS (Fully-Modified Ordinary Least Square) represents a non-parametric approach and which it takes into explanation the possible correlation between the error term and the first difference of the regressors as well as the presence of a constant term, to dealing with correction for a serial correlation. This model was developed by **(P.C.B. Phillips, 1995)**

DOLS (Dynamic OLS) is parametric method where the lagged first-difference terms are explicitly estimated. In this case, the errors of the model are augmented with leads, lags and contemporaneous values of the regressors. This model was developed by **(P. Saikkonen, 1992)** and **(J.H. Stock and M.W. Watson, 1993)**

We shall perform these two methods with Eviews 9 and we will use pooled (weighted) estimation that account for heterogeneity by using cross-section specific estimates of the long-run covariance and the asymptotic covariance estimated using a moment estimator, because we need to reweight the data prior to computing pooled FMOLS and DOLS.

3.4. Panel Granger causality tests

If variables of this study are cointegrated this implies that causality exists between the two series, but this does not indicate the direction of causality. The Granger causality in the long-run relationship employed two step processes. It involves the estimation of the residuals from the long-run model.

4. **Empirical results**

4.1. Panel unit root results

The results of the panel unit root tests for the level and 1st differenced series of (HDI), (PEC), (GDP) and (COE) were described in **Table 03, 04** and **05** (**annex**). The variables of (PEC), (GDP) and (COE) were

reported to be integrated on first difference I (1), so we rejected the null hypothesis at level significance of 1% and 5% for all tests except the **Hadri** and **Heteroscedastic consistent** test, these two tests accepted only the alternative hypothesis for (GDP) series. However, the variable of (HDI) was hard to defined, because some tests indicated that the series was stationary on level and other tests showed that the series was stationary on 1st difference. In econometric theory always we take the disastrous hypothesis about different tests. In this case we said that the variable of (HDI) is integrated on 1st difference I (1). Consequently, we can perform the Pedroni cointegration test and the estimation of FMOLS and DOLS models.

4.2. Panel cointegration results

Table 06 (**annex**) indicated the result of the panel cointegration from the statistics of Pedroni. They suggested the rejection of the null hypothesis of no cointegration at level of 5% for almost all tests. Therefore, we can say that the variables move together in the long-run. The implication is that there is a long-run relationship between (HDI), (PEC), (GDP) and (COE).

4.3. The FMOLS and DOLS estimations

The dependent variable was the indicator of socio economic factor of sustainable development (HDI). Table **07** displayed the estimated long-run coefficient; FMOLS and DOLS models estimation give obviously different results.

From both model, we showed that the variable per capita primary energy consumption was positive and significant, indicating a rise by one unit in (PEC) increase the level of (HDI) by 144625.785 in FMOLS and 123965.946 in DOLS. This implies that these MENA countries need to depend mainly on energy consumption to expanse their socio-economic situation and to attain the sustainable development in the future. Indeed, the energy in all forms is important for modern technologies and economic growth as well, but it is also vital for certain basic activities in daily life of population such as lighting, refrigeration and the running of household appliances.

We demonstrated that the variable per capita gross domestic product was positive and significant in FMOLS, but negative and insignificant in DOLS, demonstrating that an increase by one unit in (GDP) increase the level of (HDI) by 0.095 in FMOLS. This suggests that the economic growth may affect positively the well-being of population by improving

the level of education and facilitate the access to energy. However in DOLS model, the coefficient was negative and insignificant, a rise by one unit in (GDP) decrease the level of (HDI) by 9.358. In this case, we can suggest that the development of economic structure in such countries won't support the social development policy. Consequently, these developing countries are mainly focussing on improvement of their economic and industrial situation. In the same time, they are ignoring their knowledge economy sector and the well-being of their population.

DOLS and FMOLS models showed that the variable of per capita dioxide carbon emission was negative and significant; suggesting that a one unit increase in (COE) may decrease the level of (HDI) by 49445.985 in FMOLS and by 41890.137 in DOLS. This indicates that the increase of pollution in the air atmosphere may hurt the health of population and cause respiratory diseases, cancer and tuberculosis. Indeed, this problem may lead to reduce the index of human development by reducing the expectancy of birth. Also, these MENA countries are mainly depending on fossil fuel to develop their national product and improving their technologies. However, the inefficient use of these traditional fuels in opens fires could lead to the instability of the environment situation. If such problem persists for these MENA countries, they won't be able to achieve the economic and social stability for the future generation, and therefore they cannot reach the sustainable development in economic, environment and social sectors.

4.4. Granger and Hurlin panel causality test

From **table 08**, the pairwise Granger panel causality test demonstrated that there were several bidirectional relationships (feedback hypothesis) at level of 1% between (PEC) and (COE), (GDP) and (COE), (GDP) and (PEC). We found also two unidirectional causalities at level of 5%, one was running from (HDI) to (COE) and the other one was running from (HDI) to (PEC). However, a neutrality hypothesis was found between (HDI) and (GDP).

Same causalities directions were found in the literature review. Consequently, these results indicated that the resources from national income are not allocated to activities contributing to Human development index and the human capital won't help to increase the national income and production.

5. Conclusion

This paper investigated the long-run relationship between the socio-economic factor of sustainable development in (HDI), per capita primary energy consumption, per capita gross domestic production and per capita dioxide carbon emission for a panel of 6 MENA countries over the period of 1992-2016 by using panel data unit root tests and heterogeneous panel cointegration procedure. The unit root test results showed that all variables are integrated in the same level (1^{st} difference), so we can apply the procedure of panel cointegration and then estimate the FMOLS and DOLS models.

We found from these models that the variable of (PEC) had a positive impact on (HDI). This implies that the access to modern and clean sources of energy has an important effect on socio-economic factor. Also, we demonstrated that the variables of (GDP) had a positive and negative effect on (HDI) in FMOLS and DOLS models, respectively, indicating that the development of the economic growth in such countries will affect negatively the well-being of people by increasing the urbanization and the use of fires fuel. However, the sign of (COE) was negative on (HDI). This indicates that the increase of carbon dioxide emission is due to several industrial firms and the exploitation of fossil fuel.

Consequently, such MENA countries need to improve the access of adequate energy, health and education service to reach the sustainable development and which is crucial for economic growth, human development and for the fight against climate change.

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Annex:

Table 03: **Panel unit root test for individual intercept and trend**

Null hypothesis : Unit Root					Null hypothesis: No Unit Root	
Variables		Methods				
		LLC (t-stat)	Breitung (t-stat)	IPS (w-stat)	Hadri (z-stat)	Heteroscedastic consistent (z-stat)
Level	**COE**	-0.671 (0.250)	1.983 (0.976)	0.864 (0.806)	5.874 (0.000)	4.221 (0.000)
	PEC	-1.166 (0.121)	1.469 (0.929)	0.041 (0.516)	5.751 (0.000)	4.207 (0.000)
	GDP	-0.562 (0.287)	-0.682 (0.247)	-1.542*** (0.061)	3.410 (0.000)	2.880 (0.002)
	HDI	-2.483* (0.006)	3.486 (0.999)	0.709 (0.761)	5.514 (0.000)	4.774 (0.000)
1st dif	**ΔCOE**	-8.783* (0.000)	-3.122* (0.000)	-8.374* (0.000)	2.956 (0.001)	4.343 (0.000)
	ΔPEC	-6.989* (0.000)	-2.844* (0.002)	-8.219* (0.000)	3.646 (0.000)	7.855 (0.000)
	ΔGDP	-3.656* (0.000)	-2.072** (0.019)	-4.0126* (0.000)	1.687* (0.045)	3.464 (0.000)
	ΔHDI	-0.776 (0.218)	1.879 (0.969)	-1.337*** (0.0905)	4.658 (0.000)	3.027 (0.001)

Source: Done on Eviews 9

Table 04: **Panel unit root test for individual intercept**

Null hypothesis : Unit Root					Null hypothesis: No Unit Root	
Variables		Methods				
		LLC (t-stat)	Breitung (t-stat)	IPS (w-stat)	Hadri (z-stat)	Heteroscedastic consistent (z-stat)
Level	**COE**	-0.303 (0.380)	…	1.802 (0.964)	7.442 (0.000)	7.693 (0.000)
	PEC	-0.334 (0.369)	…	1.746 (0.959)	7.292 (0.000)	7.678 (0.000)
	GDP	0.893 (0.814)	…	2.345 (0.990)	6.236 (0.000)	6.371 (0.000)
	HDI	-4.514* (0.000)	…	-4.063* (0.000)	8.802 (0.000)	8.442 (0.001)
1st dif	**ΔCOE**	-9.132* (0.000)	…	-9.198* (0.000)	4.169 (0.000)	2.351 (0.009)
	ΔPEC	-7.845* (0.000)	…	-9.072* (0.000)	4.380 (0.000)	2.577 (0.005)
	ΔGDP	-5.316* (0.000)	…	-5.819* (0.000)	1.315** (0.094)	0.618*** (0.268)
	ΔHDI	-0.747 (0.227)	…	-1.286*** (0.099)	3.840 (0.000)	2.989 (0.001)

Source: Done on Eviews 9

Table 05: **Panel unit root test with no individual intercept and trend**

Null hypothesis : Unit Root					Null hypothesis: No Unit Root	
Variables		Methods				
		LLC (t-stat)	Breitung (t-stat)	IPS (w-stat)	Hadri (z-stat)	Heteroscedastic consistent (z-stat)
Level	COE	3.829 (0.999)	…	…	…	…
	PEC	4.933 (1.000)	…	…	…	…
	GDP	3.995 (1.000)	…	…	…	…
	HDI	5.411 (1.000)	…	…	…	…
1st dif	ΔCOE	-7.449* (0.000)	…	…	…	…

	ΔPEC	-6.060* (0.000)	…	…	…	…
	ΔGDP	-5.571* (0.000)	…	…	…	…
	ΔHDI	-3.263* (0.000)	…	…	…	…

Source: Done on Eviews 9

*, **, *** represents 1%, 5% and 10% levels of significance for all unit root tests. The null hypothesis is that the variable follows a unit root process, except for the Hadri and Heteroscedastic consistent tests (z-stat), the levels of significance were 10%, 5% and 1%. Δ is the 1st difference operator.

Table 06: **Pedroni residual cointegration**

	Methods	Within dimension (panel statistics)			Between dimension (individuals statistics)		
		Test	Statistics	Prob	Test	Stats	Prob
Panel model with individual intercept and individual trend	**Pedroni (1999)**	Panel v-stat	8.444*	0.000	Group p-stat	1.573	0.942
		Panel rho-stat	-0.103	0.459	Group pp-stat	0.067	0.526
		Panel PP-stat	-2.470*	0.006	Group ADF-stat	0.129	0.551
		Panel v-stat	-2.445*	0.007			
	Pedroni (2004)	Panel v-stat	7.675*	0.000			
		Panel rho-stat	0.313	0.622			
		Panel PP-stat	-1.774**	0.038			
		Panel v-stat	-1.746**	0.040			
Panel model with individual intercept only	**Pedroni (1999)**	Panel v-stat	2.249**	0.012	Group p-stat	0.479	0.684
		Panel rho-stat	-0.681	0.247	Group pp-stat	-2.048**	0.020
		Panel PP-stat	-2.720*	0.003	Group ADF-stat	-2.148**	0.015
		Panel v-stat	-1.864**	0.031			
	Pedroni (2004)	Panel v-stat	1.899**	0.028			
		Panel rho-stat	-0.243	0.403			

		Panel PP-stat	-1.939**	0.026			
		Panel v-stat	-1.543***	0.061			
Panel model with no intercept or trend	**Pedroni (1999)**	Panel v-stat	-2.032	0.978	Group p-stat	1.566	0.941
		Panel rho-stat	-0.196	0.422	Group pp-stat	0.218	0.586
		Panel PP-stat	-1.745**	0.040	Group ADF-stat	0.227	0.589
		Panel v-stat	-1.427***	0.076			
	Pedroni (2004)	Panel v-stat	-2.073	0.980			
		Panel rho-stat	0.070	0.528			
		Panel PP-stat	-0.897	0.184			
		Panel v-stat	-0.016	0.493			

Source: Done on Eviews 9

*, **, *** represents 1%, 5% and 10% levels of significance, so we accept the alternative hypothesis of existence of cointegration relationship between variables.

Table 07: Estimation of FMOLS and DOLS with weighted panel method

Dependent var: HDI	FMOLS			DOLS		
Var	**Coef**	**t-stat**	**Pr**	**Coefficient**	**t-stat**	**Pr**
PEC	144625.785*	7339606.6	0	123965.946*	11.552	0
GDP	0.095*	3.855	0	-9.358	-1.026	0.307
COE	-49445.985*	-1818249	0	-41890.137*	-9.950	0

Source: Done on Eviews 9

*, **, *** represents 1%, 5% and 10% levels of significance, so we accept the alternative hypothesis and the variables are significant.

Table 08: Granger panel causality test with eight lags, p = 8:

Null Hypothesis	F-stat	Prob
PEC does not Granger cause COE	4.657*	0
COE does not Granger cause PEC	5.096*	0
GDP does not Granger cause COE	11.271*	0
COE does not Granger cause GDP	4.509*	0
HDI does not Granger cause COE	2.279**	0.029
COE does not Granger cause HDI	1.242	0.284

GDP does not Granger cause PEC	11.826*	0
PEC does not Granger cause GDP	4.972*	0
HDI does not Granger cause PEC	2.514**	0.016
PEC does not Granger cause HDI	1.060	0.398
HDI does not Granger cause GDP	1.284	0.262
GDP does not Granger cause HDI	0.632	0.748

Source: Done on Eviews 9

*, **, *** represents 1%, 5% and 10% levels of significance, so we cannot reject the alternative hypothesis of existence of causality between variables.