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Environmental Kuznets curve for the Moroccan economy

Mossadak Anas
Mohammed V University, faculty of law
economics and social sciences, Salé

ABSTRACT

The Environmental Kuznets Curve (ECK) analyses the relationship between economic growth and environmental deterioration. The traditional view that that economic development and environmental quality are contradictory objectives reflects a pure scale effect and does not take into account technological developments. the ECK hypothesis suppose that once economies reach a certain level of development (turning point), environmental degradation tends to decline due to the use of more strict application of environmental rules and increasing public awareness of environmental issues The aim of this paper is to estimate an environmental Kuznets curve for the Moroccan economy. The objective is to investigate its existence and calculate its turning point. The empirical findings show that the Moroccan economy would observe a reversal of its CO2 emissions by 2040. At this point of time, the real GDP per capita would reach 7800 dollars.

Keywords: Environmental Kuznets Curve, pollution, CO2, turning point, environment, growth.

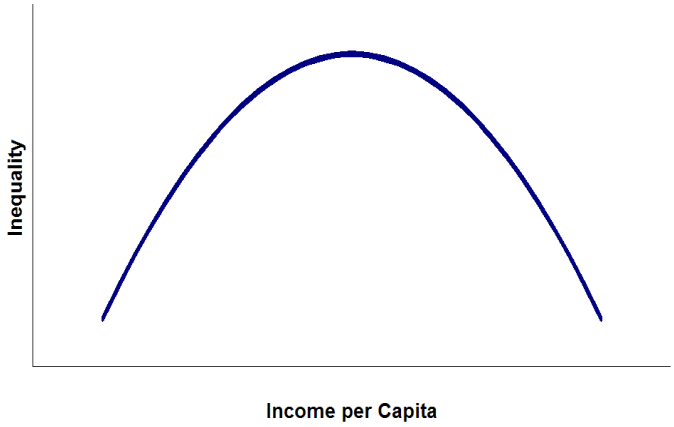
INTRODUCTION

The 1980s were characterized by the emergence of the sustainable development concept, which stressed the need to review development strategies in order to ensure the sustainability of economic growth for both present and future generations. As a result, development is no longer necessarily harmful to the environment, and poverty reduction becomes compatible with environmental protection.

Based on this idea, Grossman and Krueger (1991) introduced the concept of Environmental Kuznets Curve (EKC) in their study of the impact of the American Free Trade Agreements (NAFTA). They have shown that the increase in growth makes it possible to improve the quality of the environment in Mexico rather than to reduce it.

The Environmental Kuznets Curve analyzes the impact of economic growth on environmental degradation based on the same principle as the original Kuznets curve which postulated the existence of an inverted U-shaped relationship between the level of inequality and economic growth. Economic growth initially creates inequalities, but as economic growth accelerates, the level of inequality tended to decline over time.

Figure 1: the original Kuznets Curve

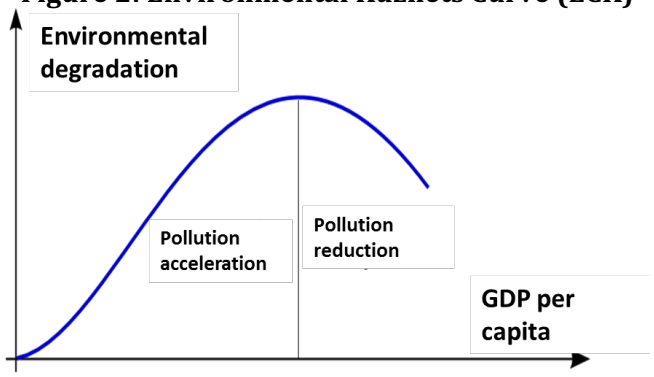


This concept has been taken up by development economists to highlight the link between environmental degradation and economic growth.

The traditional view that economic development and environmental quality are contradictory objectives reflects a pure scale effect and does not take into account technological developments. In other terms, if there were no changes in the structure of production, economic growth would inevitably lead to a proportional increase in pollution (Panayotou, 1993).

Proponents of the ECK hypothesis argue that once economies reach a certain level of development, environmental degradation tends to decline due to the use of more strict application of environmental rules and increasing public awareness of environmental issues.

Figure 2: Environmental Kuznets Curve (ECK)



The ECK was popularized by the 1992 World Development Report of the World Bank, based on the work of Shafik (1994). According this study, the view that more economic activity inevitably degrades environment is based on static assumptions about technology and environmental investments. In the same way, Beckerman (1992) argues that while economic growth generally leads to environmental degradation in the early stages of the process, at the end it is the best and probably the only way to improve the quality of the environment in most countries.

Arrow et al. (1995) criticized this approach because it assumes that there is no impact of environmental damage on production as long as growth is considered as an exogenous variable. The idea is that environmental degradation does not reduce economic activity sufficiently to stop the growth process and that any irreversibility is not too severe to reduce the level of future income.

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Shafik (1994) estimated an EKC based on ten indicators of pollution through three different functional forms. In terms of results, the lack of drinking water and the lack of urban sanitation have been reduced uniformly with the increase in incomes. Also, the concentration of air pollutants decreased with the increase in income with a turning point between 3000$ and 4000$ per capita. However, indicators of deforestation, and river water quality showed no signs of reversal and worsened with increasing income.

Selden and Song (1994) estimated a CKE for four pollutant gases: SO2, NOx, SPM, and CO. The study concerned mainly developed countries. The estimated turning points were all very high compared to previous studies: SO2, 10391$; NOx, 13383$; SPM, 12,275$ and CO, 7,114$.

The authors concluded that in the early stages of economic development, the industrial fabric tends to concentrate in a small number of cities with a very large population density. However, it is quite the reverse that occurs during the advanced stages of the development process leading to an improvement in environment quality. Stern et al. 1996 criticized these findings by arguing that it is quite possible that ambient concentrations will tend to decline as income increases, even though total national emissions are increasing.

The objective of this paper is to estimate an environmental Kuznets curve for the Moroccan economy. First, we present the methodology adopted for estimating the EKC, and then analyze the obtained results for the Moroccan case.

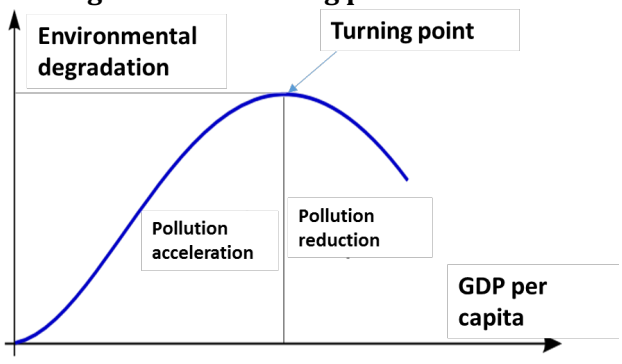
METHODOLOGY

Estimations of the EKC, in particular Shafik (1994), use a quadratic functions where endogenous variable are pollution indicators and the exogenous variable is the per capita income level, often considered in logarithm. Thus, the standard formulation of the EKC is given by:

$$lnE_t = \beta_0 + \beta_1 lnY_t + \beta_2 (lnY_t)^2 + \varepsilon_t$$

With E_t an indicator of environmental quality or emission of pollution per capita, Y_t the per capita income and ε_t is an error term.

Figure 3: the turning point of the EKC



The turning point, i.e the level of income for which the degradation of the environment is at a maximum level. The general form of a second-degree polynomial is given by:

$$y = \beta_0 + \beta_1 x + \beta_2 x^2$$

To reach a maximum, the first derivative of y must be equal to 0, we have:

$$\frac{dy}{dx} = \beta_1 + 2\beta_2 x^* = 0 \text{ , Thus: } x^* = \frac{-\beta_1}{2\beta_2}$$

x^* is positive (maximum) as long as β_2 (the second derivative with respect to x) is less than 0. If the estimate is made in logarithm, then the expression of the turning point is given by:

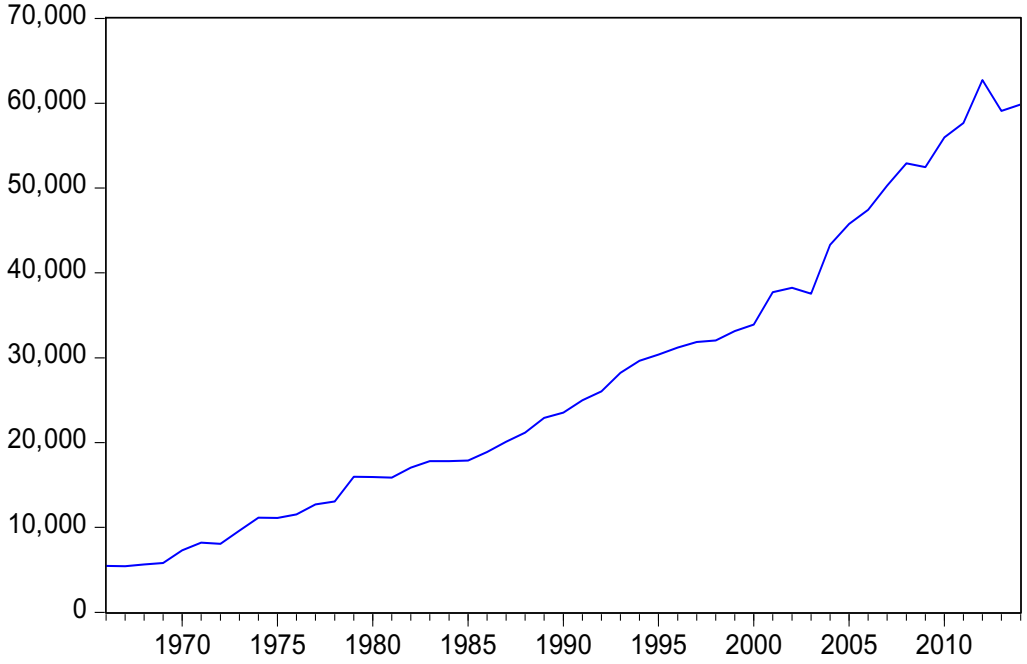
$$x^* = \exp\left(\frac{-\beta_1}{2\beta_2}\right)$$

It is obvious that this equation is quite simplistic as other omitted variables are important to explain the level of emissions. For example, Harbaugh et al. (2002) reviewed and updated the data from Grossman and Krueger (1991) and found that the turning points for the different pollutants were sensitive to both sample changes and econometric specifications.

ESTIMATIONS AND RESULTS

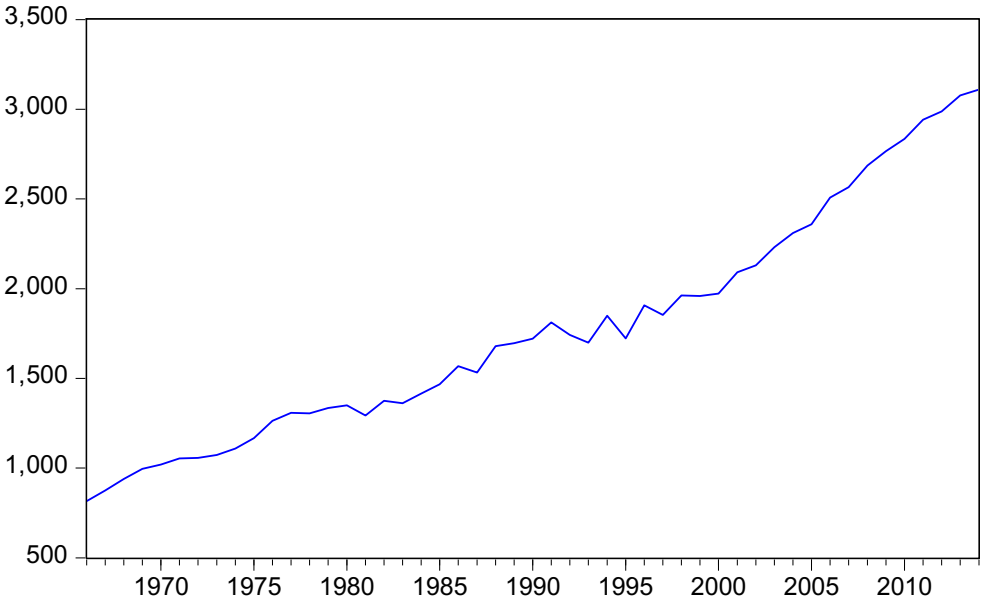
The data used in this study are from the World Bank database. The used variables are per capita CO2 emission (in kiloton) and real GDP per capita (in constant 2010 US dollars). The data cover the period from 1966 to 2014 and are expressed as logarithm. It should be noted that we have not tested other types of environmental indicators because of the unavailability of data over a long period of time.

Figure 4: Evolution of CO2/cap emissions (in kt) in Morocco between 1966 and 2014



Source: World Bank

Figure 5: evolution of real GDP/capita (2010 constant US dollar) in Morocco between 1966 and 2011



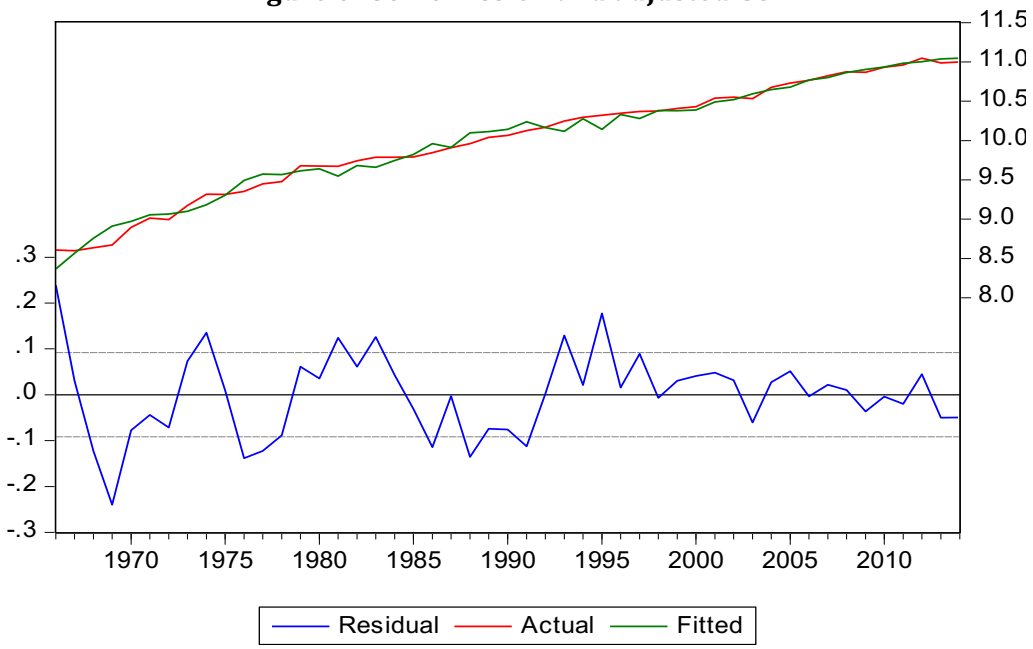
Source: World Bank

The model can be expressed as follow:

$$lnE_t = -39.03 + 11.29lnY_t - 0.63(lnY_t)^2 + \varepsilon_t$$

To ensure the robustness of our estimation we conducted a variety of tests such as t-statistic for coefficients significance, normality of residual (Jarque-Bera test), stability of the coefficients (Cusum test an) and the autocorrelation test of residuals (Durbin-Watson test). See the appendix for more details about estimations

Figure 6: CO2 emission and adjusted CO2



Source: author's calculation

Concerning the turning point we have:

$$x^* = \exp\left(\frac{-\beta_1}{2\beta_2}\right) \text{ Donc } x^* = \exp\left(\frac{11.12}{2x0.63}\right) = \exp(8.96) \approx 7800$$

Thus the turning point of the CO2 emission in Morocco should be reached when the real GDP per capita would be around 7800 US dollars (in real 2010 dollar).

Assuming that the real growth of Moroccan GDP is 4.5[1] on average, and knowing that the real GDP per cap of 2014 is 2546 dollars[2], one can write:

$$2546(1{,}045)^{\,n} = 7800 \; so \; n \approx 25{,}5$$

Thus the turning point should be reached in 2040. This result is in line with the turning points found in the empirical literature and which are generally between 6000 and 13000 $, depending on the pollution indicators used and the adopted econometric approaches.

CONCLUSION

The objective of this work was to estimate an environmental Kuznets curve for the Moroccan economy and to find the turning point from which environmental degradation should begin to decrease. The empirical results have proved the existence of a quadratic environmental Kuznets curve with a turning point of 7800$ (constant US 2010 dollars) per capita. This level of income should be reached by 2040.

Although the result is in line with the empirical literature, it is necessary to test the relevance of this approach for different types of pollution indicators as well as using other econometric methodologies to ensure the robustness of the obtained results.

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[1] Average assumption considered by the IMF for the next 7 years, see IMF WEO.
[2] Constant dollar 2010.

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APPENDIX

Estimation Details

Dependent Variable: LCO2
Method: Least Squares
Date: 10/30/17 Time: 14:24
Sample: 1966 2014
Included observations: 49

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDP	11.29433	1.450893	7.784397	0.0000
LGDP2	-0.630071	0.097783	-6.443593	0.0000
C	-39.03115	5.373053	-7.264241	0.0000

R-squared	0.984197	Mean dependent var	9.996821
Adjusted R-squared	0.983510	S.D. dependent var	0.714243
S.E. of regression	0.091719	Akaike info criterion	-1.880901
Sum squared resid	0.386971	Schwarz criterion	-1.765075
Log likelihood	49.08207	Hannan-Quinn criter.	-1.836957
F-statistic	1432.401	Durbin-Watson stat	1.865078
Prob(F-statistic)	0.000000		

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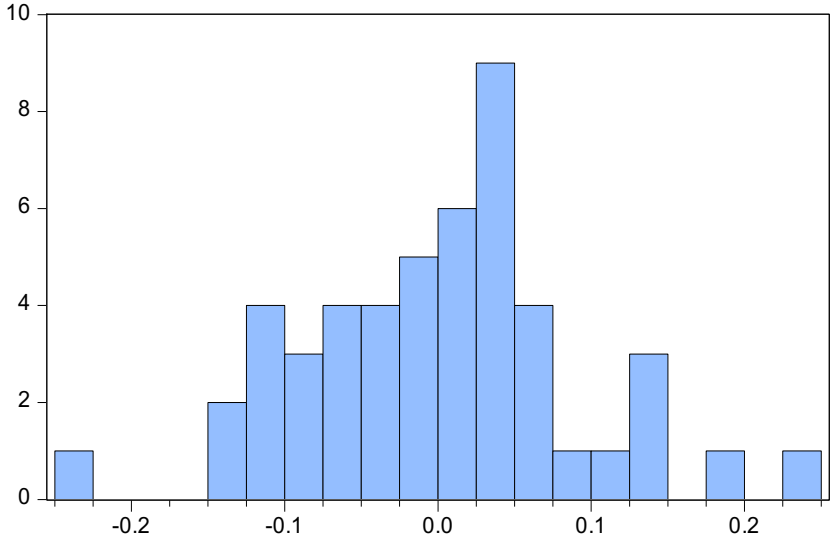
Residual normality test



Series: Residuals	
Sample 1966 2014	
Observations 49	
Mean	-3.33e-14
Median	0.009763
Maximum	0.238775
Minimum	-0.239889
Std. Dev.	0.089788
Skewness	0.042153
Kurtosis	3.443782
Jarque-Bera	0.416601
Probability	0.811963

Model stability test (Cusum test)

