# Is There An Environmental Kuznets Curve in MENAP Countries? Quadratic and Cubic Polynomial Random Coefficient Panel Regression Model

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***Abstract*—The paper aims to study the relationship between economic growth and $CO_2$ emissions in MENAP countries over the period 1994 to 2011. Breusch-Pagan LM cross-sectional dependency test, CADF panel unit-root test and Westerlund panel cointegration test have been used for the estimation. Quadratic and cubic polynomial random coefficient panel regression models (RCM) were estimated using carbon emission, economic growth and energy consumption variables. Quadratic and cubic RCM models were estimated for two sub-sample individual countries, oil-exported MENAP countries and others MENAP countries. As a result of panel unit-root test, all variables are stationary in first difference. Panel cointegration test represented that there is a long term relation among carbon emission, economic growth and energy consumption variables. In oil-exported MENAP countries, quadratic random coefficient panel regression model results proved that there is U-shaped and monotonically increasing shape, cubic random coefficient panel regression model showed that there is monotonically decreasing and N-shaped. In others MENAP countries, quadratic random coefficient panel regression model results proved that there is an inverted U-shaped, cubic random coefficient panel regression model showed that there is N-shaped. Consequently, Environmental Kuznets Curve (EKC), inverted U-shape, is valid only other MENAP countries, excluding Morocco, at the quadratic model. And, EKC reformed N-shaped in cubic model in the same sub-sample.**

***Index Terms*—Economic growth, carbon emissions, panel regression model, MENAP countries.**

## I. Introduction

Accelerated industrialization process has been increased demand for fossil fuel as petroleum and natural gas and then carbon dioxide emission since 1950. Carbon dioxide emissions was 5 Gt in 1950, reached 32 Gt by 5.5% in 2013. Increasing carbon dioxide emission caused global warming, flooding, drought and melting of glaciers. The negative effect of economic growth on environment shifted the attention to sustainable growth. In 8 MENAP countries, OPEC members, share of the total carbon dioxide emission to total world carbon dioxide emission was 4.7% in 1994 and 6% in 2011. In the literature, there exist opposing views between environmental protection and economic growth. Grossman and Krueger (1994) proved that the relationship between economic growth and environmental degradation have been presented inverted-U shaped curve, Environmental Kuznets Curve (EKC) [1]. The EKC hypothesis postulate that environmental pressure rises at the first stage of economic growth and it decreases at the last stage after reaching high level of income (EKC threshold). EKC hypothesis shows that the relationship between carbon dioxide emission and economic growth is positive before the EKC threshold and negative after the threshold level. EKC is shown in Fig. 1.

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Aim of the study is to examine the relationship between economic growth and $CO_2$ emissions in MENAP countries over the period 1994 to 2011. The study investigates whether EKC hypothesis is valid in those countries. We used cross-sectional dependency, panel unit-root and panel cointegration test in the quadratic and cubic polynomial random coefficient panel regression model (RCM) frame. The model includes carbon emission, economic growth and energy consumption variables. Quadratic and cubic models were estimated for two sub-sample, oil-exported MENAP countries and others MENAP countries.

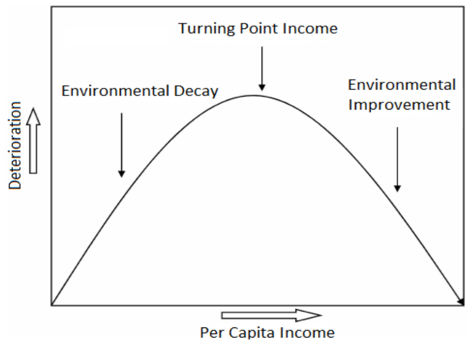


Fig. 1. Environmental Kuznets Curve (EKC).

## II. Literature Review

EKC hypothesis has been tested in both time series and panel data approach. In environmental degeneration-growth nexus literature has no any consensus. These studies showed different results, which nonlinear inverted U-shaped curve in long and short term or only long term, not supported inverted U-shaped curve, U-shaped curve, linear form or N-shaped curve.

One group of studies (Saboori *et al.* (2012), Nasir and Rehman (2011), Hassan *et al.* (2015)) found that inverted U-shaped curve relation between carbon dioxide emission and economic growth for single country. These results supported EKC hypothesis. [2]-[4] Saboori *et al.* (2012) have examined the causal relationship between economic growth and carbon dioxide emissions over the period 1980-2009 in Malaysia. EKC hypothesis was tested using ARDL methodology. The results indicate that there is an inverted-U shaped (EKC hypothesis) relationship between $CO_2$ emissions and GDP in short and long-term [2]. Nasir and

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Rehman (2011) searched the link between carbon emission, energy consumption, and foreign trade in Pakistan for the period 1972-2008 by applying Johansen co-integration method. They observed EKC hypothesis is valid for Pakistan [3]. Hassan *et al*. (2015) investigated the main factors impacting carbon dioxide emissions pattern from economic growth, inequality and poverty in Pakistan for the period 1980-2011 by using panel error correction model. Findings showed that EKC hypothesis (inverted-U shaped) is supported in Pakistan [4].

In studies proved by Narayan and Narayan (2010), Taguchi (2012), Al-Rawasdeh *et al*. (2014), Mamun (2014), Pao and Tsai (2010), Alam *et al*. (2016), Mazur *et al.* (2015) was found that there is an inverted U-shaped curve relation between carbon dioxide emission and economic growth for panel group [5-11]. Narayan and Narayan (2010) investigated that whether the EKC hypothesis is valid in 43 developing countries. They found that EKC is supported in these countries [5]. Taguchi (2012) examined that EKC hypothesis for 19 Asian countries over the period 1950-2009. Sulphur and carbon dioxide emissions per capita, GDP per capita, later degree of development variables have been used in quadratic dynamic panel regression model. They found while sulphur emissions follow inverted U-shape curve, carbon emissions is monotonically increasing [6]. Al-Rawasdeh *et al*. (2014) analyzed the relationship between economic growth and environmental quality (sulphur dioxide and carbon dioxide) in 22 Middle East and North Africa (MENA) countries. EKC hypothesis has been tested by time series for each country level. They showed that EKC hypothesis is valid for Tunusia, Morocco, Turkey and Jordan for sulphur dioxide emissions, is not valid for MENA region for sulphur dioxide emissions and carbon dioxide emissions [7]. Mamun (2014) argued that EKC hypothesis for 136 countries including five income level groups for the period 1980-2009. They studied with carbon dioxide emission per capita, GDP per capita, trade openness, agriculture value added, industry value added and service value added. The findings showed that EKC hypothesis is valid across region except for high-income OECD countries [8]. Pao and Tsai (2010) examined that causal relationship between pollutant emission, Energy consumption and output for BRIC countries (except Russia) for the period 1971-2005. They used quadratic panel vector error correction model. Findings were supported by the EKC hypothesis in these countries [9]. Alam *et al.* (2016) examined the nexus among carbon dioxide emission, economic growth, Energy consumption and population growth in Brasil, China, India and Indonesia using linear and quadratic ARDL error correction model. They found evidence supporting the EKC hypothesis for Brasil, China and Indonesia [10]. Mazur *et al*. (2015) explored that the link between economic growth and carbon emissions for the period 1992-2010 using quadratic random and fixed effect panel regression model in EU countries. They proved that EKC hypothesis was not supported for all 28 EU countries. But, EKC hypothesis is valid for older 16 EU countries, which are high income economies [11].

Lacheheb (2015) and Omay (2013) studies did not supported inverted-U shaped (EKC hypothesis) for single countries [12], [13]. Lacheheb (2015) probed that the relation between carbon dioxide emissions and economic growth in Algeria over the period 1971-2009 using ARDL bound testing approach. They used three carbon emissions type (solid fuel consumption, liquid fuel consumption and electricity and heat production), GDP per capita, gross fixed capital formation, imports and exports variables. Findings proved that EKC hypothesis does not exist in Algeria [12]. Omay (2013) examined the relation between economic growth and carbon dioxide emissions in Turkey over the period 1980 and 2009. The results of regression spline model did not support EKC hypothesis in Turkey [13].

Huang *et al.* (2008), Jaunky (2010), Apergis and Ozturk (2015) and Sari and Soytas (2009) found that inverted-U shaped (EKC hypothesis) is not valid in some panels [14]-[17]. Huang *et al*. (2008) investigated the relation between economic development and greenhouse gas (GHG) emissions; they found that the EKC hypothesis is not valid in most of the Annex II countries [14]. Jaunky (2010) investigated if EKC hypothesis is valid for 36 high-income countries over the period 1980-2005. They found that there is unidirectional causality from GDP to $CO_2$. The results showed that EKC hypothesis is not valid in these countries [15]. Apergis and Ozturk (2015) tested EKC hypothesis for 14 Asian countries and they found that the support of the EKC hypothesis [16]. Sari and Soytas (2009) investigate the relationship between carbon emissions, income, energy consumption and employment in five OPEC countries for the period 1971-2002. They used autoregressive distributed lag (ARDL) approach. They found that emission level and economic growth is not related [17].

Friedl and Getzner (2003), Akbostanci *et al*. (2009), Mert and Bozdağ (2013)) supported N-shaped curve for single country [18]-[20]. Friedl and Getzner (2003) showed that cubic model more suitable than both linear and quadratic models for Austria. The relationship between carbon dioxide emission and economic growth has an N-shaped curve for the period 1960-1999 [18]. Akbostanci *et al.* (2009) searched the relationship between $CO_2$, $SO_2$, PM10 emissions, energy consumption and economic growth in Turkey. They found a monotonic and increasing relationship in national level and an N-shaped curve in provinces level. The findings represented that EKC is not valid in Turkey [19]. Mert and Bozdağ (2013) investigated that the relation between environmental quality and economic growth in Bosnia & Herzegovina for the period 1992-2009. They concluded that EKC hypothesis not valid in Bosnia & Herzegovina. Inverted-N shaped relationship was found [20].

There are a few sample N-shaped supported studies for panel groups (Muftau *et al*. (2014) and Balın and Akan (2015)) [21], [22]. Muftau *et al*. (2014) examined that the link between carbon dioxide emissions and economic growth for West African countries for the period from 1970 to 2011. They used fixed effect panel regression model arranged by vector error correction model. The results indicated that there is a N-shaped relationship, EKC hypothesis is not supported for West African countries [21]. Balın and Akan (2015) tested EKC hypothesis for 27 developed countries over the period 1997 and 2009. Patent, research and development expenditure and value added industrial production to GDP was used as exogenous variables. They found N-shaped relationship between carbon dioxide emission per capita and GDP per capita [22].

Mir and Storm (2016) and Holtz-Eakin and Selden (1992) found monotonically increasing (linear) relationship between growth and carbon dioxide emission for panel groups [23], [24]. Mir and Storm (2016) assess EKC hypothesis using production and consumption based carbon dioxide emissions per capita and GDP per capita in forty-countries over the period 1995 and 2007. As a result of linear, quadratic and cubic fixed effect panel regression model, they found that monotonically increasing (linear) relationship between per capita GDP and production and consumption based carbon dioxide emissions [23]. Holtz-Eakin and Selden (1992) investigated the link between national carbon emissions per capita and real GDP per capita for 130 countries for the period of 1951-1986. They used a quadratic polynomial model. They found that carbon dioxide emissions did not follow EKC pattern, monotonically increasing instead [24].

Halkos (2011) tested EKC hypothesis for 32 countries for the period 1971-2006. They used panel data model and individual time series analysis. They reached a mixture of monotonic, inverted U-shaped and N-shaped relationship for countries [25]. Yang *et al.* (2015) modeled the carbon emissions-economic growth nexus for 67 countries for the period of 1971-2010. They used a novel symbolic regression method and estimate for a specific country or region. They found the relationship carbon emission-economic growth follows N-shaped and M-shaped curve in developed countries, inverted-U shaped and monotonically increasing model [26]. Ozcan (2013) tested the EKC hypothesis for 12 Middle East countries over the period from 1990 to 2008 using panel causality and error correction model. They found evidence to U-shaped curve for 5 Middle East countries, inverted U-shaped for 3 Middle East countries, no relation for others 4 countries [27].

## III. Data and Methodology

This study covers 14 MENAP countries over the period 1994-2013. MENAP countries contain Bahrain, Kuwait, Iraq, Tunusia, Sudan, Saudi Arabia, Pakistan, Oman, Morocco, Lebanon, Jordan, Iran, Egypt and Algeria. Investigated variables are Gross Domestic Product Per Capita, proxy by economic growth, Carbon Dioxide Emissions (mt) and Energy use (kg of oil equivalent per capita). Data collected from World Bank Databases.

Cross-sectional dependency is researched using Breusch and Pagan (1980) LM test. If there is cross-sectional dependence, it will be used second generation CADF panel unit-root test and Westerlund (2007) cointegration test allowed cross-sectional dependence. This study employs quadratic and cubic random coefficient model (RCM) to investigate relation between carbon dioxide emissions and GDP per capita, and energy consumption per capita, exogenous variable.

Quadratic and cubic models as below:

$$CO_{2\,it} = \beta_0 + \beta_1 GDPPC_{it} + \beta_2 GDPPC_{it}^2 + \beta_3 ECPC_{it} + \varepsilon_{it} \quad (1)$$

$$CO_{2\,it} = \beta_0 + \beta_1 GDPPC_{it} + \beta_2 GDPPC_{it}^2 + \beta_3 GDPPC_{it}^3 + \beta_4 ECPC_{it} + \varepsilon_{it} \quad (2)$$

where $CO_2$= carbon dioxide emission (*mt*); GDPPC= GDP per capita; ECPC= energy consumption per capita; $\varepsilon_{it}$ = error term. Possible relationship between GDP per capita and GHG emissions is shown in Table I. The EKC hypothesis is valid in case of $\beta_1$ to be positive and $\beta_2$ to be negative and significant.

TABLE I: Possible Relationships between GDP per Capita and GHG Emissions

| Values of coefficients βi | Relationship between income per capita (χ) and GHG emissions per capita (y) |
|---|---|
| $\beta 1 = \beta 2 = \beta 3 = 0$ | No relationship |
| $\beta 1 > 0$ and $\beta 2 = \beta 3 = 0$ | A monotonically increasing or linear relationship |
| $\beta 1 < 0$ and $\beta 2 = \beta 3 = 0$ | A monotonically decreasing relationship |
| $\beta 1 > 0$ , $\beta 2 < 0$ and $\beta 3 = 0$ | A inverted-U shaped relationship (CKC) |
| $\beta 1 < 0$ , $\beta 2 > 0$ and $\beta 3 = 0$ | A U shaped relationship |
| $\beta 1 > 0$ , $\beta 2 < 0$ and $\beta 3 > 0$ | An N-shaped relationship |
| $\beta 1 < 0$ , $\beta 2 > 0$ and $\beta 3 < 0$ | An inverted-N-shaped relationship |

Source: Mir and Storm (2016), p.5.

## IV. Results

Cross-sectional dependency (CSD) is the main problem for panel data. In CSD case, it has been used unit-root and cointegration test allowed cross-sectional dependence. For the purpose, it will be investigate whether there is cross-sectional dependency among countries. We used Breusch and Pagan (1980) *LM* test developed for *T*>*N*. Null hypothesis of Breusch-Pagan *LM* test is "No cross-section dependency" Breusch and Pagan (1980) proves *LM* statistic, as below:

$$LM = T \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{\rho}_{ij}^2$$

The results of cross-sectional dependency test have been showed in Table II. The results present that null hypothesis of "no cross-sectional dependency" can be rejected. It represent that there is cross-sectional dependency in 14 MENAP countries. This finding necessitates paying attention cross-sectional dependency for panel unit-root and cointegration test [28].

TABLE II: Breusch and Pagan (1980) LM Test

| | Chi2(91) |
|---|---|
| Fixed Effect Model | 796.829* (0.000) |

Note: (), represent probability value, *, represent 1% significance level.

It has been used Pesaran (2003, 2007) CADF, second generation panel unit-root test, allowed cross-sectional dependency [29] [30]. Table III includes the results of CADF test. Findings show that null hypothesis of "There is unit-root" is rejected[1]. This results represent all variables are integrated of order one. As a result of panel unit-root test, all variables are stationary in first difference.

In this study, it has been used Westerlund (2007) panel cointegration test allowed cross-sectional dependency. The null hypothesis of test is "There is no cointegration" [31]. Table IV represents that the results of Westerlund (2007) cointegration test. As a result of test, null hypothesis of "There is no cointegration" is rejected. Panel cointegration test represented that there is a long term relation among carbon emission, economic growth and energy consumption

[1] Critical value present in Pesaran (2007).

variables.

TABLE III: PESARAN CADF PANEL UNIT-ROOT TEST

| Variables | t-bar | p-value |
|---|---|---|
| Level | | |
| $CO_2$ | -1.999 | 0.181 |
| GDPPC | -2.215*** | 0.044 |
| ECPC | -2.346** | 0.014 |
| First Difference | | |
| $\Delta CO_2$ | -2.892* | 0.011 |
| ΔGDPPC | -2.592* | 0.001 |
| ΔECPC | -3.108* | 0.000 |

Note: *, represents critical value, -2.470, -2.260 and -2.140 for %1,** %5 and *** %10 significance level respectively.

TABLE IV: WESTERLUND (2007) PANEL COINTEGRATION TEST

| Statistics | Value | Z-value/p value |
|---|---|---|
| $G_\tau$ | -4.027* | -6.670 (0.000) |
| $G_\alpha$ | -0.677 | 6.612 (1.000) |
| $P_\tau$ | -12.371* | -4.225 (0.000) |
| $P_\alpha$ | -1.041 | 5.229 (1.000) |

Note: $G_\tau$ and $G_\alpha$ represent group mean tests, $P_\tau$ and $P_\alpha$ represent panel tests. $P_\tau$ statistics can be insignificant due to small panel data. (Westerlund, 2007).

This study followed quadratic and cubic polynomial random coefficient panel regression model (RCM) includes carbon emission, GDP per capita and energy consumption per capita variables. Quadratic and cubic RCM model was estimated for two sub-sample individual countries, oil-exported MENAP countries and other MENAP countries. Results were represented in Table V and Table VI.

In oil-exported MENAP countries, quadratic random coefficient panel regression model proved that there is U-shaped and monotonically increasing shape between carbon dioxide emission and GDP per capita. Estimated cubic random coefficient panel regression model showed that there is monotonically decreasing and N-shaped relationship between carbon dioxide emission and GDP per capita. Other MENAP countries, quadratic random coefficient panel regression model proved that there is inverted U-shaped between carbon dioxide emission and GDP per capita. The results of cubic random coefficient panel regression model showed that N-shaped relation is valid. Consequently, Environmental Kuznets Curve (EKC), inverted U-shape, is valid only other MENAP countries, excluding Morocco, at the quadratic model. And, EKC reformed N-shaped in cubic model in the same sub-sample. Energy consumption per capita has a positive and significantly effect on carbon dioxide emission for all 14 MENAP countries. These findings consistence with related literature, especially, Halkos (2011), Al-Rawasdeh *et al*. (2014) and Muftau *et al*. (2014) studies.

TABLE V: QUADRATIC AND CUBIC RANDOM COEFFICIENT MODEL ESTIMATION FOR OIL EXPORTED MENAP COUNTRIES

| | GDPPC | $GDPPC^2$ | $GDPPC^3$ | ECPC | C | Form |
|---|---|---|---|---|---|---|
| Model 1 | | | | | | |
| Algeria | -12.459 (0.241) | 0.002* (0.144) | - | 59.073 (0.224) | 56736.38 (0.057) | No Relationship |
| Iran | -50.514* (0.000) | 0.004* (0.000) | - | 303.310* (0.000) | -144437.6* (0.000) | U-shaped |
| Oman | -1.349 (0.673) | 0.00003 (0.695) | - | 9.991* (0.013) | -4925.167 (0.639) | No Relationship |
| S. Arabia | 17.517* (0.043) | -0.0003 (0.252) | - | 85.025* (0.000) | -230024.1* (0.000) | Monotonically increasing |
| Sudan | 11.521* (0.000) | -0.002 (0.086) | - | -22.332 (0.155) | 9954.825 (0.086) | Monotonically increasing |
| Iraq | -11.892* (0.040) | 0.002* (0.002) | - | -14.519 (0.295) | 113553* (0.000) | U-shaped |
| Kuwait | 2.829* (0.037) | -0.00002 (0.276) | - | -0.304 (0.924) | 14770.72 (0.513) | Monotonically increasing |
| Bahrain | -1.639* (0.050) | 0.00006* (0.014) | - | -0.499 (0.449) | 32405.48* (0.001) | U-shaped |
| Model 2 | | | | | | |
| Algeria | -61.388* (0.000) | 0.018* (0.000) | -0.000001* (0.012) | 66.178 (0.109) | 95638.06* (0.011) | Inverted U-shaped |
| Iran | -1.090 (0.942) | -0.007 (0.119) | 0.000008* (0.037) | 302.459* (0.000) | -196884.7* (0.000) | - |
| Oman | -3.987* (0.000) | 0.00009* (0.000) | -0.000003* (0.021) | 11.081 (0.157) | -5227.67 (0.874) | Inverted U-shaped |
| S. Arabia | 147.336* (0.000) | -0.009* (0.002) | 0.0000006* (0.004) | 113.358* (0.000) | -916296.4* (0.000) | N-shaped |
| Sudan | 21.043* (0.001) | -0.010* (0.010) | 0.000002* (0.006) | -30.402* (0.002) | 10274.55 (0.121) | N-shaped |
| Iraq | -33.665* (0.005) | 0.006 (0.242) | -0.000005 (0.932) | -17.575 (0.230) | 144686.1* (0.000) | Monotonically decreasing |
| Kuwait | 7.637* (0.003) | -0.00006* (0.451) | 0.000006* (0.027) | -0.418 (0.896) | 27651.17 (0.642) | N-shaped |
| Bahrain | -3.268* (0.000) | 0.0001 (0.572) | -0.000004* (0.703) | -0.683 (0.549) | 51312* (0.000) | Monotonically decreasing |

TABLE VI: QUADRATIC AND CUBIC RANDOM COEFFICIENT MODEL ESTIMATION FOR OTHER MENAP COUNTRIES

| | GDPPC | GDPPC2 | GDPPC3 | ECPC | C | Form |
|---|---|---|---|---|---|---|
| Model 1 | | | | | | |
| Egypt | 35.561* (0.000) | -0.005* (0.000) | - | 238.380* (0.000) | -6507.08* (0.000) | Inverted U-shaped |
| Jordan | 11.636* (0.000) | -0.002* (0.000) | - | 7.175* (0.022) | -7308.30* (0.002) | Inverted U-shaped |
| Lebanon | 1.122 (0.230) | 0.00001 (0.780) | - | 3.653* (0.038) | 3986.785 (0.207) | No relationship |
| Morocco | 9.612* (0.000) | -0.002* (0.001) | - | 118.575* (0.000) | -21146.1* (0.000) | Inverted U shaped |
| Pakistan | 80.640* (0.000) | -0.011* (0.000) | - | 463.942* (0.000) | -14623.8* (0.000) | Inverted U shaped |
| Tunusia | 0.720 (0.688) | 0.0001 (0.971) | - | 28.559* (0.000) | -4057.21 (0.064) | No relationship |
| Model 2 | | | | | | |
| Egypt | 211.457* (0.000) | -0.117* (0.000) | 0.00002* (0.000) | 237.679* (0.000) | -14872.3* (0.000) | N-shaped |
| Jordan | 35.497* (0.000) | -0.011* (0.000) | 0.000001* (0.000) | 10.643* (0.000) | -29662.1* (0.000) | N-shaped |
| Lebanon | 6.830 (0.067) | -0.0009 (0.167) | 0.0000005 (0.197) | 3.425* (0.039) | -6020.581 (0.191) | No relationship |
| Morocco | -30.464 (0.231) | 0.017 (0.149) | -0.000003 (0.115) | 125.821* (0.000) | 2683.471 (0.872) | No relationship |
| Pakistan | 195.159* (0.000) | -0.137* (0.000) | 0.00004* (0.000) | 452.071* (0.000) | -17256.1* (0.000) | N-shaped |
| Tunusia | -2.141 (0.766) | 0.001 (0.652) | -0.000001* (0.644) | 28.127* (0.000) | -1155.530 (0.864) | Inverted N-shaped |

## V. CONCLUSION

This study aims to examine the relationship between economic growth and carbon dioxide emission in 14 MENAP countries over the period 1994 to 2011. The study investigates that whether Environmental Kuznets Curve

(EKC) hypothesis is valid in these countries. We used cross-sectional dependency, panel unit-root and panel cointegration test. This study follows quadratic and cubic polynomial random coefficient panel regression model (RCM). The model includes carbon dioxide emissions, GDP per capita and energy consumption per capita variables. Quadratic and cubic models were estimated for two sub-sample, oil-exported MENAP countries and other MENAP countries.

The result of Breusch-Pagan LM cross-sectional dependency test showed that there is cross-sectional dependence among countries. Second generation CADF panel unit-root test and Westerlund panel cointegration test allowed cross-sectional dependence have been used. All variables are stationary at first difference. There is a long term relationship among variables. Quadratic and cubic RCM model has been estimated for oil-exported MENAP countries and other countries. In oil-exported MENAP countries, U-shaped and linear relation is valid for quadratic model; linear and N-shaped relationship is valid in cubic model. In other MENAP countries, inverted-U shaped relation was supported by the result of quadratic model; N-shaped relation is valid in cubic model. Environmental Kuznets Curve (EKC) is valid only other MENAP countries, excluding Morocco, in quadratic model.

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