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## ECONOMIC DEVELOPMENT AND ENVIRONMENT POLLUTION IN HIGH AND MIDDLE-INCOME COUNTRIES: A COMPARATIVE ANALYSIS OF ENVIRONMENTAL KUZNETS CURVE

***The aim of this study is to make a comparative analysis of the relationship between development and environment pollution and to test the validity of environmental Kuznets curve in high and middle-income countries by using the data from the period 1980-2007. According to the estimation conducted by the panel method, a negative and significant relationship was found between the improvement in development indicators and environment pollution in the middle-income countries which indicates that an increase in income is compatible with environmental Kuznets curve. In other words, the results indicate an inverted U-shaped curve in middle-income countries. However, in high-income countries, an inverted N-shaped relationship was found between development indicators and environment pollution.***

***Keywords:*** *economic development; environment pollution; environmental Kuznets curve.*

***JEL Classifications:*** *O13, Q56.*

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## ЕКОНОМІЧНИЙ РОЗВИТОК І ЗАБРУДНЕННЯ ДОВКІЛЛЯ У КРАЇНАХ З ВИСОКИМ І СЕРЕДНІМ РІВНЯМИ ДОХОДІВ: ПОРІВНЯЛЬНИЙ АНАЛІЗ ЕКОЛОГІЧНОЇ КРИВОЇ КУЗНЕЦЯ

***У статті проведено порівняльний аналіз взаємозв'язку між розвитком і забрудненням довкілля, а також перевірено обгрунтованість екологічної кривої Кузнеця в країнах з високим і середнім рівнями доходу на основі даних за 1980-2007 роки. Згідно оцінювання, проведеного панельним методом, знайдено негативний і значущий зв'язок між покращенням показників розвитку і забрудненням довкілля в країнах із середнім рівнем доходу, який означає, що зростання доходів сумісне з екологічною кривою Кузнеця. Іншими словами, результати демонструють інвертовану U-подібну криву в країнах із середнім рівнем доходу. Проте в країнах із високим рівнем доходу було виявлено інвертовану N-подібну залежність між показниками розвитку і забрудненням довкілля.***

***Ключові слова:*** *економічний розвиток; забруднення довкілля; екологічна крива Кузнеця.*

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## ЭКОНОМИЧЕСКОЕ РАЗВИТИЕ И ЗАГРЯЗНЕНИЕ ОКРУЖАЮЩЕЙ СРЕДЫ В СТРАНАХ С ВЫСОКИМ И СРЕДНИМ УРОВНЯМИ ДОХОДОВ: СРАВНИТЕЛЬНЫЙ АНАЛИЗ ЭКОЛОГИЧЕСКОЙ КРИВОЙ КУЗНЕЦА

***В статье проведен сравнительный анализ взаимосвязи между развитием и загрязнением окружающей среды, а также проверена обоснованность экологической кривой Кузнеца в странах с высоким и средним уровнем дохода на основе данных за 1980-2007 годы. По оценке, проведенной панельным методом, была найдена отрицательная и значимая связь между улучшением показателей развития и загрязнением окружающей среды в странах со средним уровнем дохода, который означает, что рост доходов совместим с экологической кривой Кузнеца. Другими словами, результаты***

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***демонстрируют инвертированную U-образную кривую в странах со средним уровнем дохода. Однако в странах с высоким уровнем дохода была обнаружена инвертированная N-образная зависимость между показателями развития и загрязнением окружающей среды.***

***Ключевые слова:*** *экономическое развитие; загрязнение окружающей среды; экологическая кривая Кузнеца.*

**1. Introduction.** When the related literature about the environment and economic development is reviewed, it is found that an effective environment policy could work with the working system of the capitalist corporations in harmony and the growth could be provided without any harm to the environment (Christoff, 1996). In recent years, a great interest in the role of natural resources and environment on the prosperity and life quality is observed. It is claimed in the report by Hulton for the European Parliament that sustainable development is an important tool for economic growth and the economic growth can also be realized through following environmentally friendly production policies (Hulton, 2001, p.15). Thereby, an increase in personal income emerged by the economic growth shows some positive effects on the environment and the usage of resource by providing an increase in the sensitivity towards the environment and in the demand of environmentally friendly products.

Beckerman's (1992) suggestion, "the most accurate way to improve environment in a long-term period is becoming rich", emphasizes the possibility of preventing environmental pollution by increasing the income level of individuals. The income level which increases with economic development enhances the demand for qualified environment and qualified environment turns from being a luxury into a necessity. Therefore, it is envisaged that pollution in middle-income countries will be temporary and it will be reduced dramatically when the economic development is realized in these countries. According to this, individuals whose income levels reach a higher life standard, want to live in a cleaner environment (Dinda, 2004). This structural change in economy forms a tendency towards lower degredation of the environment. The studies done on this topic showed that a country's having a high personal income and life quality caused the result of a gradual increase in the value that the people in that country give to the environment (Selden and Song, 1994).

In this study, the relationship between economic development and environment pollution is investigated. The relationship between environment pollution and economic development was analyzed comparatively by using the data from 71 countries. As a result, it was concluded that environment pollution showed a declining trend in parallel with economic development and the increase in personal income was compatible with environment Kuznets curve.

**2. Economic development and environment pollution.** Simon Kuznets suggested that income distribution would be thwarted with economic growth and development at first; however, the inequity of income distribution would decrease together with the continuation of the increase in income level later (Kuznets, 1955). As this hypothesis started in 1950s is similar to the relationship that Kuznets found, it was implemented to the relationship between environment pollution and the per capita income by Grossman and Krueger (1991). This approach named the environmental Kuznets curve later, has taken its place in the literature as a new impression of the relationship

between pollution and personal income. The environmental Kuznets curve (EKC) is shown in Figure 1.

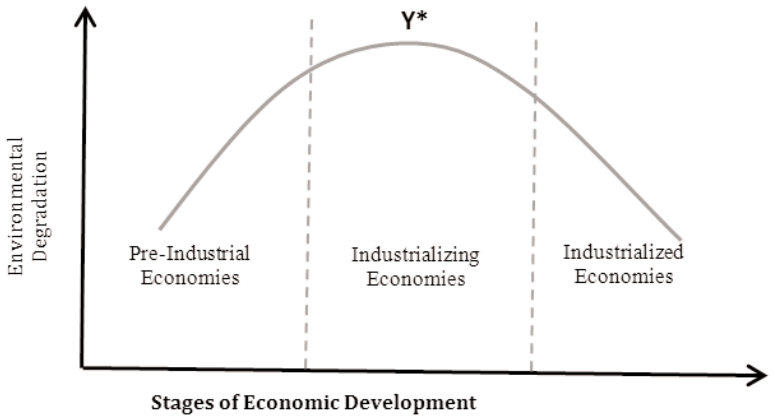


*Figure 1.* **Environmental Kuznets curve, Panayotou, 2003, p.46**

According to the EKC approach, the environmental degredation which increases at first and decreases later with the increase in income forms an inverted U-shaped curve. This U-shaped curve called a Kuznets curve overlaps with the inverted U-shaped curve finding which Kuznets obtained for the relationship between the inequality of income distribution and the per capita income level in his study of 1955 (Dasgupta et al., 2002).

Most of the models which investigate the EKC relationship show that the most important component of the demand for qualified environment is income flexibility (Beckerman, 1992; Carson et al., 1997). Together with this approach, it is also claimed that the effect of economic growth on the environmental quality is caused from 3 different channels: scale, technology and combination (Grossman and Krueger, 1991). International trade (Dinda, 2004; Suri and Chapman, 1998), market mechanism (Unruh and Moomaw, 1998) and legal regulation of environment protection (Dasgupta et al., 2002) are also being used to explain the hypothetic relationship in the curve together with the weighted effects of the mentioned influences on the EKC.

The income flexibility of environmental demand depends on the consideration of the environment as a luxury. According to this approach, the poor allocate less amount of their income which increases for the protection of the environment while the rich allocate more amount of their income for it. The influence of scale effect on EKC is related with the size of input and output that are used at production stage for providing the growth in economy. High amount of input that is used to reach a higher level of production brings along the destruction of the resources, emissions and wastes caused by production pollution. The technology effect means the rise in the funds that the countries allocate for research and development (R&D) expenses in parallel with the increase in their incomes. The technology effect that explains the declining part of EKC is that the usage of environmentally friendly technologies and the rise in the funds allocated for R&D will contribute to both the usage of natural

resources more productively and the reduction of environment pollution (Grosmann and Krueger, 1991). The combination effect means the change of economic structure in parallel with the increase of income and the transition from agricultural community to industrial community and then to knowledge society. Together with the provision of growth and the increase of income, a transition from industry economy to services information economy occurs and the usage of fewer amounts of resources in these sectors causes the reduction of pollution in developed countries which have high incomes.

The effect of international trade on EKC realizes itself in various forms. Since the increase of trading volumes in the economies that adopt free trade system can be possible with high production level, environment destruction becomes higher due to the usage of input and output. However, it is also possible for the increase of the trading volume to bring out the combination and technology effect together with the increase of income.

The effect of market mechanism on EKC can be explained with the changes in the prices for productions. If spillover costs that are brought out by non-environmentally friendly production methods by internalized within the market mechanism, increasing prices reduce the demand for dirty product and production methods while they will encourage the production with environmentally-friendly methods. The effect that environmental layouts showed on the curve is explained by the approach in which behaviours which damage the environment are punished. This relationship, however, is closely related with the ease of application of legal regulations realized for the protection of the environment. This means that rich countries have more developed and complex institutions and it is easier to implement the desired environmental layouts. On the other hand, people in middle-income countries do not notice the destruction of the environment, so to reach the mentioned sensitivity they have to complete their economic development.

**3. Literature review.** The 3 studies in which EKC relationship was tested for the first time is Grossman and Krueger (1991), Shafik and Bandyopadhyay (1992) and Panayotou (1993). In these studies, the approach in which only the increase of personal income was considered and the existence of external factors such as education and technological development was ignored by accepting the pure economic growth as the main reason of environmental destruction was presented. After 2000s, however, it is seen that some different findings were obtained in some studies carried out on the relationship between environment and growth. Hill and Magnani (2002) and Tisdell (2001) found in their studies that not only income but also some welfare indications such as health and education had some positive effects on the relationship between growth and environment pollution. Some writers claimed that the role in that positive change was related to variations in production technologies, the increase of the human capital level and the quality of institutionalization (Atkinson and Hamilton, 2003).

In addition to the mentioned studies, many other studies tested EKC hypothesis and reached the conclusions confirming the hypothesis. In their study Dasgupta et al. (1995) investigated 31 developed and developing countries and determined a significant relationship between environment pollution and per capita income. On the other hand, the empirical studies by Torras and Boyce (1998), Richmond and

Kaufmann (2006), Ozturk and Acaravci (2010) which dealt with different countries and variables were not able to reach findings to confirm the EKC hypothesis.

In the EKC hypothesis, it is expressed that the hypothetic shape between income and environment pollution will reach a particular turning point as the income increases and it is accepted that the sensitivity to the environment will rise from this point. However, it is seen that there are large intervals in determining the point that is stated as the turning point in the literature and shown with Y* in Fig. 1 since the level at which this sensitivity is realized might differ depending on the socioeconomic structure of countries. Grossman and Krueger (1995) found the turning point as $ 5967; Selden and Song (1994) found it as $ 12786; and Galeotti and Lanza (1999) found it as $ 13260 in their studies. According to the observations gained in various studies, Dinda (2004) suggests that the income level between $ 4464 and $ 14880 can be accepted as the turning point and the sensitivity of the individuals may start to increase and the pollution level may start to decrease from that turning point on.

**4. Data and empirical analysis.** In the literature, it is seen that EKC relationship was investigated by using the economic growth and environmental data belonging to many countries through cross-sectional data or panel data analysis. For example, Shafik and Bandyopadhyay (1992) used the data of 149 countries the income levels of which were different to test the EKC relationship. However, grouping the countries by income levels is important in terms of explaining the relationship better and evaluating the effects of external variables in this relationship. In this particular study on high and middle-income countries the effects of the per capita income (PCGDP), development (LIFE, POP>65) and population density (POP) indicators on the environment pollution in these countries will be analyzed through the panel data method.

*4.1. Data Set, Variables and Model Setup.*

The data set used in this study were obtained from World Banks' World Development Indicators (WDI) database for 1980-2007. CO2 emmissions added to the model as the dependent variable were taken as tonnes per capita. The variables used are shown in Table 1.

*Table 1.* **The Definitions of Variables**

| Variable | Definition |
|---|---|
| $CO_2$ | Carbon dioxide emission (tonnes per capita) |
| PCGDP (Y) | GDP per capita (ln taken) |
| LIFE | Life expectancy at birth |
| POP | The rate of population aged between 15 and 64 in the total population |
| POP>65 | Population growth rate of over 65 years |

It was aimed to reflect the values of environmental pollution properly by taking the CO2 emmission value as the dependent variable. International Panel of Climate Change accepted CO2 gas as the most important gas directly effecting the global warming (IPCC, 1997). As the basic assumption of the EKC hypothesis is explained by the relationship between income level and pollution (CO2, SO2, NOx etc.), CO2 emmissions and average gross domestic products (GDP) per capita values of high and middle income countries.

As it can be seen in Table 2, the United Arab Emirates have the highest income with $54310 among high-income countries and Venezuela has the highest income with $9957 among middle-income countries. When CO2 rates per capita in tonnes

were analyzed, it is seen that the United Arab Emirates which also have the highest income level are at the top in terms of CO2 emmission with 30,92 tonnes while Thailand has the highest CO2 rate with 3,66 tonnes among middle-income countries.

*Table 2.* **The mean of CO2 and PCGDP (1980-2007)**

| High income countries | $CO_2$ | PCGDP* | Middle income countries | $CO_2$ | PCGDP* |
|---|---|---|---|---|---|
| The United Arab Emirates | 30,92 | 54.310 | The Philippines | 2,28 | 2.516 |
| Australia | 16,67 | 25.839 | Bolivia | 2,05 | 3.253 |
| Austria | 7,69 | 27.398 | Paraguay | 1,71 | 3.961 |
| Belgium | 11,02 | 26.401 | Chile | 0,79 | 8.346 |
| Bahrain | 25,71 | 21.577 | China | 2,31 | 1.971 |
| Bahama | 8,06 | 23.227 | The Ivory Coast | 3,00 | 1.904 |
| Brunei Darussalam | 17,94 | 53.326 | Cameroon | 2,25 | 2.065 |
| Canada | 16,28 | 28.511 | Republic of Kongo | 1,55 | 3.452 |
| Switzerland | 5,89 | 32.467 | Colombia | 1,73 | 6.211 |
| Denmark | 10,41 | 27.528 | Costa Rica | 1,29 | 7.111 |
| Spain | 6,40 | 21.124 | Dominican Republic | 2,38 | 4.685 |
| Finland | 10,89 | 23.720 | Equator | 2,94 | 5.787 |
| France | 6,75 | 25.085 | Egypt | 2,67 | 3.442 |
| Greece | 7,27 | 19.184 | Guatemala | 2,92 | 3.676 |
| England | 9,63 | 25.430 | Honduras | 1,23 | 2.843 |
| Iceland | 7,50 | 27.051 | Indonesia | 1,34 | 2.382 |
| Israel | 8,09 | 19.521 | India | 2,28 | 1.496 |
| Italy | 7,35 | 24.339 | Iran | 1,75 | 7.391 |
| Japan | 9,17 | 25.657 | Sri Lanka | 2,96 | 2.468 |
| Luxembourg | 23,08 | 47.760 | Morocco | 2,58 | 2.808 |
| Netherlands | 10,78 | 28.443 | Malaysia | 3,36 | 8.252 |
| Norway | 8,29 | 36.814 | Pakistan | 1,58 | 1.752 |
| New Zealand | 7,34 | 20.844 | Panama | 2,14 | 7.482 |
| Saudi Arabia | 14,39 | 21.299 | Peru | 0,86 | 5.564 |
| Singapore | 13,63 | 29.874 | Argentina | 2,43 | 9.560 |
| Sweden | 6,52 | 25.800 | Brasil | 1,59 | 7.645 |
| Trinidad and Tobago | 17,56 | 14.050 | Sudan | 1,86 | 1.199 |
| The USA | 19,54 | 34.039 | Senegal | 3,48 | 1.467 |
| Hong Kong | 5,10 | 25.650 | El Salvador | 0,98 | 4.480 |
| Barbados | 3,84 | 16.062 | Syria | 0,47 | 3.534 |
| Cyprus | 6,26 | 18.787 | Thailand | 3,66 | 4.595 |
| Ireland | 9,20 | 23.309 | Turkey | 2,47 | 8.271 |
| Makao | 3,06 | 23.818 | Uruguay | 2,77 | 8.213 |
| Malta | 5,66 | 15.568 | Venezuela | 1,89 | 9.997 |
| Umman | 7,93 | 16.496 | South Africa | 2,68 | 8.080 |
| Portugal | 4,69 | 17.091 | | | |

* The values related with PCGDP show the values before ln was taken in the model.

The following probable results may be obtained between the estimation of model (2) and economic growth/development (Dinda; 2004):

(i) $\beta_1 = \beta_2 = \beta_3 = 0$, there is no relationship between *x* (income) and *y* (pollution).

(ii) $\beta_1 > 0$ ve $\beta_2 = \beta_3 = 0$, there is a linear increasing relationship between *x* and *y*.

(iii) $\beta_1 < 0$ ve $\beta_2 = \beta_3 = 0$, there is a linear decreasing relationship between *x* and *y*.

(iv) $\beta_1 > 0$, $\beta_2 < 0$ ve $\beta_3 = 0$, there is an inverted U-shaped (EKC) relationship between *x* and *y*.

(v) $\beta_1 < 0$, $\beta_2 > 0$ ve $\beta_3 = 0$, there is a U-shaped relationship between *x* and *y*.

(vi) $\beta_1 > 0$, $\beta_2 < 0$ ve $\beta_3 > 0$, there is an N-shaped relationship between *x* and *y*.

(vii) $\beta_1 < 0$, $\beta_2 > 0$ ve $\beta_3 < 0$, there is an inverted N-shaped relationship between *x* and *y*.

The relationship between income and pollution is explained by the environmental Kuznets curve. The basic assumption of the EKC hypothesis can be formulated in the most general way as follows:

$$E = f(Y, Y^2, Y^3, Z) \quad (1)$$

In the formula, the letters stand for explanatory variables that are assumed to have effects on the environment pollution: E for the environment indicator, Y for income and Z for population density. Considering the hypothesis numbered (1) and the studies by Lucas et al. (1992), Grossman and Krueger (1991; 1995), Selden and Song (1994), Torras and Boyce (1998), Bruyn et al. (1998) and Dinda (2004), the model in which the EKC hypothesis will be tested was established as follows:

$$CO_{2it} = \alpha_i + \beta_1 Y_{it} + \beta_2 Y2_{it} + \beta_3 Y3_{it} + \beta_4 Z_{kit} + \varepsilon_{it} \quad (2)$$

In the equation, $CO_{2it}$ shows the carbondioxide emission amount per capita in *t* time in *i* country, $Y_{it}$ shows *ln* taken GDP per capita and $Z_{kit}$ = [LIFE, POP, POP65] variables which represent the other explanatory variables show the life expectancy at birth (LIFE) and population growth rate of over 65 years (POP65) which are accepted as a development indicator in the literature and which are assumed to have effects on environment pollution. POP variable represents the rate of population between the ages of 15 and 64 in the working age to the total population. The studies which aimed to test the EKC hypothesis used many variables in their models to measure environmental pollution and degredations. In the empirical studies, however, the environment pollution is measured through the variables that represent air and water pollution.

The EKC hypothesis accepts the relationships between income coefficients as $\beta_1 > 0$, $\beta_2 < 0$ and $\beta_3 = 0$. In our study, our expectation towards the size and the value of the coefficient of income per capita in the middle-income countries will be in this direction considering the results of the studies which had analyzed the turning point. Since it is accepted that high-income countries exceed the turning point which is taken as threshold value in the literature, the relationship in these countries between the coefficients of income is expected to be a linear decreasing relationship $\beta 1 < 0$ ve $\beta 2 = \beta 3 = 0$. While a negative correlation between the increase in $CO_2$ emmission ($CO_2$), life expectancy at birth (LIFE) and population growth rate of over 65 years old (POP>65) is predicted, a positive correlation between the variable that represents the population between 15 and 64 years old (POP) is predicted.

High correlations between the independent variables make the variances and covariances of the predictors increase, and so they make the t-statistics meaningless. In order to investigate the existence of a situation like this, the correlations between the independent variables belonging to high- and middle-income countries are presented in Table 3. As it can be seen in Table 3, there is no high correlation between the independent variables that can affect the accuracy of the predictions.

*Table 3.* **Correlations Between the Independent Variables**

| | | LNPCGDP | POP | POP>65 | LIFE |
|---|---|---|---|---|---|
| Middle-income countries | LNPCGDP | 1.000000 | 0.340122 | 0.429461 | 0.561782 |
| | POP | 0.340122 | 1.000000 | 0.581347 | 0.625280 |
| | POP>65 | 0.429461 | 0.581347 | 1.000000 | 0.456781 |
| | LIFE | 0.561782 | 0.625280 | 0.456781 | 1.000000 |
| High-income countries | LNPCGDP | 1.000000 | 0.300811 | 0.008041 | 0.251253 |
| | POP | 0.300811 | 1.000000 | 0.144461 | 0.434349 |
| | POP>65 | 0.008041 | 0.144461 | 1.000000 | 0.759385 |
| | LIFE | 0.251253 | 0.434349 | 0.759385 | 1.000000 |

*4.2 Maintaining the Stability and Panel EGLS Estimation Results.* A lot of panel unit root tests have been developed to investigate the stability between panel series. The panel unit root tests suggested by Levin and Lin (LL) (2002), Im, Pesaran and Shin (IPS) (2003), Maddala and Wu (MW) (1999) and Hadri (2000) exist in the literature in a standard format. While LL, IPS and MW test the null hypothesis in which the series are not stable, Hadri tests the null hypothesis in which series are stable.

The format of LL model is as follows:

$$\Delta Y_{it} = \alpha_i + \rho Y_{i,t-1} + \sum_{k=1}^{n} \lambda_k \Delta Y_{i,t-k} + \delta_i t + \theta_t + u_{it} \quad (3)$$

This tests the $\rho_i = \rho$ assumption which says all $i$ section units are not stable by the limitation of homogeneity against the $\rho_i = 0$ null hypothesis which says all sections are stable and the $\rho < 0$ alternative hypothesis which says all series are stable.

The limitation of $\rho$ to be homogenous for all sections is loosened and the null and alternative hypotheses are stated in the IPS test as follows:

H0: $\rho_i = 0$ for all "$i$"s

H1: $\rho < 0$ for at least one "$i$"

The $t$-statistics of IPS is obtained from the mean of single ADF unit root test statistics for each $i$:

$$\bar{t} = \frac{1}{N} \sum_{i=1}^{N} t_{\rho i}$$

Im et al. (2003) expressed that $\bar{t}$ which is rightly standardized would have standard normal distribution asympotically. Furthermore, Im et al. proved that their own t-statistics have better features than LL test by using Monte Carlo simulations.

The results of IPS test are seen in Table 4. The null hypothesis which suggests that the series in 2 out of 5 are not stable in both fixed and fixed-trended models is rejected. According to this, the variables of LNPCGDP and LIFE have unit roots in respect of their level values, but they are stable series when their first differences are taken. It is seen that all the variables are stable in respect of their level values in fixed and trended models.

Since the series are stable, the relationship between the variables can be estimated by panel data methods. Table 5 shows the prediction results of 36 high-income countries and 35 middle-income countries. In this prediction, period SUR and white diagonal panel (EGLS) methods were used to take changing variance and autocorrelation causing from variables belonging to those countries into consideration.

*Table 4.* **The Results of IPS Unit Root Test**

| | High-income countries | | Middle-income countries | |
|---|---|---|---|---|
| | Fixed | Fixed and trended | Fixed | Fixed and trended |
| $CO_2$ | -2.02 (0.02)** | -1.72 (0.04)* | -10.61 (0.00)* | -8.07 (0.00)* |
| LNPCGDP | -10.09 $\Delta$ (0.00)* | -2.83 (0.00)* | -1.21 (0.04)* | -4.51 (0.00)* |
| POP | -21.02 (0.00)* | -59.64 (0.00)* | -4.31 (0.00)* | -5.34 (0.00)* |
| POP>65 | -7.93 (0.00)* | -31.53 (0.00)* | -2.83 (0.00)* | -2.66 (0.00)* |
| LIFE | -16.85 $\Delta$ (0.00)* | -2.93 (0.00)* | -5.15 (0.00)* | -3.69 (0.00)* |

*Notes:* The null hypothesis in the tests is like this: The series are not stable. The statistics, standardized average t values and the numbers in paranthesis are the probability values of these values. The signs * (**) show the statistics are stable at the 5% (10 %) level of significance. $\Delta$ shows that the first differences of the variables are taken.

*Table 5.* **The Weight Matrix of Panel (EGLS) Prediction Results**

| | High-income countries | | Middle-income countries | |
|---|---|---|---|---|
| | Coefficient | t-value | Coefficient | t-value |
| LNPCGDP ($y$) | -7,866** | -17,21(0,02) | 6,517** | 1,77(0.08) |
| LNPCGDP^2 ($y^2$) | 6,029** | 17,73(0,06) | -1,573* | -3,50(0.00) |
| LNPCGDP^3 ($y^3$) | -2,011** | -39,68(0,08) | 0,104* | 5,78(0,00) |
| POP>65 | -0,959* | -24,36 (0,00) | -0,060* | -12,20(0,00) |
| POP | 0,446* | 14,68 (0,00) | 0,144* | 17,85(0.00) |
| LIFE | -0,145* | -3,22 (0,00) | -0,315* | -10,98(0.00) |
| Sabit | -30,763 | 0,80(0,42) | -7,063 | -0,70(0,48) |
| $\overline{R}^2$ | 0,79 | | 0,88 | |
| $N*T$ | 1008 | | 962 | |
| $F$ | 118,80(0,00)* | | 251,79(0,00)* | |
| $D$-$W$ | 1,997 | | 2,014 | |

*Notes:* The statistics in paranthesis near the coefficients are autocorrelation between the fault terms of data section and corrected t-statistics of changed variance. The numbers in paranthesis show the probability values of test statistics. F-statistics test the null hypothesis which says "fixed effects are invalid simultaneously". The signs * (**) show that the null hypothesis is rejected at the 5% (10%) level of significance.

According to the results obtained from the panel (EGLS), the signs and the size of the coefficients were compatible with the literature on middle-income countries as expected, while an inverted N-shaped relationship was found instead of a decreasing relationship as predicted in the literature on high-income countries. Considering the coefficient results of panel (EGLS) model, one-unit increase in personal income causes a unit of 6,51 raise in the emission oscillation in middle-income countries when the other variables are fixed; this rate occurs as negative when the income is squared and it comes up to zero when the income is cubed. Therefore, the coefficient of β in model (2) has come up compatible with the results of coefficient (iv) $\beta 1>0$, $\beta 2<0$ ve $\beta 3$ that shows the Kuznets hypothesis exists, see Dinda (2004). These results show that the inverted-U-shaped relationship known as the EKC hypothesis is valid for middle-income countries and the increase in personal income wil cause a decrease in environmental pollution as time passes.

In high-income countries, one-unit increase in personal income causes a unit of -7,86 decrease in emissions; in middle-income countries this rate occurs as positive when the income is squared and it turns to negative when the income is cubed. These results show that the sign of β coefficient expresses that the curve has an inverted-N shape. The EKC hypothesis assumes that the increase in environmental degredations at the beginning period is temporary, but the decrease in later periods is permanent (Dinda, 2004). The results of the analysis done for high-income countries are contradictory with this assumption and they show there are more than one turning point on the curve. Accordingly, pollution decreases at first, increases later and decreases again at last. Borghesi (1999) explains the realization of such a relationship with the highness of economic activity capacity in very high income levels. The positive effect of information and technology mentioned above on the environment in such a large economy can not be balanced (Borghesi, 1999).

According to the results obtained by the panel (EGLS) method, the coefficient signs and the size of development and population density indicators are found in harmony with the literature. The variable of POP represents the rate of the population between 15 and 64 years old to total population. A one-unit increase in POP variable causes an increase of 0,44 and 0,14 unit in the amount of emission in high and middle-income countries, respectively. Population growth rate's being high in this interval can be seen among the reasons of pollution, especially in middle-income countries which have high population growth rate, and the lack of infrastructure required for the growing population resulting in more waste for the environment.

The variable of POP>65 which is considered as one of economic development indicators represents the population of over 65 years old to the total population and the increase in this variable shows that individuals live longer and therefore there is an increase in the development level of a country. As the variable of LIFE which shows the life expectancy reflects the improvements in health and social indicators of countries, a decrease in pollution is expected when the coefficient related with this variable decreases in both groups of countries.

**5. Conclusion.** The results of panel EGLS that is done for middle-income countries in the study correspond with the inverted-U-shaped environmental Kuznets curve theoretically and this shows that an increase in per capita income carries vital importance in preventing the environmental degredation in these countries. The results of the analysis proved the proposition of Beckerman (1992) which says "the most certain way to improve the environment in the long run is increasing welfare" right and it was determined that the increase in countries' environment quality was possible with the increase in per capita income in addition to ensuring the development and the decrease in population growth rate.

The results of analysis for high-income countries did not correspond with the assumption to which the EKC hypothesis points and which says "the environmental degredation in industralized countries which have high income has a decresing tendency". Even though the results show a decreasing relationship in the environment degredation at first, a conclusion which is compatible with the results of the similar studies (inverted-N shaped curve) in the literature, but different from the EKC literature when the income is squared or cubed.

## References:

*Atkinson, G., Hamilton, K.* (2003). Savings, Growth and The Resource Curse Hypothesis, World Development, 31(11), 1793-1807.

*Beckerman, W.* (1992). Economic Growth and The Environment: Whose Growth? Whose Environment?, World Development, 20, 481-496.

*Borghesi, S.* (1999). The Environmental Kuznets Curve: A Survey of The Literature, FEEM Working Paper, No. 85-99.

*Bruyn, S.M., Van Den Bergh, J.M., Opschoor, J.B.* (1998). Economic Growth and Emissions: Reconsidering The Empirical Basis of Environmental Kuznets Curves, Ecological Economics, 25(2), 161-175.

*Carson, R.T., Jeon, Y., McCubbin, D.R.* (1997). The Relationship Between Air Pollution Emissions and Income: US Data, Environment and Development Economics 2, 433-450.

*Christoff, P.* (1996). Ecological Modernisation, Ecological Modernities. Environmental Politics 5(3), 476-500.

*Dasgupta, S., Mody, A., Roy, S., Wheeler, D.R.* (1995). Environmental Regulation and Development: A Cross-Country Empirical Analysis, PRD Working Paper, No. 1448, World Bank.

*Dasgupta, S., Laplante, B., Wang, H., Wheeler, D.* (2002). Confronting the Environmental Kuznets Curve, Journal of Economic Perspectives, 16(1), 147-168.

*Dinda, S.* (2004). Environmental Kuznets Curve Hypothesis: A Survey, Ecological Economics, 49(4), 431-455.

*Galeotti M., Lanza, A.* (1999). Richer and Cleaner? A Study on Carbon Dioxide Emissions in Developing Countries, Proceedings from the 22nd IAEE Annual International Conference, 9-12 June, Roma.

*Grossman, G.M., Krueger, A.B.* (1991). Environmental Impacts of The North American Free Trade Agreement, NBER Working Paper, 3914.

*Grossman, G.M., Krueger, A.B.* (1995). Economic Growth and The Environment. Quarterly Journal of Economics, 110(2), 353-377.

*Hadri, K.* (2000). Testing for Stationarity in Heterogeneous Panels, The Econometrics Journal, 3, 148-161.

*Hill, R.J., Magnani, E.* (2002). An Exploration of The Conceptual and Empirical Basis of The Environmental Kuznets Curve, Australian Economic Papers, 41(2), 239-254.

*Hulton, A.* (2001). Report on Environmental Policy and Sustainable Development, European Parliament, Preparing for the Gothenburg European Council, A5-0171.

*Im, S.K., Pesaran, M.H., Shin, Y.* (2003). Testing for Unit Roots in Heterogeneous Panels, Journal of Econometrics, 115(1), 53-74.

*Intergovernmental Panel on Climate Change* (IPCC) (1997). Greenhouse Gas Inventory Reference Manual, Revised 1996. IPCC Guidelines for National Greenhouse Gas Inventories. OECD, IEA.

*Kuznets, S.* (1955). Economic Growth and Income Inequality, American Economic Review, 45, 1-28

*Levin, A., Lin, C.F.* (2002). Unit Root Tests in Panel Data: New Results, Discussion Papers, 93-56.

*Lucas, R., Wheeler, P., Hettige, H.* (1992). Economic Development, Environmental Regulation and The International Migration of Toxic Industrial Pollution: 1960-1988, P. Low (Ed.), International Trade and the Environment, World Bank Discussion Paper No. 159, Washington, DC.

*Maddala, G.S., Wu, S.* (1999). A Comparative Study of Unit Root Tests With Panel Data and a New Simple Test, Oxford Bulletin of Economics and Statistics, 61, 631-52.

*Ozturk, I., Acaravci, A.* (2010). CO2 Emissions, Energy Consumption and Economic Growth in Turkey, Renewable and Sustainable Energy Reviews, 14(9), 3220-3225.

*Panayotou, T.* (1993). Empirical Tests and Policy Analysis of Environmental Degradation at Different Stages of Economic Development, ILO, Technology and Employment Programme, Geneva.

*Panayotou, T.* (2003). Economic Growth and The Environment. Economic Survey of Europe, No. 2. http://www.unece.org/fileadmin/DAM/ead/sem/sem2003/papers/panayotou.pdf

*Richmond, A.K., Kaufmann, R.K.* (2006). Is there a Turning Point in The Relationship Between Income and Energy Use and/or Carbon Emissions?, Ecological Economics, 56, 176-89.

*Selden, T., Song, D.* (1994). Environmental Quality and Development: is There a Kuznets Curve for Air Pollution Emissions?, Journal of Environmental Economics and Management, 27(2), 147-162.

*Shafik, N., Bandyopadhyay, S.* (1992). Economic Growth and Environmental Quality: Time Series and Cross-Country Evidence, Background Paper for the World Development Report, The World Bank, Washington, DC.

*Suri, V., Chapman, D.* (1998). Economic Growth, Trade and The Environment: Implications for Tthe Environmental Kuznets Curve, Ecological Economics, 25, 195- 208.

*Tisdell, C.* (2001). Globalisation and Sustainability: Environmental Kuznets Curve and The WTO, Ecological Economics, 39(2), 185-196.

*Torras, M., Boyce, J.K.* (1998). Income, inequality, and pollution: a reassessment of the environmental Kuznets Curve, Ecological Economics, 25(2), 147-160.

*Unruh, G., Moomaw, W.* (1998). An alternative analysis of apparent EKC-type transitions, Ecological Economics, 25(2), 221-229.

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