The Validity of Environmental Kuznets Curve in the Case of Iran

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Abstract- **This study investigates the validity of environmental Kuznets curve (EKC) in Iran during 1955-2010 by using various models such as linear, quadratic and cubic to investigate the robust model for EKC hypothesis. The variables of GDP per capita and CO_2 emissions were used as indicators of economic growth and environmental degradation, respectively. Moreover, a time trend T, was used as a proxy for technology change and environmental awareness. Results showed that among the various models, the cubic equation is a good description of the EKC hypothesis in Iran. All the GDP and the T^2 factors seem to play a significant role in explaining the CO2 fluctuations. However, the T factor seems not to influence the CO2 emissions. In addition, Results showed that an inflection point could be found at a level of 5,344 in GDP in 2000 US dollars. This level of GDP was reached twice, once in 1972, after which there was a fall in GDP levels, and again in 2000. There was no maximum for the cubic equation, however. The estimation of quadratic maximum is around 11,044. This means that the two equations largely differ and, thus, the EKC does not hold in the case of Iran.**

Keywords- Environmental Kuznets Curve; CO_2 Emission; Economic Growth; Iran

I. INTRODUCTION

There has been a long debate on the relation between economic growth and environmental quality in economic literature. It has been noted that the so-called environmental Kuznets curve (EKC) describes the relationship between economic growth and environmental quality. The EKC theory predicts that pollution levels rise at low GDP levels, then they reach a peak at a certain level of GDP, and finally they fall with increasing income from then on [1].

The EKC theory proposes that a county can 'grow out of' some pollution problems [2]. However, it is not always the case that the relationship between economic growth and CO_2 emissions follows the path that the environmental Kuznets curve predicts. Literature provides evidence against the inverted U-shape relationship for some environmental indicators. For example, river basins' quality often worsens when income increases. Additionally, both municipal waste and carbon dioxide emissions seem to increase with increasing GDP [3]. Previous literature on the EKC shows that there is much empirical analysis provided on the topic. Some literature shows that the EKC can describe the relationship between the environment and economic development, whereas there is evidence of a different situation. This debate can be dated back to the 1960s' controversy of the limits of economic growth. Some economists, for example the Club of Rome, argued that there is only a finite amount of resources and therefore growth cannot continue forever, but will have a limit. They also advertised a steady state economy as a means to avoid future ecological disasters [4]. Most EKC studies on air pollution investigated the presence and turning point of the EKC ([2], [5], [6], [7], [8] and [9]). Ref. [10] found that for carbon dioxide (CO2) emissions, the turning point ranged from $8000 per capita to $35,000 per capita in previous studies. Ref. [11] used Carbon Dioxide Information Analysis Centre (CDIAC) data and also data from the International Energy Agency in order to examine how robust the EKC is for CO2. They concluded that, regardless of the data, OECD countries produce inverted U-shaped curves while non-OECD countries produce slightly concave curves.

This paper makes an empirical study of the data available to determine whether the Environmental Kuznets Curve can be used to describe the relationship between CO_2 emissions and the levels of GDP per capita in Iran.

II. MODEL SPECIFICATION

The Environmental Kuznets curve theory, as mentioned earlier, predicts an inverted U-shaped relationship between economic growth and environmental quality. In econometric analysis, this relationship could be described as quadratic. There is also a possibility that GDP is proportional to CO_2, this would be a linear relationship, and finally the N-shaped curve, that takes a cubic form in econometrics.

In order to evaluate whether the two variables actually have the quadratic relationship described in literature, a statistical analysis must be conducted. This could be done by using the Least Square Regression method, which would allow for the determination of the shape of the relationship between the two variables giving a wide range of possible solutions. It will also help to determine whether the relationship is significant in different situations discussed further in the section. However, both variables are time dependant. This means that both variables are dependent on technology, historical events, etc. In order to eliminate this factor from the analysis, it must be included in the regression, allowing us to control for these events. This factor will be expressed as a time factor, T, which will take all the above mentioned events into account. However, the time trend is introduced into the estimation to account for changes in technology and environmental awareness which are not related to income. Ref. [12] showed that the use of a time trend has important effects. T=1 in year 1955 and T=56 in year 2010. In order to correct for the possible quadratic dependence on this factor, the T^2 term will also be introduced and analyzed to test for non-linear time effects. This might be needed to eliminate some of the effects of time that influence both variables. If, however, this is not done, then the analysis will become ambiguous as third-factor problems might arise.

In order to find what relationship is significant, if any, the following equations can be used.

$$CO_{2t} = \alpha_1 + \alpha_2 GDP_t + \alpha_3 T + \alpha_4 T^2 + \varepsilon_{1t}$$
$$CO_{2t} = \beta_1 + \beta_2 GDP_t + \beta_3 GDP_t^2 + \beta_4 T + \beta_5 T^2 + \varepsilon_{2t}$$
$$CO_{2t} = \gamma_1 + \gamma_2 GDP_t + \gamma_3 GDP_t^2 + \gamma_4 GDP_t^3 + \gamma_5 T + \gamma_6 T^2 + \varepsilon_{3t}$$

The term ε represents the error term. This is the term that takes into account all the other factors not included in the analysis.

III. EMPIRICAL RESULTS

The graph below represents a preliminary analysis of the data. The blue points represent the actual observations. The other three colours represent the predicted relationships. The analysis below will look closely at each of the predicted relationships and draw conclusions about what type of relationship is more representative of the actual data.

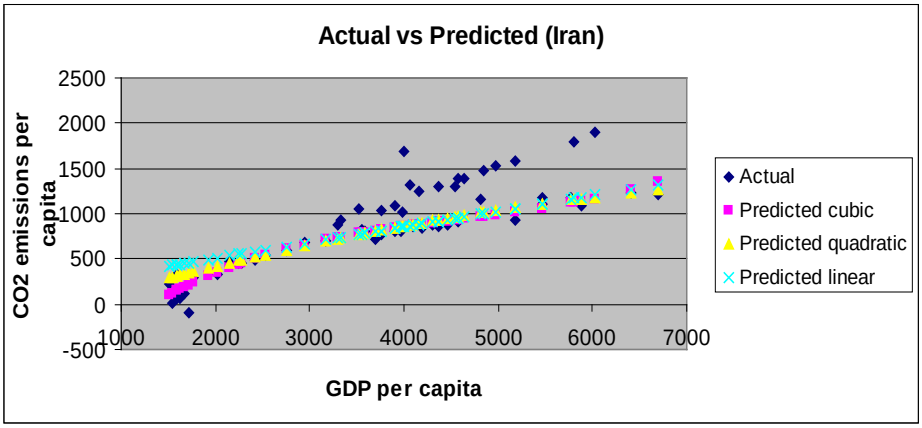

Figure 1 ACTUAL VS PREDICTED DATA FOR CO2 EMISSION AND GDP PER CAPITA IN IRAN

The first relationship to be discussed is the linear relationship. The reason for this is that it allows a logical progress through all the three types of equations, discussed in the previous section. This also allows us to look at each individual case in detail. The linear relationship can be represented by the following equation:

$$CO_{2t} = \alpha_1 + \alpha_2 GDP_t + \alpha_3 T + \alpha_4 T^2 + \varepsilon_{1t}$$

TABLE I LINEAR RELATIONSHIP IN EKC

Variable	Coefficient	Standard Error	t Stat	P-value
Intercept	-99.87	51.67	-1.95	0.048
GDP	0.16	0.018	9.97	0.00
T	2.36	5.02	0.47	0.59
T^2	0.25	0.076	3.11	0.011

In order to determine whether a quadratic relationship is a better fit, the following equation should be used and analysed.

$$CO_{2t} = \beta_1 + \beta_2 GDP_t + \beta_3 GDP_t^2 + \beta_4 T + \beta_5 T^2 + \varepsilon_{2t}$$

TABLE II QUADRATIC RELATIONSHIP IN EKC

variable	Coefficient	Standard Error	t Stat	P-value
Intercept	-270.36	151.97	-1.73	0.07
GDP	0.36	0.128	2.49	0.01
GDP^2	0.00	0.00	-1.14	0.22
T	-5.67	7.85	-0.63	0.45
T^2	0.35	0.13	2.91	0.01

A cubic relationship is the last relationship that will be taken into account in this analysis. The equation, representing it is shown below.

$$CO_{2t} = \gamma_1 + \gamma_2 GDP_t + \gamma_3 GDP_t^2 + \gamma_4 GDP_t^3 + \gamma_5 T + \gamma_6 T^2 + \varepsilon_{3t}$$

TABLE III CUBIC RELATIONSHIP IN EKC

Variable	Coefficient	Standard Error	t Stat	P-value
Intercept	-1022.21	388.46	-2.52	0.01
GDP	1.07	0.34	2.73	0.01
GDP^2	0.01	0.00	-2.23	0.02
GDP^3	0.011	0.012	2.08	0.03
T	-15.71	9.48	-1.59	0.08
T^2	0.44	0.128	3.64	0.01

IV. CONCLUSION

This paper investigated the validity of EKC hypothesis in Iran during 1955-2010 by using OLS approach. Moreover, the present study examined the existence of various EKC models such as linear, quadratic, and cubic models to establish a robust EKC model.

However, the results of estimation indicated that the cubic equation is a good description of the relationship in this country. All the GDP and the T^2 factors seem to play a significant role in explaining the CO_2 fluctuations. However, the T factor seems not to influence the CO_2 emissions and has a coefficient not significantly different from zero.

In addition, the above analysis showed that, using the cubic equation provided by the regression analysis, an inflection point could be found at a level of 5,344 in GDP in 2000 US dollars. This level of GDP was reached by the country twice, once in 1972, after which there was a fall in GDP levels, and again in 2000. There was no maximum for the cubic equation, however. The estimation of quadratic maximum is around 11,044. This means that the two equations largely differ and the EKC does not hold for Iran.

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