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Economic Growth and Carbon Dioxide Emissions: Investigating the Environmental Kuznets Curve Hypothesis in Algeria

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ABSTRACT

This study examines the existence of environmental Kuznets curve (EKC) hypothesis between economic growth and carbon dioxide (CO_2) emission in Algeria for the period 1971-2009 using autoregressive distributed lag co-integration framework. Data were retrieved from World Bank Development Indicators. Importantly, our findings reveal that EKC hypothesis does not exist. In addition, the long run models show that income and population appear to have significant impact on CO_2 emission especially from solid fuel consumption and electricity and heat production. However, only population is revealed to promote CO_2 from liquid fuel consumption. These findings suggest a dire need for Algeria to shift towards service intensive economy rather than resource intensive, and alternative renewable energy sources in order to mitigate environmental degradation as well as promote economic development.

Keywords: Air Pollution, Economic Growth, Environmental Kuznets Curve Hypothesis
JEL Classifications: Q53, O47, Q56

1. INTRODUCTION

The increasing threat of air pollution and global warming has been widely discussed in various international reunions. As per the Intergovernmental Panel on Climate Change (IPCC), carbon dioxide emissions (CO_2) are the major source of global warming. IPCC (2007) projected a global temperature increment from 1.1° to 6.4° and 16.5 to 53.8 cm rise in sea level by 2100. CO_2 emission as a main source of greenhouse gases is mainly indorsed to energy consumption mostly, fossil fuels burning such as oil and gas. Unlike other gases such as SO_2 and NO_x, CO_2 emission spreads beyond the borders to other countries and indirectly affect the health, thus a country is likely less incentive in CO_2 emission reducing especially during rapid economic expansion period.

Environmental Kuznets curve (EKC) become an independent research issue and motivated a bulky number of studies. EKC claims an inverted U-shaped relationship between income and CO_2; at early stage of development, environmental degradation occurs, but at certain point the increase in economic development will decrease CO_2 emission (Grossman and Helpman, 1991; Panayotou, 1993; Shafik and Bandyopadhyay, 1992). The application of EKC hypothesis is increasingly important since no policy prevention is required as the effect of economic progress on CO_2 tend to become negative at the turning point.

Apart from other environmental indicators such as deforestation, carbon emission, sulfur dioxide, and municipal waste, the existence of EKC hypothesis amid CO_2 emission and economic development has been largely probed, but yet this relation is still inconclusive. Shafik and Bandyopadhyay (1992), Shafik (1994) and Azomahou et al. (2006) probed and found a linear relationship between CO_2 emission and income. While, Roberts and Grimes (1997), Cole et al. (1997), Schmalensee et al. (1998), Galeotti and Lanza (1999), Apergis and Payne (2009a), Lean and Smyth (2010) and Saboori et al. (2012) confirmed the existence of EKC hypothesis. However, numerous studies employed EKC hypothesis in tempting to overcome environmental degradation using several environmental quality indicators. For instance, Panayotou (1993), Koop and Tole (1999), Bhattarai and Hammig (2001) and Bulte and Van Soest

(2001) utilized deforestation. Dinda (2004), Holtz-Eakin and Selden (1995), Roberts and Grimes (1997) and Ozturk and Uddin (2012) used carbon emissions. De Bruyn (1997), Grossman and Helpman (1991), Kaufmann et al. (1998), Selden and Song (1994), and Stern et al. (1996) employed sulfur dioxide.

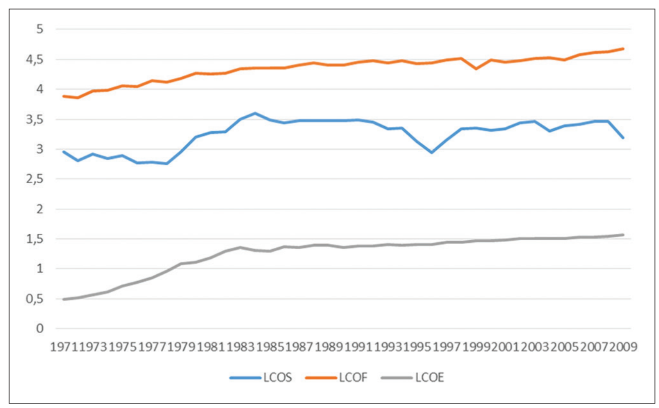
Despite the bulky number of literatures that investigated the existence of EKC among income and CO_2, only few studies applied individual countries to explore the hypothesis. Consequently, lack of policy implications to each country arises, since pollution feature differs from country to another (Ang, 2008). Studies employed time series technique include De Bruyn et al. (1998) for Netherlands, West Germany, UK and USA; Roca et al. (2001) for Spain; Day and Grafton (2003) for Canada and Friedl and Getzner (2003) for Austria; Fodha and Zaghdoud (2010) for Tunisia; Saboori et al. (2012) for Malaysia; Shahbaz et al. (2013) for Turkey; Shahbaz et al. (2014a) for Tunusia; Shahbaz et al. (2014b) for UAE; Ozturk and Al-Mulali (2015) for Cambodia; Shahbaz et al. (2015) for Portugal; Al-Mulali et al. (2015) for Vietnam.

On the other hand, few studies found inclusive results include Ozturk and Acaravci (2010) for Turkey; Menyah and Wolde-Rufael (2010) for South Africa. Findings in exploring EKC hypothesis between CO_2 emission and economic growth for individual countries is likely to vary as a result of various econometrics techniques, time span, and different employed proxies. Earlier studies tend to employ causality and co-integration methods in order to investigate the relationship between CO_2 emission and economic growth. For instance, (Ghosh, 2010) utilized Granger causality based on vector error correction model for India; Jalil and Mahmud (2009) used pair wise Granger causality for China; Soytas and Sari (2009) used Toda and Yamamoto for Turkey.

The relationship between CO_2 emission and economic development has been extensively explored. Table 1 provides an overview of several studies probed this relation in order to validate the existence of EKC hypothesis. Obviously, this hypothesis is still questionable. Moreover, the relationship between CO_2 emission and economic growth may vary from one country to the other as a result of different individual country specifications.

This study investigates the dynamic relationship between CO_2 emission and economic growth and the existing of EKC hypothesis in Algeria. Algeria as a country of well-endowed fossil fuel resources has experienced rapid growth rate since 1970s. These resources permitted Algeria to promote economic expansion. The over-use of energy resources led to higher environmental degradation as CO_2 emission augmented gradually. The increase in energy use is a result of domestic usage as well as oil and gas export. Algeria owns large of oil and gas resources. The oil and gas sector is the backbone of the economy, accounting for about 35% of the gross domestic product (GDP), and two-thirds of total exports. Algeria holds the third-largest amount of proved crude oil reserves in Africa. Energy use in Algeria relies solely on fossil fuels (oil and natural gas), causing huge CO_2 emissions that contribute to global climate. CO_2 emission from liquid fuel consumption was about 7623 million metric tons in 1971, and reaches 27,308 million

Figure 1: Carbon dioxide (CO_2) emission in Algeria, *LCOS*: CO_2 emissions from solid fuel consumption, *LCOS*: CO_2 emissions from liquid fuel consumption, and *LCOS*: CO_2 emissions from electricity and heat production



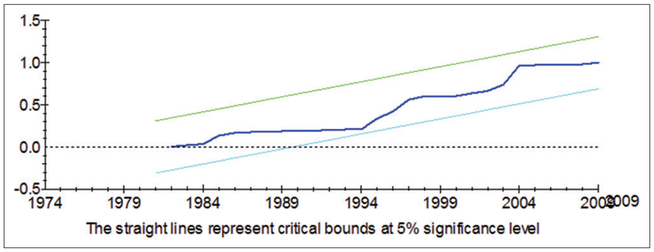
Source: World Bank Database 2014

Table 1: Summary of the existing empirical studies on the relationships between CO_2 emissions and economic growth

Study	Countries	Period	Methodology	Results
Saboori et al. (2012)	Malaysia	1980-2009	The ARDL bounds testing approach, VECM Granger causality	EKC hypothesis exist
Lau et al. (2014)	Malaysia	1970-2008	The ARDL bounds testing approach, VECM Granger causality	EKC hypothesis exist
Ozturk and Acaravci (2010)	Turkey	1960-2005	The ARDL bounds testing approach, VECM Granger causality	EKC hypothesis exist for Denmark and Italy
Esteve and Tamarit (2012)	Spain	1857-2007	Threshold VECM model	EKC hypothesis exist
Hamit-Haggar (2012)	Canada	1990-2007	Pedroni co-integration test, FMOLS, VECM Granger causality	EKC hypothesis exist
Day and Grafton (2003)	Canada	1958-1995	Johansen co-integration, OLS model, and VAR Granger causality	No evidence of EKC hypothesis
Fodha and Zaghdoud (2010)	Tunisia	1961-2004	Johansen co-integration test, VECM Granger causality	EKC hypothesis exist
Osabuohien et al. (2014)	Africa	1995-2010	Pedroni co-integration, and DOLS	EKC hypothesis exist

DOLS: Dynamic ordinary least squares, ARDL: Autoregressive distributed lag, VECM: Vector error correction model, FMOLS: Fully modified ordinary least squares, VAR: Vector autoregressions, EKC: Environmental Kuznets curve, CO_2: Carbon dioxide

Figure 2: Plot of cumulative sum for Case 1



metric tons in 1988. Figure 1 highlights the slow advancement of income in Algeria from 1971 till 2009. GDP per capita in Algeria experienced a gradual increase till 1985, after that and due to fallen oil prices, income per capita fall to 7245 DZD in 1994, while it was 8996 DZD in 1985. Figure 2 shows the gradual increase in the three CO_2 emission. It is worthwhile to investigate the policies proven effect on CO_2 emission reduction in Algeria.

This paper attempts to test the hypothesis of: (1) The long-run co-integration among CO_2 emission and economic growth. This hypothesis is investigated employing three CO_2 resources, namely: CO_2 emission from solid fuel consumption, CO_2 emission from liquid fuel consumption, and CO_2 emission from electricity and heat production, (2) unidirectional causality occurs from energy use to economic growth, (3) EKC theory on the association between each type of CO_2 emission towards economic growth in Algeria over the period of 1971-2009.

The rest of the paper is organized as follows: Section 2 describes the data and section 3 presents used methodology and model. Section 4 provide the empirical findings. And Section 5 discuss results and policy implication. While Section 6 concludes the paper.

2. DATA

This study uses annual data from 1971 to 2009. CO_2 emission is measured in metric tons and categorized into three types as follows: (1) CO_2 emissions from solid fuel consumption, (2) CO_2 emissions from liquid fuel consumption and (3) CO_2 emissions from electricity and heat production. Per capita GDP, gross fixed capita formation, import, and export are measured in local currency DZD. Time series data were retrieved from World Bank Database.

3. MODEL AND METHODOLOGY

Based on EKC hypothesis, a non-linear quadratic association exists between pollution and income. That is EKC hypothesis may formulated as follows:

$$E = f(Y,\, Y^2, Z) \tag{1}$$

Where, E refers to environmental degradation, Y is income and Z represents other descriptive variables that may influence environmental degradation. CO_2 emission has been widely used as dependent variable (Al-Mulali et al., 2014; Lau et al., 2014; Osabuohien et al., 2014; Pao and Tsai, 2011a; Pao and Tsai, 2011b; Tiwari et al., 2013; Wang et al., 2011; Yavuz, 2014). Economic growth is widely used as economic development and to incorporate EKC hypothesis. Apergis and Payne (2009b), Ghali and El-Sakka (2004) and Huang et al. (2008) validated the influence of gross fixed capital formation and labor towards pollution level. Furthermore, several studies have employed import and export as an indicator to trade such as Al-Mulali et al. (2014), Du et al. (2012), Osabuohien et al. (2014) and Tiwari et al. (2013).

In this study, we employ autoregressive distributed lag approach (ARDL) bound testing approach, which proposed, by Pesaran et al. (2001). This approach has several advantages over alternatives. For instance, this method can be applied whether variables are stationary or integrated in different order. Hence, it overcomes problem of integration order related to Johansen (1995). This approach redresses heterogeneity and mitigates serial correlation problems through accurate order augmentation of the repressor and appropriate lag selection.

Co-integration test will be performed using F-statistics. The computed F-statistic value will be evaluate with the critical values presented in Table 2 of Narayan (2005). Consequently, if the computed F-statistic is greater than the upper bound value, then agriculture area and its determinants share a long-run relationship level. Conversely, if the computed F-statistic is smaller than the lower bound value, then the null hypothesis is not rejected and we can conclude that there is no long-run relationship between CO_2 emission and its determinants. On the other hand, if the computed F-statistic falls within these bounds, inference would be inconclusive.

Once co-integration is performed, short-run and long-run relationship will be estimated. (Narayan and Narayan, 2010) suggested an alternative method to investigate EKC hypothesis in order to eliminate multicollinearity problem. Multicollinearity may arise between GDP per capita and GDP per capita square. This approach suggests a comparison between short-run and long-run elasticity. If the long-run income elasticity is smaller than the short run income elasticity, then we can conclude that, over time, income leads to less CO_2 emission. Following Al-Mulali et al. (2014), Narayan and Narayan (2010) and above discussed empirical literatures, the ARDL model is estimated as follows:

$$\begin{aligned}
\Delta LnCOS_t &= \beta_0 + \sum_{i=1}^{n} a_1 \Delta LnCOS_{t-1} + \sum_{i=1}^{n} a_2 \Delta LnGDPCLCU_{t-1} + \\
&\sum_{i=1}^{n} a_3 \Delta LnGFCFLCU_{t-1} + \sum_{i=1}^{n} a_4 \Delta LnPOP_{t-1} + \sum_{i=1}^{n} a_5 \Delta LnEXPLC_{t-1} \\
&+ \sum_{i=1}^{n} a_6 \Delta LnIMPLC_{t-1} + \beta_1 LnCOS_{t-1} + \beta_2 LnGDPCLCU_{t-1} \\
&+ \beta_3 LnGFCFLCU_{t-1} + \beta_4 LnPOP_{t-1} + \beta_5 LnEXPLC_{t-1} + \\
&\beta_6 LnIMPLC_{t-1} + \theta ECT_{t-1} + \varepsilon_t
\end{aligned} \tag{2}$$

Table 2: Co-integration bound test results

Model	Optimal lag	F-test [P]	Result
Case 1			
FlnCOS [*lnCOS*|*lnY*, *lnY*², *lnZ*]	(1,2, 0, 0, 0, 0)	5.3267 [0.002]**	Co-integration
Case 2			
FlnCOF [*lnCOF*|*lnY*, *lnY*², *lnZ*]	(1,2, 0, 0, 0, 0)	4.9073 [0.003]**	Co-integration
Case 3			
FlnCOE [*lnCOE*|*lnY*, *lnY*², *lnZ*]	(1,2, 0, 0, 0, 0)	5.7388 [0.001]**	Co-integration
Critical values for F-statistics (%)	Lower I(0)	Upper I(1)	
1	4.045	5.898	
5	2.962	4.338	
10	2.483	3.708	

Critical values were retrieved from Narayan (2005). Case 3: Unrestricted intercept and no trend. **Denotes significance at 5% level

$$\Delta LnCOF_t = \beta_0 + \sum_{i=1}^{n} a_1 \Delta LnCOF_{t-1} + \sum_{i=1}^{n} a_2 \Delta LnGDPCLCU_{t-1} + \sum_{i=1}^{n} a_3 \Delta LnGFCFLCU_{t-1} + \sum_{i=1}^{n} a_4 \Delta LnPOP_{t-1} + \sum_{i=1}^{n} a_5 \Delta LnEXPLC_{t-1} + \sum_{i=1}^{n} a_6 \Delta LnIMPLC_{t-1} + \beta_1 LnCOF_{t-1} + \beta_2 LnGDPCLCU_{t-1} + \beta_3 LnGFCFLCU_{t-1} + \beta_4 LnPOP_{t-1} + \beta_5 LnEXPLC_{t-1} + \beta_6 LnIMPLC_{t-1} + \theta ECT_{t-1} + \varepsilon_t \quad (3)$$

$$\Delta LnCOE_t = \beta_0 + \sum_{i=1}^{n} a_1 \Delta LnCOE_{t-1} + \sum_{i=1}^{n} a_2 \Delta LnGDPCLCU_{t-1} + \sum_{i=1}^{n} a_3 \Delta LnGFCFLCU_{t-1} + \sum_{i=1}^{n} a_4 \Delta LnPOP_{t-1} + \sum_{i=1}^{n} a_5 \Delta LnEXPLC_{t-1} + \sum_{i=1}^{n} a_6 \Delta LnIMPLC_{t-1} + \beta_1 LnCOE_{t-1} + \beta_2 LnGDPCLCU_{t-1} + \beta_3 LnGFCFLCU_{t-1} + \beta_4 LnPOP_{t-1} + \beta_5 LnEXPLC_{t-1} + \beta_6 LnIMPLC_{t-1} + \theta ECT_{t-1} + \varepsilon_t \quad (4)$$

Where, t and ε_t stand for time period and white noise, respectively. $\theta\ ECT_{t-1}$ in Equation (2), Equation (3), and Equation (4) corresponds to the error correction term (ECT). *ECT* indicates the speed of the adjustment and shows how quickly the variables return to the long-run equilibrium. In Equation (2) *COS* represent CO_2 emissions from solid fuel consumption (*kt*). In Equation (2) *COF* stands for CO_2 emissions from liquid fuel consumption (*kt*), in Equation (4) *COE* refers to CO_2 emissions from electricity and heat production. α_i where $i = 1, 2, 3, 4, 5, 6$ are the corresponding short-run multipliers, while the parameters β_i, where $i = 1, 2, 3, 4, 5, 6$ are the long-run dynamic coefficients of the underlying ARDL model. In Equation (2) *GDPCLCU*, *GFCFLCU*, *POP*, *EXPLC*, and *IMPLC* correspond to real GDP per capita in DZD, gross fixed capital formation, population, export of goods and services, and import of goods and services in DZD, respectively. The same applies for Equation (3) and Equation (4). Once all equation are estimated, diagnostic tests are performed to validate model adequacy. These tests include serial correlation, functional form, normality and heteroscidasticity as well as cumulative sum (CUSUM) and CUSUM of squares (CUSUMSQ) tests to verify the stability of the coefficient in the estimated models (Pesaran et al., 2001).

4. EMPIRICAL RESULTS

Although ARDL bound testing approach is applicable regardless of co-integration order of the variables (whether variables are I(0), I(1), or are integrated in different order), unit root test is conducted to avoid spurious regression results. Augmented Dickey and Fuller (Dickey and Fuller, 1979) (ADF) test is performed[1]. Results of unit root test confirm the absence of I(2) for all the variables; hence utilizing ARDL is feasible.

Results of computing F values for testing the existence of long-run relationship are demonstrated in Table 2. The maximum lags length is calculated following Akaike information criterion (AIC) minimization criteria in order to prevent classical assumptions violation. Calculated F-statistic is sensitive to the number of lags imposed for co-integration test (Bahmani-Oskooee and Brooks, 1999; Narayan et al., 2008). Case 1 represents calculated F-statistic of co-integration result of Equation (2). Since F-statistic is greater than the upper bound in all cases, co-integration amongst CO_2 emission from solid fuel consumption and its determinants. Baseline Equation (3) and Equation (4) are as reported in Table 2 in which CO_2 emission is replaced by CO_2 emission from liquid fuel consumption and CO_2 emission from electricity and heat production, respectively.

The existence of long-run relationship between CO_2 emission and its determinants based on bound testing approach permits us to estimate long- and short run models of environmental degradation in Algeria. In order to examine the existence of EKC hypothesis, long-run and short-run models were compared (Narayan and Narayan, 2010). Tables 3 and 4 report long-run and short-run estimated models, respectively. The estimated ARDL models are set to 1 lag length. AIC-base suggests (1, 0, 0, 0, 0, 0), (0, 1, 0, 1, 0, 1), and (1, 0, 0, 0, 1, 0) for Case 1, 2 and 3, respectively. While negative and significant ECT in Table 4 provides an extra evidence of long-run co-integration among variables. ECT indicates the adjustment speed of the variables towards the long-run equilibrium.

1 To save space, the results from unit root analysis are not reported here but available upon request.

Table 3: Long-run ARDL model

Variables	Case 1	Case 2	Case 3
lnCOS	0.47344 (0.12264)***	-	-
lnCOF	-	-	-
lnCOE	-	-	0.51725 (0.12002)***
lnGDPCLCU	6.2331 (1.4552)***	−1.2907 (0.94235)	1.4181 (0.60134)**
lnGFCFLCU	−2.0343 (0.64218)***	0.49548 (0.24432)*	0.052513 (0.17291)
lnPOP	3.4692 (1.0477)***	28.9410 (12.6162)**	2.1229 (0.71437)**
lnIMPLC	−2.5326 (0.70479)***	−0.10093 (0.19931)	−0.21876 (0.15237)
lnEXPLC	0.24757 (0.54176)	−0.028509 (0.46214)	−0.37381 (0.34486)
C	8.9228 (3.4208)**	−6.6817 (3.4584)*	1.0643 (1.0199)

Figures in parentheses ( ) indicate the standard errors. While, *,**,***denotes statistical significance at 10%, 5%, and 1% level, respectively. ARDL: Autoregressive distributed lag

Table 4: Short-run ARDL model

Variables	Case 1	Case 2	Case 3
lnCOS	-	-	-
lnCOF	-	-	-
lnCOE	-	-	-
lnGDPCLCU	6.2331 (1.4552)***	−1.2907 (0.94235)	1.4181 (0.60134)**
lnGFCFLCU	−2.0343 (0.64218)***	0.49548 (0.24432)*	0.052513 (0.17291)
lnPOP	3.4692 (1.0477)***	28.9410 (12.6162)**	2.1229 (0.71437)***
lnIMPLC	0.24757 (0.54176)	−0.10093 (0.19931)	−0.21876 (0.15237)
lnEXPLC	−2.5326 (0.70479)***	−0.028509 (0.46214)	−0.37381 (0.34486)
C	8.9228 (3.4208)**	−6.6817 (3.4584)*	1.0643 (1.0199)
Ect (−1)	−0.52656 (0.12264)***	-	−0.48275 (0.12002)***

Figures in parentheses ( ) indicate the standard errors. While, *,**,***denotes statistical significance at 10%, 5%, and 1% level, respectively. ARDL: Autoregressive distributed lag

Provided long-run and short-run computed models, there is no evidence of EKC hypothesis in all cases. Moreover, regardless of CO_2 emission sources, whether from solid fuel consumption, liquid fuel consumption, or from electricity and heat production EKC hypothesis is unproven. The estimated results are in line with other studies such as Jalil and Mahmud (2009), Saboori et al. (2012). A possible explanation of non-existence of EKC hypothesis in Algeria is that the Algerian economy is still resource intensive rather than services intensive; in which oil sector donates 45.9% of total GDP per capita in 2006, while services and agriculture sectors contribute 20.1% and 7.6% respectively (OECD, 2008).

In long-run models (Table 3), income and population appear to have a positive impact on CO_2 emission from solid fuel consumption, that is, an increase by 1% in real GDP per capita leads to 6% increase in CO_2 emission from solid fuel consumption; while, investment and import seem to have a negative effect. However, only population appears to promote CO_2 from liquid fuel consumption (Case 2). In Case 3, CO_2 emission from electricity and heat production appears to be positively affected through income and population growth (Table 3), where an increase by 1% in income level leads to 1.41% increase in CO_2 emission from electricity and heat production.

In short-run models (Table 4), coefficients of real GDP per capita and population appears to have significant and positive impact towards CO_2 emission from solid fuel consumption; increase by 1% in income level leads to 6.23% increment in CO_2 emission from solid fuel consumption. While in Case 2, only population appears to be significant and positively affecting CO_2 emission from liquid fuel consumption. However, in Case 3 real GDP per capita and population seem to be significantly and positively associated to CO_2 emission from electricity and heat production; increase by 1% in income level leads to 1.41% increment in CO_2 emission from electricity and heat production. In Table 4, ECT indicates to the speed of the adjustment and shows how quickly the variables return to the long-run equilibrium; the negative and significances of ECT is an efficient way of establishing co-integration among variables (Kremers et al., 1992). For instance, ECT of −0.52 in Case 1 reveals that 52% of discrepancy between the actual and value of real GDP per capita is corrected each year. Comparing income coefficient in the long-run (Table 3) with itself in short-run model (Table 4) reveal no evidence to an inverted-U shape relationship between CO_2 emission and income, since the coefficients are almost equal in both short-run and long-run equations. These findings are in line with Jalil and Mahmud (2009).

In order to verify the adequacy of the estimated results, a bulky of diagnostic tests were applied. Table 5 presents serial correlation, functional form, normality, and heteroscedasticity tests. The null hypothesis of serial correlation is not rejected in all cases, except Case 2 at 10% level of significance. Also, null hypothesis of functional form is accepted in Case 1 and Case 2 only. Apart from Case 2, all cases are free from normality harms. Similarly, null hypothesis of heteroscedasticity is accepted; with no heteroscedasticity in all cases. Furthermore, the stability test for the model applies the CUSUMSQ of recursive residuals and the CUSUM of recursive residuals proposed by Brown et al. (1975), which are presented in Figures 3-7. Obviously, the CUSUM and CUSUMSQ statistics stay within the critical bounds except for Case 3 for CUSUMSQ. Since CUSUM and CUSUMSQ lines stay within the critical bounds, there is an indication of significant relationship between dependent and independent variables.

Table 5: Diagnostic results

Model	Serial correlation	Functional form	Normality	Heteroscedasticity
Case 1	2.0704 [0.150]	1.2753 [0.259]	2.1361 [0.344]	0.099363 [0.753]
Case 2	2.7163 [0.099]*	1.8006 [0.180]	52.2746 [0.000]***	0.50937 [0.475]
Case 3	0.72587 [0.394]	5.4394 [0.020]**	0.25425 [0.881]	0.40907 [0.522]

Values in parenthesis represent P value, while *,**,***denote significance at 10%, 5%, and 1%, respectively

Figure 3: Plot of cumulative sum-squared for Case 1

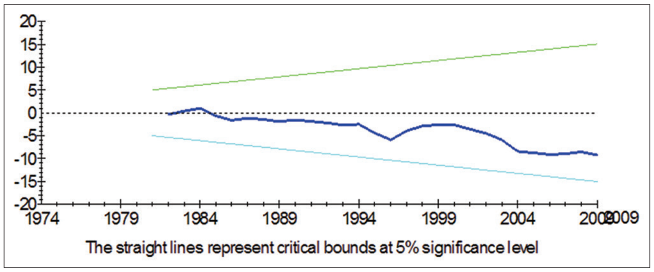
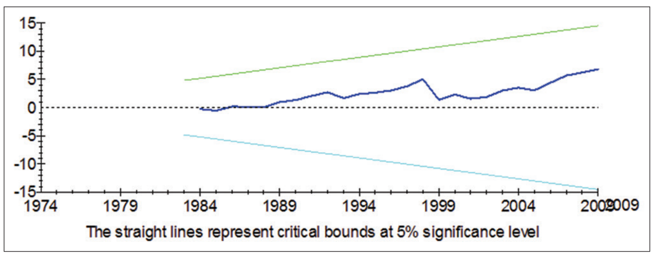


Figure 4: Plot of cumulative sum for Case 2



5. DISCUSSION AND POLICY IMPLICATION

Economic expansion and development is key target for most emerging countries to be fully developed nations. In the same time, economic expansion usually causes environmental degradation. Hence, implementation of appropriate policies regarding halt environmental degradation without harming economic development in the country is crucial for policy makers.

Long-run findings suggest that CO_2 emission from solid fuel consumption and from electricity and heat production are significantly associated to the economic development in Algeria. While, CO_2 emission from liquid fuel consumption is statistically unrelated to the economic growth in the country. Obviously, any reduction in CO_2 emission from solid fuel consumption or from electricity and heat production will harm economic expansion. Thus, any control towards CO_2 emission must suitably implied, and appropriate policies may be favored to efficient energy consumption. Moreover, reduction in CO_2 emission from liquid fuel consumption may reduce pollution as well as it does not harm economic growth in Algeria. Oil and gas sector remains the driving force of the Algerian economy which contribute up to 50% of GDP and 97% of Algerian exports; as a result, the choice of renewable energy in Algeria is needed. In fact, Algeria has implemented Energy Efficiency Program (EEP) to reduce pollution through pollution free sources. EEP includes solar water heating development, spreading the use of low energy consumption lamps, and promoting energy efficiency in the industrial sector.

Figure 5: Plot of cumulative sum-squared for Case 2

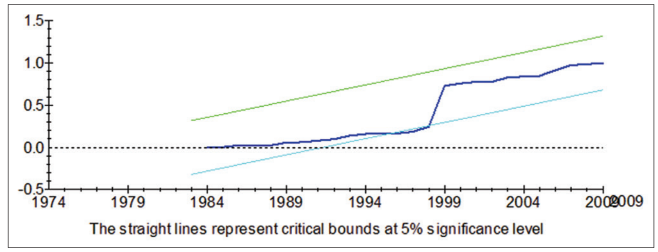


Figure 6: Plot of cumulative sum for Case 3

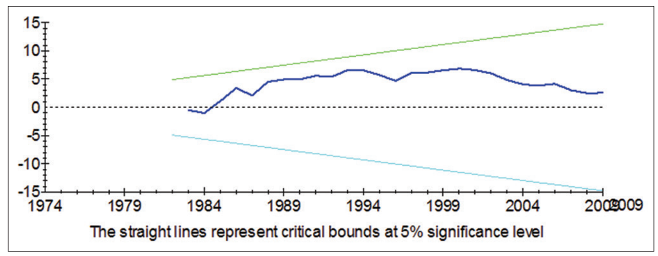
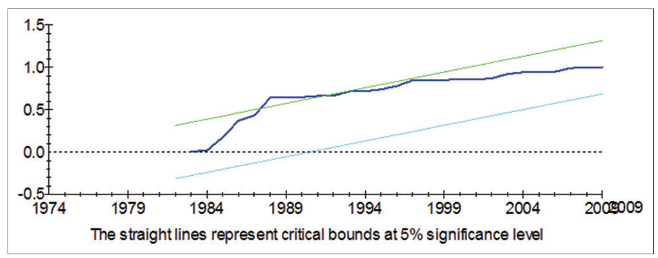


Figure 7: Plot of cumulative sum-squared for Case 3



Algeria needs to embrace a new integral policies of controlling CO_2 emission and find alternative energy source, such as solar energy. This may reduce environmental degradation, reduce air pollution, and protect individuals' health with no damage to the Algerian economy. Of late, Algeria government has commenced initiatives meant to make full usage of solar energy through Desertec project. This project with total plant output of 150 MW may cause reduction in non-renewable resources such as oil and gas, and hence, mitigate CO_2 emission. The implementation of solar energy will permit Algeria to reduce one-third of its CO_2 emissions (Sahnoune et al., 2013). Thus, It is recommended to invest in clean energies include wind and solar energy to reduce CO_2 emission from solid fuel consumption, electricity and heat production, this may also save the quantity of oil and gas available for export purpose. At the same time, an energy efficiency usage would be implemented to reduce CO_2 emission. For instance, industries are encouraged to minimize their air pollution through adopting green technologies.

6. CONCLUSION

This paper examines whether the EKC hypothesis holds in the case of Algeria or not. The CO_2 emission from different sources, such as solid fuel consumption, liquid fuel consumption, and from electricity and heat production, is separately used to have evidence that is more robust. The study adopts time series analysis for the period from 1971 to 2009. The ARDL bound test approach is employed since it is more appropriate for small sample size and applicable if there are some variables I(0) and other are I(1). The results reveal that CO_2 emission from solid fuel consumption, liquid fuel consumption, and electricity and heat production fail to show any evidence of EKC hypothesis. These findings indicate that the hypothesis of EKC does not exist in the case of Algeria. However, the long-run models show that income and population appear to have significant impact on CO_2 emission especially from solid fuel consumption and electricity and heat production. However, only population is revealed to promote CO_2 from liquid fuel consumption.

The findings draw some serious policy implications, especially energy consumption, need to be addressed by the government of the country. Applicable policies that aim to efficient energy consumption, control CO_2 emission and reduce environmental degradation must immediately implemented. In addition, clean energies include wind and solar energy to reduce CO_2 emission from solid fuel consumption, electricity and heat production can be alternative sources of energy that the country can consider.

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