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International Journal of Current Research
Vol. 8, Issue, 11, pp.42554-42560, November, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

VALIDITY TEST OF ENVIRONMENTAL KUZNETS CURVE HYPOTHESIS IN TURKISH ECONOMY: APPLICATION OF ARDL MODEL

[1]Dr. Unzüle Kurt, [2,*]Dr. Zehra Doğan Çalişkan and [3]Ayşen Yılmaz

[1]Dr. Ardahan University, Faculty of Economy and Administrative Sciences
[2] Abant İzzet Baysal University, Gerede Applied Sciences Faculty
[3]Lec. Ardahan University, Faculty of Economy and Administrative Sciences

ARTICLE INFO

Article History:
Received 15th August, 2016
Received in revised form
03rd September, 2016
Accepted 08th October, 2016
Published online 30th November, 2016

Key words:
Environmental Kuznets Curve Hypothesis,
Economic Growth,
ARDL Model.
Jel Code: Q50, Q51, Q53

ABSTRACT

In this study is researched validity of Environmental Kuznets Hypothesis, which investigates the relationship between economic growth and environmental pollution, for the Turkish economy for 1960-2015 periods. The validity of Environmental Kuznets Curve in the relevant period is tested by means of CO_2, GDP, energy consumption, industrial production and service production variables. At the end of the study, the relationship in inverse U-shaped between environmental pollution and economic growth that Environmental Kuznets Curve put forth has been confirmed.

Citation: Dr. Unzüle Kurt, Dr. Zehra Doğan Çalişkan and Ayşen Yılmaz. 2016. "Validity test of environmental Kuznets curve hypothesis in turkish economy: application of ardl model", *International Journal of Current Research*, 8, (11), 42554-42560.

INTRODUCTION

Kuznets (1955) study explains the relationship between economic growth and income distribution. The said relationship shows that income distribution will deteriorate in the beginning as economic growth increases, the deterioration in income distribution will improve in the next process as economic growth reaches a certain level. In Environmental Kuznets Hypothesis as an environmentally adapted form of this relationship between economic growth and income distribution, environmental pollution and ecological deterioration increase at the beginning as economic growth increases, environmental pollution decreases because environmentally friendly applications and products will increase as economic growth reaches a certain level and the level of social prosperity increases. In their study, Grossman and Krueger (1991) who defines this relationship between environmental pollution and per capita income as inverse U-shaped reveal three effects in the said relationship.

Corresponding author: Dr. Zehra Doğan Çalişkan,
Dr. Ardahan University, Faculty of Economy and Administrative Sciences.

Firstly, economic growth trend in the country's economy causes increase in production scale and therefore more natural resource usage and environmental destruction. In this case called scale effect, increase in production scale reflects in nature as more dirty waste output as well as more natural resources usage and environmental damage occurs. In this case, negative effect, a positive relationship is expected between economic growth and environmental pollution. Secondly, the economic growth achieved by the transition of the economy from agricultural production to industrial production increases environmental pollution. In this case called structural effect, a positive relationship is expected to be between economic growth and environmental pollution while focusing on the negative effects of economic growth. Finally, environmental pollution and economic growth interaction that is associated with technological progress takes the shape of a negative relationship and positive effect by product development and production to prevent environmental destruction of economic growth, which is increasing with technological progress. The usage mechanism of three effects described here in explaining of the shape of Environmental Kuznets Curve occurs as follows.

Figure 1 explains the part of Environmental Kuznets Curve with positive slope. Here, environmental pollution increases with the growth of economic growth; this case explains the concept of positive relationship. On the other hand, negative effect in the figure explains the damage of economic growth to the environment. Arrow marks in Figure 1 show the direction of influence. Namely, economic growth causes to increase in production scale, increase in production scale causes to use more natural resources and this case causes to increase in environmental pollution.

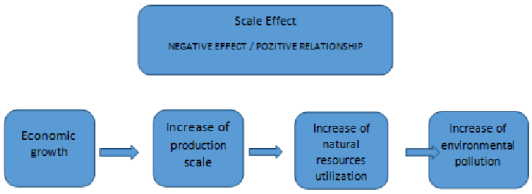


Figure 1. Environmental Kuznets Curve: ScaleEffect

Figure 2 explains the structural effect and transition from positive influence to negative influence in Environmental Kuznets Curve. Concepts of economic growth and production scale, which are associated with the change in production structure in the country, show that economic growth that is provided by the transition from agricultural production to industrial production increases environmental pollution and economic growth that is provided by the transition from industrial production to service production decreases environmental pollution.

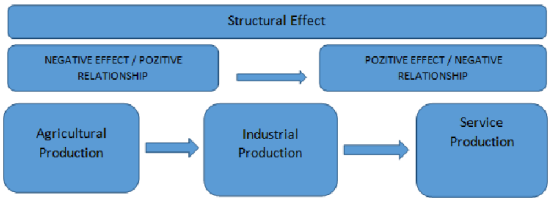


Figure 2. Environmental Kuznets Curve: Structural Effect

Figure 3: explains the part of Environmental Kuznets Curve with negative slope. Factors of information economy, which are increasing in the countries with economic growth due to technological progress, show that economic growth reduces environmental pollution in this process. Negative relationship, positive effect between economic growth and environmental pollution is provided by technological progress, increased production of environmentally friendly products, development of technologies to reduce the amount of environmental waste and making legislation on environmental protection.

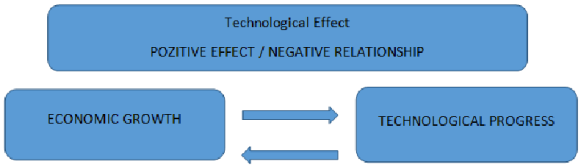


Figure 3. Environmental Kuznets Curve: Technological Effect

In the context of these three effects, economic growth and environmental pollution relationship reveals a Environmental Kuznets Curve in inverse U-shaped. In this study, the existence of this relationship is being investigated for the Turkish economy during the period 1960-2015.

In the study, the change of Environmental Kuznets Curve in inverse U-shaped is discussed by expanding with industrial production and service production variables, which are added within the framework of scale effect and structural effect. The scope of the work expanded with these variables reveals original value in the context of the literature.

Literature Review

Findings, which are obtained as a result of literature review that is focusing on studies using time series analysis, in particular the studies which are examining the relationship between economic growth and environmental pollution for Turkish economy are given in Table 1. In the conducted literature review, it is observed that environmental pollution aspect of Environmental Kuznets Curve is discussed generally with CO2 Carbon dioxide emissions variable and GNP, GDP, Economic growth variables are used as economic growth variables and energy consumption is included in the models as control variable. The results obtained in the context of the literature show that a common judgment about the validity of Environmental Kuznets Curve in Turkish economy could not have been reached. Atıcı and Kurt (2007), Halıcıoğlu (2009), Saatçi and Dumrul (2011), Öztürk and Acaravcı (2015), Çetin and Şener (2014), Özcan (2015), Keskingöz and Karamelikli (2015), Lebe (2016) obtained the result with their studies that Environmental Kuznets Curve is valid in Turkish economy, whereas Omay (2013), Dam and Karakaya (2013), Başar and Temurlenk (2007), Öztürk and Acaravcı (2010), Koçak (2014) obtained the result with their studies that Environmental Kuznets Curve is not valid in Turkish economy.

EmpricialAnalaysis

Method and Data

The hypotheses, which are established to determine co-integration relationship between variables, are as follows (Esen, Yıldırım and Kostakoğlu 2012: 256).

$$H_0: \varepsilon_1 = \varepsilon_2 = \cdots = \varepsilon_k = 0 \rightarrow There\ is\ no\ cointegration$$
$$H_1: \varepsilon_1 \neq \varepsilon_2 \neq \ldots \neq \varepsilon_k \neq 0 \rightarrow There\ is\ cointegration.$$

F tests are compared with asymptotic critical values for testing of hypothesis tests. In the evaluation in which lower and upper limits are determined at significance levels of 1%, 5% and 10%, null hypothesis in which there is no co-integration relationship is accepted if (LOWER VALUE > F) and it is understood that there is no co-integration relationship between variables. Null hypothesis is rejected if (UPPER VALUE < F) and it is understood that there is co-integration relationship between variables. If it is calculated as (LOWER VALUE > F > UPPER VALUE), it is in instability area and no judgment can be made on the presence of co-integration relationship. ARDL model in long term and short term under these hypotheses is formed as follows

$$Y_T = \varphi_0 \sum_{i=1}^{m} \varphi_{1i}\, \Delta Y_{t-i} + \sum_{i=0}^{n} \varphi_{2i}\, \Delta X_{1t-i} + \cdots \sum_{i=0}^{r} \varphi_{ki}\, \Delta X_{kt-i} + u_t$$

$$\Delta Y_T = \varphi_0 \sum_{i=1}^{m} \varphi_{1i}\, \Delta Y_{t-i} + \sum_{i=0}^{n} \varphi_{2i}\, \Delta X_{1t-i} + \cdots \sum_{i=0}^{r} \varphi_{ki}\, \Delta X_{kt-i} + \mu ecm_{t-1} + u_t$$

Table 1. Literatür Review

Author(s)	Period/Country	Methot	Veriables	Environment KuznetsCurveValidity
Atıcı and Kurt (2007)	1968-2000 Turkey	Time Series Analysis	CO_2 GDP percapita Trade Openness İndex AgriculturelTradeOpennessİndex	Supported
Ang (2007)	1960-2000 France	Time Series Analysis	CO_2 Emission GDP percapita EnergyConsumption	Supported
Başar and Temurlenk (2007)	1950-2000 Turkey	Time Series Analysis	CO_2percapita CO_2 fossilfuel CO_2 solidfuel CO_2 fueloil GDP percapita	Not Supported
Halıcıoğlu (2009)	1960-2005 Turkey	Time Series Analysis	CO_2 Income EnergyConsumption Foreigntrade	Supported
Jalil and Mahmud (2009)	1975-2005	Zaman Serisi Analiz	CO_2 Income	Supported
Öztürk and Acaravcı (2010)	1968-2005 Turkey	Time Series Analysis	CO_2 EcononmicGrowth EnergyConsumption	Not Supported
He and Richard (2010)	1948-2004 Canada	Time Series Analysis	CO_2 EconomicGrowth	Not Supported
Fodha and Zaghabud (2010)	1961-2004 Tunusia	Time Series Analysis	CO_2 GDP percapita	Not Supported
Saatçi and Dumrul (2011)	1950-2007 Turkey	Time Series Analysis	CO_2 GDP	Supported
Ahmed and Long (2012)	1971-2008 Pakistan	Time Series Analysis	CO_2 EconomicGrowth EnergyConsumption TradeLiberalization Population	Supported
Shahbaz (2012)	1971-2009 Pakistan	Time Series Analysis	CO_2 GDP percapita EnergyConsumtation TradeOpenness	Supported
Omay (2013)	1980-2009 Turkey	Time Series Analysis	CO_2 EconomicGrowth	Not Supported
Dam and Karakaya (2013)	1960-2010 Turkey	Time Series Analysis	CO_2 percapita GDP percapita	Not Supported
Öztürk and Acaravcı (2013)	1960-2007 Turkey	Time Series Analysis	CO_2 EconomicGrowth EnergyConsumption Financial Development ForeignTrade	Supported
Koçak (2014)	1960-2010 Turkey	Time Series Analysis	CO_2 Income EnergyConsumption	Not Supported
Çetin and Şener (2014)	1980-2010 Turkey	Time Series Analysis	CO_2 EconomicGrowth ForeignTrade	Supported
Jula and Dimitiescu (2015)	1960-2010 Romania	Time Series Analysis	CO_2 GDP percapita	Supported
Keskingöz and Karamelikli (2015)	1960-2011 Turkey	Time Series Analysis	CO_2 EconomicGrowth EnergyConsumption ForeignTrade	Supported
Lebe (2016)	1960-2010 Turkey	Time Series Analysis	CO_2 EconomicGrowth EnergyConsuption TradeOpenness Financial development	Supported

A lagged value of the model where long term relationship is derived is added to short-term model. This reveals how much of an imbalance, which occurs in short term can be eliminated in long term. It is expected that error correction coefficient is significant and has negative sign. This study used. Industry sector's GDP, DSYH2 of industrial production, energy consumption, GDP share in the service sectorshare in GDP and CO_2 emissiondata. The encoding that is used in the analysis of this data and resources located in Table 2.

Preliminary Tests Which Are Used In the Analysis

The first stage in the selection of method for the detection of co-integration relationship between variables is determining the

Table 2. Variables Used In The Analysis

Coding	Variable Name	Source
GSYH	Gross domestic product	World Bank
$GSYH^2$	Square of the gross domestic product	
ENERJİ	Energy Consumption	World Bank
HİZMET	Service Production / GDP	World Bank
SANAYİ	Industrial Production / GDP	World Bank
CO2	Carbon Emission	World Bank

integration degrees of the series. Here, Ziwot Andrews unit root test, which determines the integration degrees of the series ADF and PP unit root tests and structural fractions in series as internally, is used. Results of unit root tests for the variables used in the model are given in table 3 and table 4. According to results of ADF and PP unit root tests given in table 3, GSYH and $GSYH^2$ variables do not include unit root in level values whereas other variables that are used include unit root in level values.

Taking difference operation was applied to the variables, which include unit root, and it is detected that these variables get rid of unit root in the first differences of them and become stable series. It shows the applicability of ARDL model that other series are stable in I(1) first differences in I(0) level values of GSYH and $GSYH^2$ series, which were derived from ADF and PP unit root tests. Because application of ARDL model is not possible if one or some of the series that were used are stable in I(2) level. Since ADF and PP tests do not consider structural fractions in series, Ziwot Andrews unit root test, which determines structural fractions as internally, was applied to series and relevant test results are given in Table 3. It is seen that the obtained results of Ziwot Andrews unit root test and stability level of the series are the same as ADF and PP unit root tests. Here also, GSYH and $GSYH^2$ variables are stable in level values whereas other variables that were used are stable in first differences. In this case, the test results of all three unit root tests show that it is possible to test the relationship

Table 3. Unit Root Test Conclusion

	ADF		PP	
	INTERCEPT	TREND INTERCEPT	INTERCEPT	TREND INTERCEPT
GSYH	7.44*	-7.47*	-7.46*	-7.60
$GSYH^2$	-7.21*	-7.13*	-7.45*	-7.35*
ENERJİ	0.11	-2.94	0.48	-3.04
DENERJİ	-7.35*	-7.30*	-7.82*	-7.84*
CO2	-0.93	-2.95	-0.89	-2.95
DCO2	-5.96*	-5.85*	-6.72*	-6.51*
SANAYİ	-1.63	-3.71*	-1.81	-3.90*
DSANAYİ	-5.12*	-4.90*	-4.83*	-5.02*
HİZMET	-0.23	-2.96	-5.73*	-5.78*
DHİZMET	-5.73*	-5.78*	-5.72*	5.77*

*: 0.01 significance level.

Table 4. Ziwot Andrews unitroot test conclusion

Variables	I(0)	I(1)	Break Point
CO2	-1.46	-8.15*	2002/2007
GSYH	-7.98*		2009
$GSYH^2$	-7.67*		1976
SANAYİ	-2.35	-9.04*	1978/1986
HİZMET	-2.54	-9.66	1998

*: 0.01 significance level.

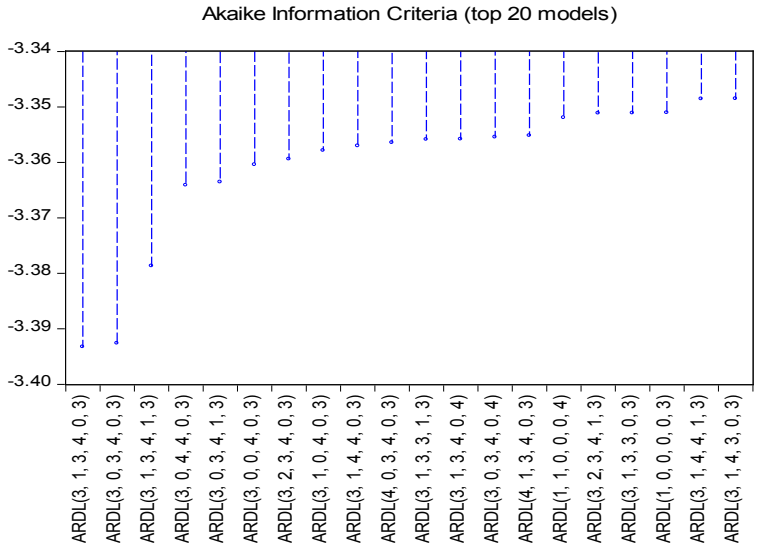


Figure 4. Determination of the length of the lag

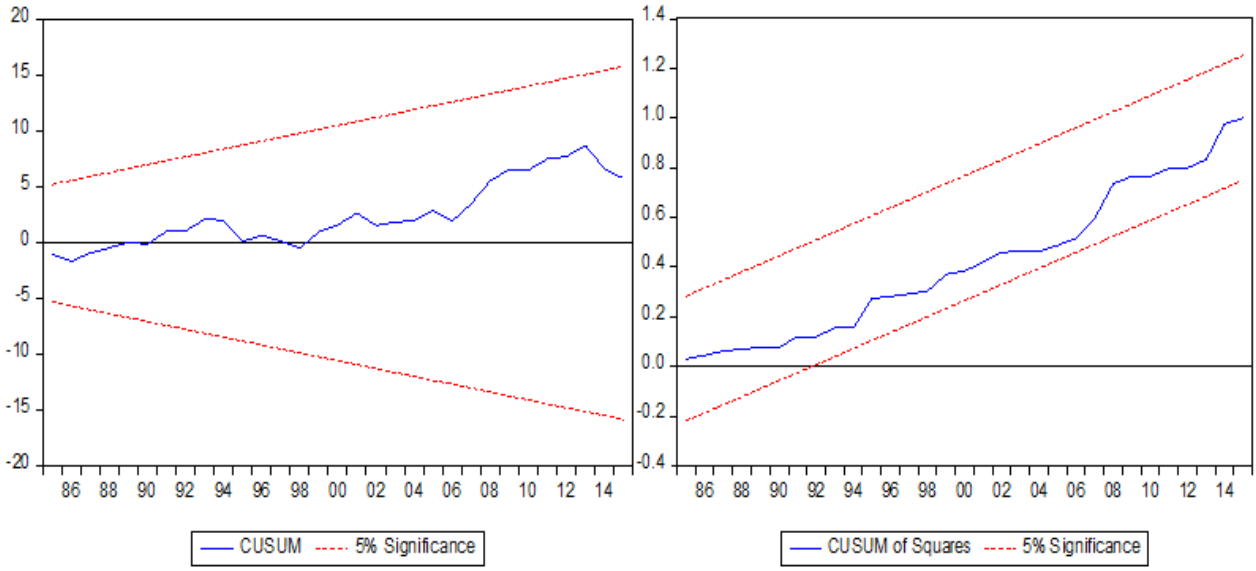
Table 5. ARDL (3,1,4,0,3,) ModelBounds test conlusions

AIC Criteria Model	(3,1,4,0,3)		
F Statistic	5.09		
	Critical Value		
Significiance	%1	%5	%10
Critical Value I(0)	3.5	2.81	2.49
Critical Value I(1)	4.63	3.76	3.38
Diagnostic Test Results			
R^2	0.94		
Adjustmented R^2	0.91		
Breusch- Pegan- Goldfrey Test	1.33		
RamseyReset Test	1.96		
Jague Bera Normalitiy Test	1.03		
Durbin Watson Test	2.10		
F Statistic Value	27.06		

Table 6. Long run conclusion

Variable	Coefficient	t-Statistic	Prob.
ENERJI	0.002734	12.857045*	0.0000
$GSYH^2$	-0.001665	-1.909903***	0.0654
GSYH	0.015212	1.793711***	0.0826
HIZMET	-0.001544	-0.436151	0.6657
SANAYI	0.012010	4.717778*	0.0000

*:0.01, ***:0.10 significancelevel.



Graph 5. CUSUM ve CUSUM Q Test Conclusions

Table 7. Cointegration Model Conclusions

Variable	Coefficient	t-Statistic	Prob.
D(ENERJI)	0.003075	15.458872*	0.0000
$D(GSYH^2)$	-0.000446	-1.769278***	0.0867
$D(GSYH^2(-1))$	0.000527	1.578140	0.1247
$D(GSYH^2(-2))$	0.000624	2.547202**	0.0160
D(GSYH)	0.005450	2.224496**	0.0335
D(GSYH(-1))	-0.005016	-1.572126	0.1261
D(GSYH(-2))	-0.009103	-3.889259*	0.0005
D(GSYH(-3))	-0.002514	-1.926661***	0.0632
D(HIZMET)	0.002398	0.515058	0.6102
D(SANAYI)	0.009650	2.086272**	0.0453
D(SANAYI(-1))	-0.009496	-2.431514**	0.0210
D(SANAYI(-2))	-0.010134	-2.452031**	0.0200
CointEq(-1)	-0.884643	-5.980576*	0.0000

*:0.01, **:0.05,***:0.10 significance level

between series with ARDL model. Variables in the determination of the cointegration relationship between ARDL model estimated for these cond prerequisite is identifying the appropriate lag. The length of the lag in the identification, within the framework of the AIC information criterion is located in Figure 4. In selecting the appropriate delay length model considering the AIC information criterion among 20 created the smallest model, the statistical value as ARDL (3,1,3,4,0,3) selecting the model.

ARDL Model Conclusions

In the selected ARDL (3,1,4,0,3) model, the existence of a long-term relationship between variables is researched with the help of bound testing. The results of boundary testing are shown in Table 5. According to obtained results of boundary testing, F statistical value was calculated as 5.09. Since this value is greater than the upper critical values at 0.01-0.05 and 0.10 significance levels in the table, absence hypothesis, which is based on that there is no co-integration relationship between variables, is rejected. In this case, it is understood that variables used in analysis are in relationship in long term. In addition to co-integration relationship that is detected in the model, a number of diagnostic tests have been performed for the detection of problems in the model. Firstly, R^2 and adjusted R^2values are calculated as 0.94 and 0.91 respectively in the estimated model and this shows that explanatory power of dependent variable by the dependent variables is high. Secondly, Durbin Watson test statistic, which considers the test of autocorrelation problem in the model, also shows that there is no autocorrelation problem in the model. Thirdly, the value of Jaque Bera test statistic is calculated as 1.03 and this shows that there is no normal distribution problem in the model and in ongoing diagnostic tests, Ramsey Reset test results explains that there is no specification problem in the model. Also, F statistical value calculated as 27.06 shows that the model is statistically significant totally.

Long-term model, which is estimated to be able to comment about the direction of the said relationships, of coefficients of variables between which a co-integration relationship is detected is in Table 6. When long term coefficients are evaluated, it was found compatible with the inverse U sign of Environmental Kuznets Curve that the coefficient of GDP variable is statistically significant and its sign is positive and the coefficient of GDP^2 variable is statistically significant and its sign is positive. In other words, national income increase increases environmental pollution at the beginning and income increase decreases environmental pollution after the national income reaches a certain point. In addition to this, energy consumption and industrial production growth in the long-term increases environmental pollution in the relevant period. The coefficient of service production variable is statistically insignificant however when evaluated in the context of its sign the development in the service sector decreases environmental pollution. This situation supports scale effect and composition effect approaches of Environmental Kuznets Hypothesis. In scale effect, development of industrial sector in the country increases environmental pollution. In composition effect, enhancing impact of economic development on environmental pollution disappears with the development of service sector.
In the period covered by the model, CUSUM and CUSUM Q test results, which are applied to determine the stability of error terms, are shown in figure 5. If CUSUM and CUSUM Q test statistics are within the limits of 5% significance level, it is understood that the error terms in the model are stable.

In this case, it is understood that there is no structural break in graphics as the model is within limits and long-term relationships estimated in model are stable. At the point of eliminating long-term imbalances, the results of error correcting model that put forths short-term causal relationships between variables are shown in Table 7. The results obtained in the error correction model are compatible with long-term model results. Here, error correction coefficient that is calculated as the criterion for evaluation of the model should be statistically significant and with negative sign. Based on this criterion, error correction coefficient in the model is calculated as -0.88 and it was determined as statistically significant. In this case, about 88% of long-term imbalances occurred in the model are resolved in the short term. Imbalance occurred in the long-term reaches to a balance quickly by the calculated coefficient.

Conclusion

As the environmentally adapted form of Kuznets hypothesis which was put forward to examine the relationship between economic growth and income distribution of countries, Environmental Kuznets Curve shows that growth of economic growth increases environmental pollution at the beginning and this effect changes in the way of decreasing environmental pollution with the income reaching a certain level in the country. In the study, the validity of Environmental Kuznets Curve for Turkish economy is researched for the period 1960-2015. In the context of literature review, CO2 emissions are used as an indicator of environmental pollution and GDP figures are used to represent income in the study. At the point of contribution by aparting from the literature within the scope of the analysis, industrial production and service production variables within the framework of scale and structural effect as the two functions of the Environmental Kuznets Hypothesis are used as control variables. The aim here is to reveal the effects of increases in industrial production on environmental pollution on one hand and to determine the mitigating effects of environmental pollution with the transition from industrial production to service production on the other hand. These factors reveal the original value of the study.

According to the econometric analysis results that ARDL model is used, F statistical value reached by bounding testing shows the existence of the co-integration relationship between the variables. In this case, it is understood that the variables used in the analysis are in relationship in long-term. At the same time, the long term coefficients that are obtained and signs of coefficients reached by error correction model support the validity of Environmental Kuznets Curve. In this context, positive relationship determined between GDP and CO2 shows the process that economic growth increases environmental pollution, negative relationship determined between GDP^2 and CO2 shows the process that economic growth decreases environmental pollution. This situation supports the general proposal that economic growth increases environmental pollution to a certain level of income increase and economic growth decreases environmental pollution after the income reaches a certain level. Besides, while positive relationship between industrial production index and CO2 emissions supports scale effect function, which is developed in the direction that increase in industrial production increases environmental pollution, negative relationship between service sector and CO2 supports structural effect function which shows that environmental pollution decreases with the transition from industrial production to service production so

with the development of the service sector in the country. In the context of obtained results, it is shown that increases in industrial production increases environmental pollution and this effect is removed with the income reaching a certain level. Effects of income increase on environmental pollution decrease are proposed to emerge with social consciousness, increase in the demand for eco-friendly products, improvements in service and technological progress. Then, they have been identified as important points to develop social consciousness and sensitivity at the point of decrease and remove of environmental damage that is emerging with industrialization and economic growth, to take institutional measures in this direction in legal framework, to ensure the support of environmentally friendly production by organizing increase in industrial production within the framework of environmental policies.

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