The relationship between economic growth and environment in the MENA Region: An environmental Kuznets curve

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Abstract:

This paper studies the relationship between economic growth and environmental performance through the assessment of Kuznets curve which has two shapes. The first takes an inverted U- shape, meaning that pollution increases with GDP growth up to a certain limit after which, it declines. The second takes N-shape, implying that pollution increases with the GDP growth to a maximum point, then it declines, till a minimum beyond which pollution starts to increase again with GDP growth. The relationship between per capita GDP and a set of air pollutants variables are explored. These variables are: per capita CO2 emissions, Nitrous oxide emissions and the other greenhouse gases (HFC, PFC and SF6) emissions. The models used are, for Egypt, ARDL Model during the studied period (1965-2013), and for the MENA region, fixed effects model is tested based on a Hausman test during the covered period (1980-2011). The results support the applicability of the environmental Kuznets curve in its inverted –U shape for Egypt and for MENA region in both forms between the same variables.

Key words:

Environmental Kuznets curve , The MENA Region , ARDL Model, Fixed Effects Model.

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العلاقة بين النمو الاقتصادي و البيئة في منطقة الشرق الأوسط و شمال إفريقيا :منحنى كوزنتس البيئي

الملخص

تبحث هذه الورقة في قياس العلاقة بين النمو الاقتصادي و الأداء البيئي من خلال اختبار مدى إنطباق منحنى كوزنتس البيئي في منطقة الشرق الأوسط و شمال إفريقيا . و يأخذ هذا المنحنى شكلين ، الأول حرف U مقلوبة – و هي تعني أن الناتج المحلي الإجمالي ينمو بزيادة التلوث و يصل إلى أقصى قيمة له عند مستوى معين من التلوث و بعده يأخذ في التناقص- و الشكل الثاني للمنحنى هو حرف N– و هو يعني أن الناتج المحلي الإجمالي ينمو مع زيادة التلوث و يصل إلى أقصى قيمة له عند مستوى معين من التلوث و بعده يأخذ في التناقص ليصل لأدنى قيمة له و بعدها يعاود ارتفاعه مرة أخرى مع زيادة التلوث- و هذه العلاقة بين متوسط نصيب الفرد من الناتج المحلي الإجمالي - كمتغير تابع- و مجموعة من الملوثات – كمتغيرات تفسيرية- وهي :متوسط نصيب الفرد من انبعاثات ثاني أكسيد الكربون ، و ثاني أكسيد النيتروز و غازات أخرى ناتجة عن الصوبات الزجاجية و المسببة لظاهرة الاحتباس الحراري. و تم تطبيق ذلك على مصر وحدها باستخدام نموذج الانحدار الذاتي لفترات الإبطاء الموزعة Autoregressive distributed lag خلال الفترة (1965-2013) ، و استخدام نموذج fixed effects model على منطقة المينا خلال الفترة (1980-2011) باستخدام اختبار هوسمان .
و قد أظهرت النتائج أن العلاقة معنوية بين الإنفاق الحكومي و معدل النمو الاقتصادي و تأخذ شكل حرف U مقلوب على مصر ، بينما تأخذ شكل حرف N على منطقة المينا.

1. Introduction:

Kuznets curve gained a fundamental interest by many studies (Fogel, R.W., 1987). Additionally, since 1991, when Eugene Grossman and Alen Kreuger published their paper "environmental impacts of a North American free trade agreement", and numerous other studies.[1]

The environmental Kuznets curve (EKC) assumes that; the relationship between economic growth and environmental damages takes the shape of an inverted U implying that, environmental degradation and pollution begin to increase in early stages of economic growth. Then they tend to decrease, due to realizing the importance of environmental quality (Kuznets, 1955).

Published studies which dealt with the relationship between economic growth and environmental performance could be divided into three groups. The first group argued that this relationship takes an inverted U-shaped relationship. The second group believed that it takes N-shaped curve. The third group demonstrated the inapplicability of Kuznets curve.

Examples of the first group are: Bimontea, S. and Stabile, A.(2017), Javid, M. and Sharif, F.(2016), Jeblia, M. , Youssef, S. and Ozturkc, I.(2016) , Selden, T. M., and Song D. (1995) ,.Lim, J.(1997) ,Grossman, E. and Krueger, A., (1995) , John , A. et.al. (1995), Wolde, E (2015) and John, A. and Pecchnelno, R.(1994), Ahmad, N. et.al. (2017) and Stern, D.I. (2004). The second group embrace few number of studies including, Özdemir, Ö. and Özokcu, S. (2017), Grossman, E. and Krueger, A.(1991) , Harbaugh et al. (2002) and Akpan , U.F and Chuku , A.(2011).

Examples of the third group are: Romeroa, M. and Jesús, J.(2017) Bölüka, G., Mertb, M. (2014), Grossman, E. and Krueger, A. (1993), Burnett, W.J (2009),

[1] See Yandle, B. et.al., (2004) ((*Environmental Kuznets Curves: A Review of Findings, Methods, and Policy Implication*)) *s*, RS-01-1a, Bozeman, MT: Property and Environmental Research Center. , AND ECONOMIC KINDA,S.(2015)((ESSAYS ON ENVIRONMENTAL DEGRADATION DEVELOPMENT)), Universite d'Auvergne - Clermont-Ferrand I, HAL, archives – overtes and Katircioğlu,S. , Taşpinar,N.(2017)((Testing the moderating role of financial development in an environmental Kuznets curve: Empirical evidence from Turkey)), Renewable and Sustainable Energy Reviews, Vol. 68, Part 1, February 2017, PP. 572–586.

Ozturk, I. et.al. (2017), Shahbaza, M., et.al. (2014), Sulaiman, J. and Saboori, B. (2013) and Ekins, P. (1997).

All previous studies have not studied this relationship in the MENA except the study of(Abdouli,M. , Hammami,S.,2017), , which has tested the causality links between environmental quality, foreign direct investment and economic growth of 17 MENA countries over the period 1990–2012, but it did not test the applicability of the environmental Kuznets curve.
Hence the importance of this paper emerges from investigating the applicability of the environmental Kuznets curve for 21 countries of MENA region over the period 1980–2011 and for Egypt separately during the period (1965-2013). This study did not use co2 emissions only, but also it used a set of air pollutants variables .These variables are: per capita CO2 emissions, Nitrous oxide emissions and the other greenhouse gases (HFC, PFC and SF6) emissions.

This study aims mainly at examining the validity of environmental Kuznets curve for Egypt by using the co-integration method, autoregressive distributed lags (ARDL) model, and for the MENA region by applying fixed effects model.

The rest of the paper is structured as follows, the second section includes the model specification and data. The third section presents the econometric analysis and the estimation results. The fourth concludes.

2. Model specification and data description:

This paper focuses on two cases, firstly, Egypt and secondly, the MENA region.

2.1. The case of Egypt [2] :

To test the applicability of the environmental Kuznets curve to Egypt during the period 1965-2013, the following equation is used:

$$(E/P)it = \alpha 1 + \beta 1(GDP/p) + \beta 2(GDP/p)^2 + \varepsilon it \ ,$$

where E is emissions, P is population, (E/P) is CO2 emissions (metric ton per capita), (GDP/p) is (Gross domestic product in $ per capita), α1 is the intercept parameter. β1, β2 denotes parameters of the equation , εit is the random error term.

All used data are obtained from the World Bank Indicators (WDI) and the International Financial Statistics (IFS), during the period 1965-2013, Table 1 displays the descriptive statistics of the variables.[3]

Table 1: Descriptive statistics of the variables.

Obs.	Mean	St. Dev.	Max.	Min.
E/P	1.465769	0.624932	2.591831	0.578629
GDP/p	0.957	0.796	3.264	0.165
(GDP/p)2	1537.419	2541.382	10656.634	27.413

Table 1 shows that the mean of CO2 emissions is 1.5 metric ton per capita , with a maximum value of about 2.6 and a minimum around 0.6. The mean of per capita GDP is about thousand $0.975, with a maximum of about thousand $3.264, and a minimum of thousand $ 0.165

[2] The applicability of the environmental Kuznets curve in its N-shape between CO_2emissions and per capita GDP was tested, but the results didn't support Kuznets claim of (N-Shape) to Egypt during the period (1965-2013). This is because Egypt has not yet reached the advanced stages of economic growth enough to make it go through the final stage of the curve.

[3] WDI, World Bank, www.worldbank.org , and IFS, the International Monetary Fund /www.IMF.org

2.2. The case of MENA region:

The study sample of MENA region includes 21 countries, namely: Algeria, Bahrain, Djibouti, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Sudan, Syria, The United Arab Emirates, Yemen, Mauritania and Tunisia.

The model used to test the EKC for MENA region during the period (1980-2011) takes the following equation form:

$$(E/P)it=\alpha i+\beta 1(GDP/p)+\beta 2(GDP/p)^2+ \beta 2(GDP/p)^3+ \varepsilon it \ ,$$

where E is emissions, P is population, (E/P) is rotated between carbon dioxide and nitrous oxide, and other greenhouse gases measured per capita, (GDP/p) is (Gross domestic product $ per capita), αi is the intercept parameter which vary across countries i and years t. β1, β2 , β3 are the equation parameters.

All utilized data are obtained from WDI and IFS, during the period 1980-2011. Table 3 and 4 show the descriptive statistics of the variables and their correlation.

Table 2: Descriptive statistics of the variables.

Obs.	Mean	St. Dev.	Max.	Min.
E/P	9.79	12.79	68.6	0.103
N/P	160.5	17.6	186	123
G/P	19.31	18.6	92.11	2.4
GDP/p	8463.518	11571.91	99431.50	94.93000
$(GDP/p)^2$	2.05E+08	6.65E+08	9.89E+09	9011.705
$(GDP/P)^3$	8.44E+12	5.14E+13	9.83E+14	855481.1

Table 2 shows that the mean of CO2 emissions is 9.79 metric ton per capita , with a maximum value of about 68.6 metric ton. and a minimum value of

about 0.1 metric ton. The mean of Nitrous oxide emissions is 160.5 thousand metric tons of CO2 equivalent, with a maximum value of about 186 thousand metric tons of CO2 equivalent. and a minimum value of about 123 thousand metric tons of CO2 equivalent. The mean of Other greenhouse gas emissions, HFC, PFC and SF6 is 19.31 thousand metric tons of CO2 equivalent, with a maximum value of about 92.11thousand metric tons of CO2 equivalent. and a minimum value of about 2.4 thousand metric tons of CO2 equivalent .The mean of per capita GDP is about $8463.5 , a maximum about $99431.5 , and a minimum of $94.93.

3. Econometric analysis and the estimation of results:

3.1.The case of Egypt[4]:

In order to estimate the coefficients of the Egyptian model, Unit root stationarity test is applied to determine the order of integration, a Phillips – Perron test is performed. Table 5 displays the results.

Table 3: Unit root test (Phillips – Perron) results

Variable	Level		First difference	
	Intercept	Intercept and trend	Intercept	Intercept and trend
E/P		-3.76 ** (0.027)		
GDP/P				-3.57** (0.0102)
$(GDP/P)^2$			-3.3428** (0.018)	

Note: - *, **, * indicate significance at 1%, 5% and 10%, respectively.**

[4] The results show that the applicability of the kuznets curve to the Egyptian economy in its (inverted -U shape) (between Nitrous oxide emissions (thousand metric tons of CO2 equivalent),Other greenhouse gas emissions, HFC, PFC and SF6 (thousand metric tons of CO2 equivalent) per capita and per capita GDP during the same period.

The results shown in Table 3, indicate that the dependent variable (E/P) is stationary at the Level; i.e., the variable is integrated of degree zero I(0) at 5% significance level. The independent variables (GDP/P and (GDP/P)2) are stationary at the first difference I(1), they are integrated of degree one , at 5% significance level. These results make it possible to apply the bounds testing approach, using the ARDL test.

The next step is to perform the co-integration test between the model variables. Results are shown in table 4.

Table 4: Bounds testing results

Regressors: (K = 2)		**F-statistic**
E/P = *f*(GDP/P,. (GDP/P)2), ARDL (4, 0, 1)		**4.9188****
Significant level	**Critical values bounds**	
Lower Critical Bounds (LCB)		**Upper Critical Bounds (UCB)**
10%	**3.17**	**4.14**
5%	**3.79**	**4.85**
2.5%	**4.41**	**5.52**
1%	**5.15**	**6.36**

Note: *, #, **, * indicate significance at 1%, 2.5%, 5% and 10%, respectively.**

From the previous table, F-statistic value is greater than the upper critical bounds (UCB), This means that a long – run relationship exists between CO2 emissions per capita , GDP per capita and its squared value. Therefore, the analysis is completed as follows:

As for the estimation of long and short-run coefficients of the variables and the error correction coefficient an ARDL model is applied. The results of the estimated model are shown in Table 5.

Table 5: ARDL regression estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long-run coefficients				
GDP/P	**1.816*** **	**0.184**	**9.887**	**0.0000**
(GDP/P)2	**-0.299 *** **	**0.07**	**-4.27**	**0.0001**
Constant	**0.339*** **	**0.094**	**3.9344**	**0.0003**
Error correction coefficient φ_i	**-0.36638*** **	**0.124700**	**-2.938**	**0.0056**
Short-run coefficients				
D(E/P(-1))	**-0.3581** **	**0.13085**	**-2.736**	**0.0094**
D(GDP /P) (1))	**0.00066*** **	**0.00019**	**3.375**	**0.0017**
D(GDP /p)2(2))	**0.0000*** **	**0.0000**	**0.62655**	**0.5347**
D(GDP /p)2(-1))	**0.00000** **	**0.0000**	**2.889**	**0.0063**
D(GDP /p)2(-2))	**-0.0000*** **	**0.0000**	**-3.685**	**0.0007**
F.stat.:				
Prob(F-statistic).:	**378.6**			
	0.0000			
Durbin-Watson stat	**1.913157**			
R-squared	**0.985864**			
Adjusted R-squared	**0.983260**			

Note: - *, **, * indicate significance at 1%, 5% and 10% respectively.**

It can be seen from table 5 that both per capita GDP and(GDP/P)2 have a significant effect on per capita carbon dioxide emissions at the significance level of 1% in the long run. However it is positive for (GDP/P) and negative for (GDP/P)2 .This means that at lower levels of GDP per capita environmental degradation and pollution were increasing. Upon reaching a certain level it starts to fall due to realizing the importance of environmental improvements for better quality of life . This result supports Kuznets claim of the inverted U-Shape in Egypt during the period 1965-2013 .

Table 5 indicates that R-squared is 98.33% which explains that percentage of changes in the dependent variable.

The estimated regression equation is:

$(E/P)it=0.339+1.816\ (GDP/p)\ -0.299\ (GDP/p)^2$

Differentiating this equation with respect to per capita GDP, it is found that the maximum level of pollution is reached at a level of per capita GDP of about thousand $3.033 after which the rate of pollution declines. This happened between 2010-2011, with a per capita CO2 emissions of 3.1 metric ton see Figure (1). It is interesting to note that this coincides with the time when Egyptian environmental regulation and policies became strict in enforcing the law5.

In general ,the reasons for the low level of pollution can be explained as follows:

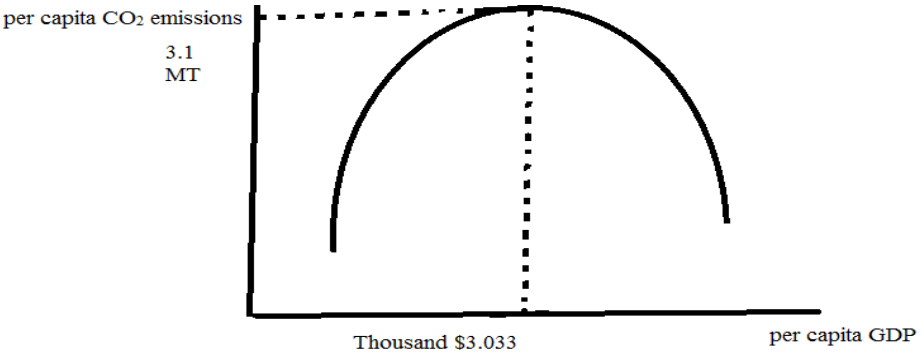
In general ,the reasons for the low level of pollution can be explained as follows:

In the early stage of development, the economy depends on agriculture and has limited industrial activities. Thereafter the economy moves towards industrialization , which causes pollution, due to greater emissions. Hence the income and pollution are increasing together. At a certain level of income the state begins to pay attention to the general welfare of the people, and enforces

[5] Law number 4 of 1994, promulgating, the environmental law, amended by law no. 9 for 2009. (The Ministry of Environment / Environmental Affairs Agency/ http://www.eeaa.gov.eg/ar-.aspx).

the reduction of pollution (Everett, T. et.al. 2010) and (Chakravarty, D. Mandal , S. 2016).

Figure (1) The relationship between CO2emissions per capita and per capita GDP in Egypt (1965-2013)



This pollution reduction can be explained in Egypt by:

1- Law number 4 of 1994, promulgating, the environmental law amended by law no. 9 for 2009.

2- To test the role of government efforts in reducing pollution since the establishment of the Ministry of Environment in 1997, this paper adds a dummy variable for this(zero from 1965 to 1996 and one from 1997 to 2013).However, the results showed that there is no significant effect of this variable , However, the results showed that this variable has no significant effect. Therefore, the efforts of the Ministry of environment have no significant effect on pollution reduction.

The estimated regression equation is:

(E/P)it =0.378+1.7(GDP/p) -0.299 (GDP/p)2+0.1Gov.
t-statistics: (3.4) (7.5) (-4) (0.6)
prob. (0.0015) (0.000) (0.003) (0.4909)

Where:Gov. is the government efforts towards the reduction of pollution.

On the other hand, an estimation of the N-shape curve is attempted. However, it was found that the Egyptian data do not give a good fit .This means that the estimation of the N-Shape curve is not applicable for Egypt6.

3.2. The case of MENA region:

In order to estimate the coefficients of the MENA region model, Hadri Unit root test is performed to determine the order of integration of the variables. Table 9 displays the results.

Table 6: Unit root test (Hadri) results:

Variable	Level
	Intercept
E/P	6.59344*** 0.0000
GDP/P	11.1*** 0.0000
(GDP/P)2	10.96*** 0.0000
(GDP/P)3	10.55*** 0.0000

Note: *, **, * indicate significance at 1%, 5% and 10%, respectively.**

[6] When the model was estimated as a cubic function the results were as follows:
(E/P)it=0.36+0.0012 (GDP/p) +0.000001 (GDP/p)2 -0.0000(GDP/P)3
Prob. (0.0006) (0.002) (0.27) (0.04)
These results indicate the lack of applicability of the EKC in its advanced form (N- Shape) as a cubic function for Egypt during the same period.

From Table 6, the results indicate that the model variables (E/P, GDP/P, (GDP/P)2, (GDP/P)3) are stationary at the Level; i.e., they are integrated of degree zero I(0) , at 1% significance level. These results makes it possible to apply pooled OLS, fixed effects model or random effects model to estimate parameters.

Using the fixed effects model and the random effects model, taking carbon dioxide emissions per capita as the independent variable. The results are shown in Table 7.

Table 7:MENA region estimation of results

Variable	Coefficient	St.dev.	T.statistic	Prop.	
	Fixed	Fixed	Fixed	Fixed	
GDP/P	0.494358***	0.09726	8.28	0.0000	
(GDP/P)2	-7.2E-06***	2.7E-06	16.5	0.0000	
(GDP/P)3	2.95E-11***	2.1E-11	-6.36	0.0000	
Constant	6844.326***	482.508	14.18	0.0001	
LSDV R-squared	0.9311			Within R-squared	0.9287
F-statistics	349.95			Durbin-Watson	0.4446
Prob. (F-statistic)	0.0000				
Hausman test: Chi-Sq. Statistic	115.5968	Hausman test: Prop.		0.0000	

Note: - *, **, * indicate significance at 1%, 5% and 10%, respectively.**

From the previous table, when the dependent variable is the carbon dioxide emissions per capita, R-squared indicates that the independent variables explained about 93% of changes in dependent variable. From the above showed results, it could be conclude that there are two turning points on the curve. Table 10 illustrates that the per capita GDP has a significant positive effect on the carbon dioxide emissions per capita at the significance level of 1%., while the per capita GDP squared has a significant negative effect at the same significance level, and the per capita GDP cubed has a significant positive effect at the same significance level. These results support Kuznets claim of N- shape in MENA Region during the period 1980-2011as shown in Figure (2). The estimated regression equation is:

$(E/P)it=6844.3+0.494\ (GDP/p)\ -7.22E-06(GDP/p)^2+2.95E-11(GDP/p)^3$

Differentiating it with respect to per capita GDP, it is found that there are two turning points, the minimum is (17202, 48322), and the maximum is (13076.2, 94841.8) for income and pollution, respectively. [7]

The results indicate that, at low level of per capita GDP, pollution abatement is not a priority. Once a certain level of income is reached, the country and individuals begin considering the trade-off between environmental quality and better consumption. Therefore, environmental quality begins to improve alongside economic growth. At a later stage economic growth leads to increasing the level of environmental pollution (Özdemir, Ö.and Özokcu ,S.

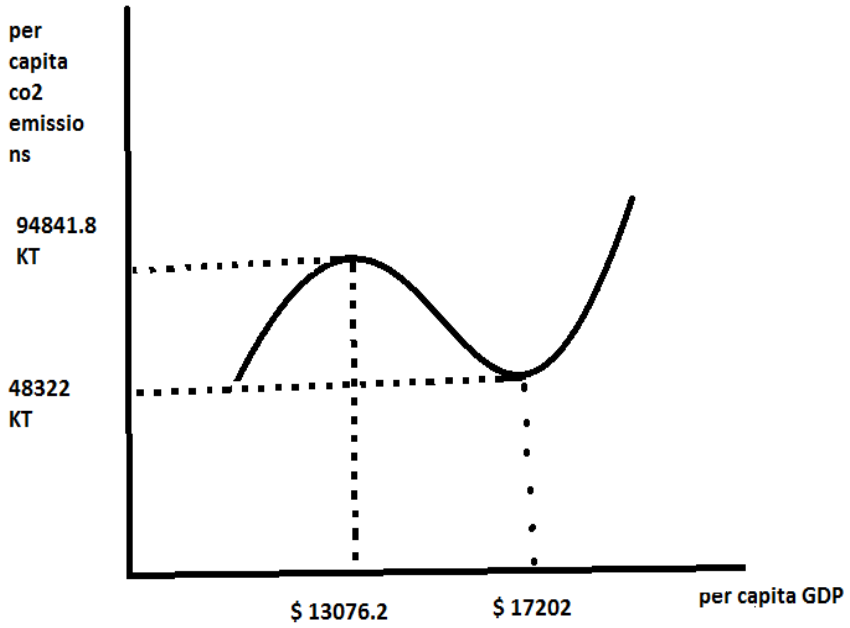
[7] 1-The paper also tested The same for the greenhouse gasses (thousand metric tons of CO2 equivalent) as independent variable and the results support Kuznts claim of N- shape inMENA Region during the period 1980-2011,The estimated regression equation is: $(E/P)_{it}=1416.829+0.156222\ (GDP/p)\ -3.30E-06\ (GDP/p)^2\ +1.96E-11\ (GDP/p)^3$, ,we find that there are two turning points , the minimum is(3687.4,34338.35), and the maximum is (2946,76214.4).

2- The paper also tested The same for the Nitrous oxide emissions (thousand metric tons of CO2 equivalent) as independent variable and the results support Kuznts claim of N- shape inMENA Region during the period 1980-2011,The estimated regression equation is: $(E/P)_{it}=4444.7+0.031\ (GDP/p)\ -1.79E-06\ (GDP/p)^2+1.26\ E-11(GDP/p)^3$

Differentiating it with respect to per capita GDP, we find that there are two turning points , the minimum is (3849,35406), and the maximum is (2602.76,59302.9).

2017). Subsequently, giving rise to a positive relationship between the rate of economic growth and pollution[8].

Figure (2): The relationship between CO2 emissions per capita and per capita GDP in MENA region during (1980-2011)



It is worth mentioning that the Middle East and North Africa was divided into two groups: the first group includes low-income countries namely: Algeria, Djibouti, Egypt, Iran, Iraq, Jordan, Lebanon, Libya, Morocco, Sudan, Syria, Yemen, Mauritania and Tunisia. The second group includes high-income countries namely: Bahrain, Israel, Kuwait, Oman, Qatar, Saudi Arabia, the United Arab Emirates. In an attempt to test the applicability of the Kuznets curve in its original form and in the advanced form. The results support the

[8] See.Brock,W.A. and Taylor,S. M.(2004),((The green solow model)), NBER working paper no.10557.

applicability of EKC in its inverted U-shape only for the first group. As for the second group both forms of EKC are applicable 9 .

Some studies indicate the existence of bidirectional causality from CO2 emissions and economic growth in MENA region10. Some other studies have confirmed that the EKC hypothesis is supported for only the whole and oil-exporting countries in MENA region11.

4. Conclusion:

The main objective of this paper is to verify the applicability of the Kuznets curve regarding the relationship EKC between economic growth and environmental performance for Egypt and the Middle East and North Africa. It is found that it is applicable to Egypt in its initial form, inverted U-shape ,during the period 1965-2013, with a maximum point of pollution at a per capita income of about $2698.This happened between 2010 and 2011, with a maximum value of CO2 emissions about of 2.59 metric ton per capita. It was also found there were two turning points (maximum then a minimum) for MENA region during the period 1980-2011.

[9] See Al-mulalia, U. , Waib, Ch., , Tingc, L., Mohammedd,A. (2015)((Investigating the environmental Kuznets curve (EKC) hypothesis by utilizing the ecological footprint as an indicator of environmental degradation)), Ecological Indicators, Vol. 48, January 2015, PP. 315–323.

[10] Abdouli,M. , Hammami,S.(2017) ((Investigating the causality links between environmental quality, foreign direct investment and economic growth in MENA countries)), International Business Review Vol. 26, Issue 2, April 2017, PP. 264–278.

[11] Charfeddine,L. , Mrabet,Z.(2017) ((The impact of economic development and social-political factors on ecological footprint: A panel data analysis for 15 MENA countries)), Renewable and Sustainable Energy Reviews,Vol. 76, September 2017, PP. 138–154

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