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Relationships among CO_2 Emissions, Economic Growth and Foreign Direct Investment and the Environmental Kuznets Curve Hypothesis in Turkey

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ABSTRACT

This study examines the causal relationships between economic growth, carbon dioxide emission and foreign direct investment (FDI) and evaluates the environmental kuznets curve (EKC) hypothesis for Turkey in 1974-2011. Firstly, the causality relationships investigated by using the Johansen Cointegration test, The Granger Causality Test, Impulse-Response and Variance Decomposition Analysis of vector autoregression model (VAR) model. The causality relationships display that FDI (LFDI) and economic growth (LGDP) have a significant effect on carbon dioxide emissions (LCO_2). Moreover, impulse-response functions and variance-decompositions of VAR model support these relationships among LGDP, LCO_2 and LFDI. Secondly, the study investigates the validity of the EKC hypothesis in Turkey for the period 1974-2011 by using regression model approach for the various EKC model forms such as linear, quadratic, and cubic. Consequently, economic growth leads to degradation of environment and depletion of natural resources. It must be the major aim to obtain a sustainable economic growth by less CO_2 emissions and consuming less energy. Moreover, the policy makers may take account exogenous impacts such as foreign investments to plan energy policies, and to maintain economic growth against global climate warming.

Keywords: CO_2 Emission, Economic Growth, Environmental Kuznets Curve Hypothesis, Granger Causality, Johansen Cointeration, Impulse-Response
JEL Classifications: C58, C51, Q43, Q56

1. INTRODUCTION

Environmental pollution and protecting the environment have been one of the most global issues which have the priority in international political agenda. According to the Kyoto Protocol, countries have taken precautions to preserve the environment. The Kyoto protocol adapted in 1997 contains an international strategy to restrict greenhouse gas emissions. The protocol's main aid is to succeed the reduction in the emissions of greenhouse gases by establishing quantified limitation and reduction obligations to the Organization for Economic Cooperation and Development (OECD) member States and East European countries. Increasing concentrations of greenhouse gases in the world is accepted as a significant factor affected changing of the climate conditions. Because, a small changing in the climate conditions may cause economic losses and natural disasters. Greenhouse gas emission reduction affects various sectors in the world economy, such as energy sectors, transport, production processes and industry. Increasing economic activity of countries represents the level of energy consumption and carbon dioxide (CO_2) emissions (Kuo et al., 2014; Stern, 2004; Lieb, 2002). In the 1980s, environmental issues such as global warming, descending biodiversity and ozone layer depletion led to debates about the effects of environmental degradation on economic growth of the World's countries. Therefore, there has been a need to clarify the relationships among economic growth, environmental pollution and other factors.

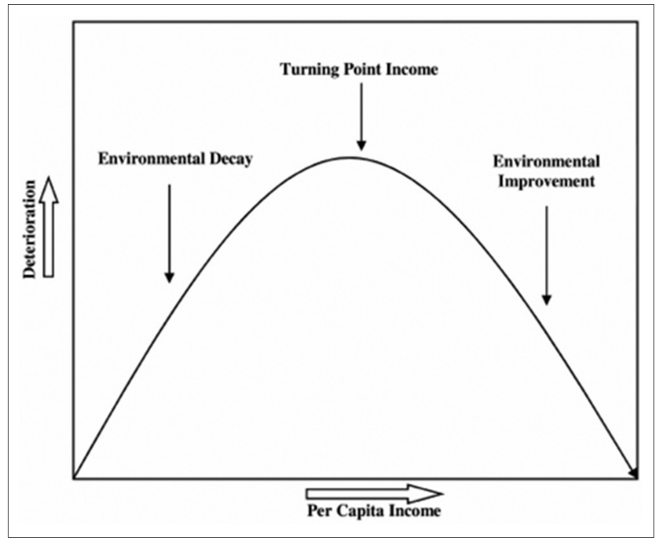
The primary aim of this study is to reexamine the causality relationships between foreign direct investment (FDI), economic growth and carbon dioxide emission (CO_2) by using Johansen Cointegration Test, the vector autoregression model (VAR) or vector error correction (VEC) model, Granger Causality Test of VAR or VEC model, Impulse-Response Functions and Variance Decompositions of the model. Secondly, the study aims to test the

EKC hypothesis by using OLS Regression Model approach for Turkey for the period of 1974-2011.

2. THEORY AND LITERATURE REVIEW

Most empirical studies are related to testing of hypothesis namely the EKC. The EKC hypothesis was introduced by Grossman and Krueger's (1991) study on environmental effects of the North American Free Trade Aggrement (NAFTA) in 1990s, and 1992 World Bank Report. According to the EKC hypothesis, environmental quality or emissions of pollutants are related to economic growth. The EKC hypothesis supports that at the beginning of economic development of the country, environmental degradation will increase until a specific income level "turning point" is reached, and environmental quality will begin to improve as growing income (Selden and Song, 1994). After the turning point, environmental quality indicators begin to indicate decreases in pollution and environmental degradation. This relationship in some cases means that the environmental impact indicator is an inverted U-shaped curve of income per capita (Lieb, 2002; Stern, 2004; Selden and Song, 1994; Kuo et al. 2014). A generalized EKC is plotted in Figure 1 (Yandle, 2002).

Figure 1: The environmental kuznets curve



From Figure 1, the EKC hypothesis actually summarizes an essentially dynamic process of change, as income of an economy increases over time, firstly, emission levels increase, reaches a peak point and then starts decreasing after a threshold level (turning point) of income (Dinda, 2004). The EKC hypothesis analysis used in the literature is identified by various forms such as linear (1) quadratic (2) and cubic (3) as the follow:

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \varepsilon_{it} \quad , \text{i=1,2,…N} \qquad (1)$$

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 X_{it}^2 + \varepsilon_{it} \quad , \text{i=1,2,…N} \qquad (2)$$

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 X_{it}^2 + \beta_3 X_{it}^3 + \varepsilon_{it} \quad , \text{i=1,2,…N} \qquad (3)$$

where;
i=1, 2,…N, countries
t=1,…T, time
Y_{it}=CO_2 emissions per capita
β_0=Estimated parameters
X_{it}=GDP per capita
ε_{it}=Error term

The values of the parameters, if the EKC hypothesis is valid, should be, for β_1 and β_3 positive and for β_2 negative. The squared term in model indicates the U-shape behaviour while the cubic term of model explains monotonically rising pollution (N-curves turn). If the cubic term (β_3) is insignificant, it can be removed from model (3). If quadratic term (β_2) is also not significant in quadratic model (2), model will returns linear form (1). In brief, cubic form produces various results such as a monotonically increasing or decreasing pollution-income relationship, an inverted U-shape (i.e., the EKC), a U-shape, a N-shape (first rising, then falling, and finally rising again), an inverted N-shape or an insignificant (i.e., flat pollution-income relationship) (Lieb, 2002; Stern, 2004).

If β_1 is negative and statistically significant but β_2 is statistically insignificant, there are indicators that display an certain improvement with rising per capita income. If β_1 is positive and statistically significant but β_2 is statistically insignificant, these are indicators that indicate an certain deterioration as incomes increase. These consist per capita carbon dioxide emissions (CO_2). It is possible that these indicators will show the EKC but at much higher per capita turning points. In addition, If β_1 is positive and statistically significant and β_2 is negative and statistically, the estimated EKC has a maximum turning point per capita income level calculated by $Y^* = (-\beta_1/2\beta_2)$ (Neumayer, 2003; Neumayer, 2004).

On the other hand, FDI is considered as an important driving force of economic development for countries. In recent years, FDI inflows have raised questions such as if there is a causal relationship between FDI, economic growth and environmental deterioration. Therefore, several studies have implemented on the relationships among FDI, economic growth, energy intensity and CO_2 emissions, and testing of the EKC hypothesis, estimate of the EKC. For example, Saidi and Hammami (2015) examined the impact of economic growth and CO_2 emissions on energy consumption for a global panel of 58 countries using dynamic panel data model estimated by means of the generalized method of moments (GMM) for the period 1990-2012. They found that significant positive impact of CO_2 emissions on energy consumption. Leitao (2014) investigated the correlation between economic growth, carbon dioxide emissions, renewable energy and globalization for the period 1970-2010 by using time series methods (OLS, GMM, Unit Root Test, VEC model and Granger causality) for Portuguese economy. He found that carbondioxide emissions and renewable energy are positively correlated with economic growth. Moghadam and Lotfalipour (2014) investigated the impact of financial development on environmental quality in Iran by using the auto regression model distributed lag over the period from 1970 to 2011, and they examined short-term and long-term relationships among the variables. They found that financial development accelerated the degradation of the environment. Omri et al. (2014) investigated the causality relationships between CO_2 emissions, FDI, and economic growth using dynamic simultaneous-equation panel data models for a global panel of 54 countries over the period 1990-2011. They showed that there was an evidence of bidirectional causality between FDI inflows and economic growth for all countries and between FDI and CO_2 for all the panels, except Europe and North Asia. They also indicated that there was unidirectional causality relationship from CO_2 emissions to economic growth, with the exception of the Middle East, North Africa, and sub-Sahara panel. Shaari et al. (2014) examined the effects of FDI and economic growth on CO_2 emission by using panel data analysis by data the period of 1992 to 2012 from 15 developing countries. They showed a cointegration relationship between variables, and found that FDI didn't has any effect on CO_2 emissions. Sahinoz and Fotourehchi (2014) investigated the relationship between FDI in Turkey and CO_2 emissions for the voladility of pollution haven hypothesis between 1974 and 2011.

Chen and Huang (2013) examined the relationship between carbon dioxide (CO_2) emission per capita and economic growth in Next Eleven (N-11) over the period 1981-2009 by using panel unit roots, cointegration in heterogeneous panels and panel causality tests. They presented that there were positive long-run relationship among CO_2 emissions, electric power consumption, energy use and GDP, and there was a bi-directional causality between CO_2 emission and electric power consumption. Ozturk et al. (2013) examined short-run and long-run relationship and causality between energy consumption and economic growth for the period 1960-2006 in Turkey. They employed Johansen and Juselius cointegration methods and VEC model (VECM). The findings of study indicated that there was not short-term causality relationship between energy consumption and GDP, and there was an unidirectional long-run causality from per capita GDP to per capita energy consumption. Ozturk and Acaravci (2013) investigated the causal relationships between financial development trade, economic growth, energy consumption and carbon emissions in Turkey for 1960-2007 period. They indicated that an increase in foreign trade to GDP result, an increase in per capita carbon emissions and financial development variable has no significant effect on per capita carbon emissions in the long-run. Shahbaz et al. (2013) investigated relationships between CO_2 emissions, energy intensity, economic growth and globalization for the period of 1970-2010 in Turkey. They used unit root test and cointegration approach in the presence of structural breaks. They displayed that there was a cointegration relationship between the series, and energy intensity and economic growth increased CO_2 emissions. Farhani and Rejeb (2012) examined the relationships between EC, GDP and CO_2 emissions for 15 Mena countries by using the panel unit root tests, panel cointegration methods and panel causality test covering the annual period 1973-2008. They found that there was no causality relationship between GDP and EC; and between CO_2 emissions and EC in the short run. However, in the long run, there was a unidirectional causality relationship from GDP and CO_2 emissions to EC. Ozturk and Uddin (2012) investigate the long-run Granger causality relationship between energy consumption, carbon dioxide emission and economic growth in India over the period 1971-2007. The most important result is that there is feedback causal relationship between energy consumption and economic growth in India which implies that the level of economic activity and energy consumption mutually influence each other; a high level of economic growth leads to a high level of energy consumption and *vice versa*. The value of the error correction term confirms the expected convergence process in the long-run for carbon emissions and growth in India which implies that emission reduction policies will hurt economic growth in India if there are no supplementary policies which seek to modify this causal relationship.

Kaplan et al. (2011) examined the causal relationship between energy consumption and economic growth in Turkey for the period 1971-2006. They used demand model and production model based on vector error correction model. The study indicated that energy consumption and economic growth had a cointegration relationship and there was bidirectional causality relationship between energy consumption and economic growth. Kim et al. (2010) considered the linkage between carbon dioxide emissions and economic growth in Korea. They presented that the causality relationship between carbon dioxide and growth by using Granger Causality test. Choi et al. (2010) investigated the debates over the excistence of the EKC, and used VAR/VECM models for the period 1971-2006 in China, Korea and Japan. They found that Korea, China and Japan showed very different EKC results. Ozturk and Acaravcı (2010) investigated causal relationships between economic growth, carbon emissions, energy consumption and employment ratio in Turkey. They used autoregressive distributed lag bounds testing of cointegration for the period 1968-2005, and presented an evidence of a long-term cointegration relationship between variables. Akbostancı et al. (2009) investigated the relationship between environmental quality and income for Turkey in 1968-2003 at two levels by using cointegration techniques and PM10 and SO2 measurements in Turkish provinces. They showed that the results of time series and panel data analyses do not support the EKC hypothesis. Soytas and Sarı (2009) investigated the long term granger causality relationship between economic growth, carbon dioxide emissions and energy consumption in Turkey. They found that the lack of a long term causal relationship between income and emissions could be implying that to reduce carbon emissions. Halicioglu (2008) examined empirically dynamic causality relationships between carbon emissions, energy consumption, income, and foreign trade in Turkey by using the time series data for the period 1960-2005. The study indicated that income was the most significant variable in explaining the carbon emissions in Turkey which is followed by energy consumption and foreign trade.

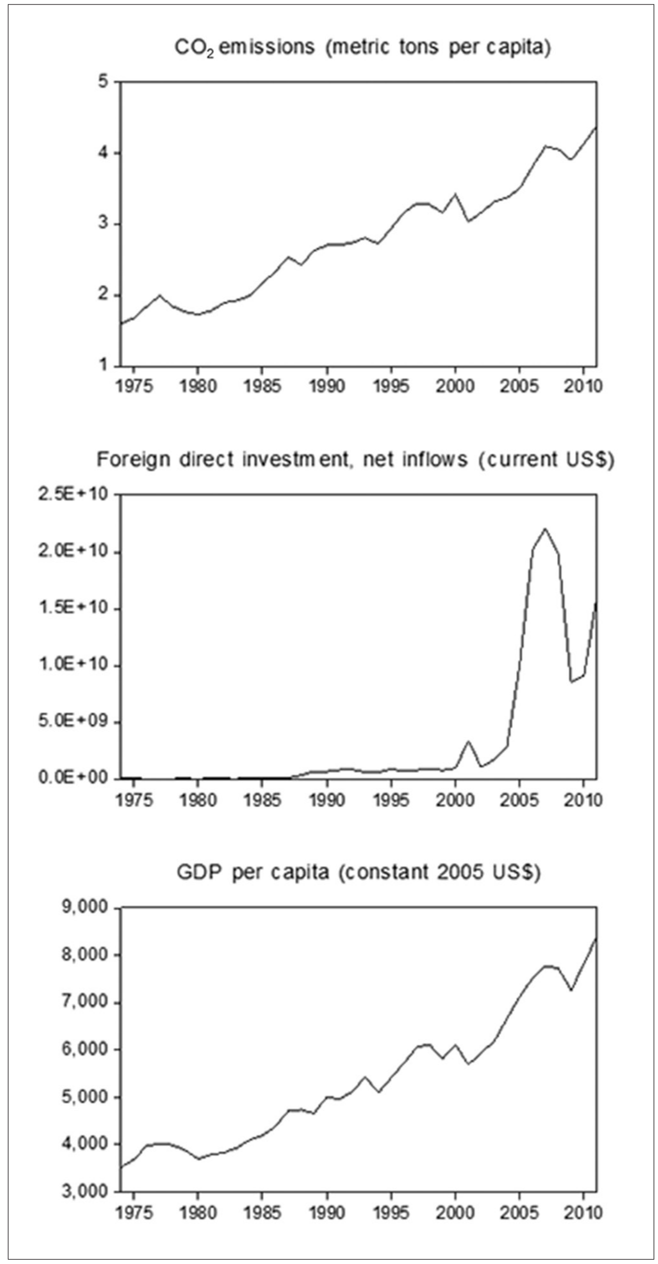
Mazzanti et al. (2006) presented new empirical evidence on trends concerning emission-related indicators in Italy. They investigated the related EKC literature critically. They used two panel datasets concerning (a) 1990-2000 emissions at province level (b) and sectoral disaggregated NAMEA emissions sources over 1990-2001 in analysis. The findings of study displayed mixed evidence in support of the EKC hypothesis. They found that it doesn't exist an EKC dynamic, but many EKC dynamics, differing by period of observation, country/area, emissions/environmental pressures, sectors. Lieb (2002) presented the empirical evidence about that economic growth had been promoted as a method of improving the environment. Selden and Song (1994) investigated EKCs for four emissions series: SO_2, CO_2 etc. They showed that the turning point for emissions was to be higher than that for ambient concentrations. Grossman and Krueger (1991) estimated EKCs for SO_2 dark matter (fine smoke), and suspended particles using the GEMS data set. They found that the turning points for sulfur oxide (SO_2) and dark matter were at around \$4000-5000.

3. EMPIRICAL ANALYSIS

3.1. Preliminary Analysis of Data

This study considers time series data set of The World Bank Database. The yearly data consists of FDI, GDP per capita used as a proxy of economic growth and CO_2 emissions (metric tons per capita) for the sample period from 1974 to 2011. All variables were transformed into logarithms namely LCO_2, LFDI and LGDP. All empirical tests had been carried out by using the Eviews-8. The time series of CO_2, FDI and GDP are presented in Figure 2.

Figure 2: CO_2 emissions, foreign direct investment and GDP



From Figure 2, it has been seen that all variables are nonstationary. Stationary series can be described as one series with a constant mean, constant variance and constant autocovariance for each lag during time[1]. The augmented dickey fuller (ADF) Test, Phillips-Perron (PP) Test and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test are used to determine the stationary of time series of LCO_2, LFDI, LGDP. Table 1 presents the results of the ADF test, PP test and KPSS test.

According to Table 1, the results of the stationary tests indicate that all variables are stationary at first level in ADF, PP and KPSS tests. In other words, all variables are integrated of order one I (1).

3.2. The Johansen Cointegration Test, the Granger Causality Test of the VAR/VEC Model, Impulse-Response Functions and Variance-Decompositions

Because the variables are integrated with order I (1), it is tested whether there is a long term relationship among these variables by using the Johansen Cointegration test. If cointegration relationship exists among LCO_2, LFDI and LGDP, VECM approach will be used to determine long term relationships among variables. Since the results of the Johansen cointegration analysis depend on the lags of the model, prior to the cointegration test, the lag order selection criteria for standard VAR are presented in Table 2. According to Table 2, one lag lenght is more appropriate for the model.

In the VEC model, all variables are endogenous, and the equation of VECM system is specified as follows:

$$Y = \varphi(L)Y_t + Y_t^{/}\delta + \varepsilon_t \qquad (1)$$

where, Y=(CO_{2t}, FDI_t, GDP_t), φ(L) is the coefficient matrices for lag operators L, and δ is the cointegrating vectors capturing the long-run relationships among the variables in the system. In addition, the results of the Johansen Cointegration Analysis with one lag order are indicated in Table 3.

From Table 3, the results display the rejection of null hypothesis that there isn't any cointegration relationship between variables, and there is only a cointegration equation according to trace and maximum eigenvalue statistics at 5% significant level.

According to the results of VEC (1) Granger Causality in Table 4, there does not exist any causality relationship between LCO_2, LFDI and LGDP. Carbondioxide emissions, FDI and economic growth are not related in long term. Furthermore, VAR Granger Causality Test is applied also, and the results are displayed in Table 5.

From Table 5; it can be said that there is bidirectional causality relationship from FDI (LFDI) to carbon emissions (CO_2) at 5%

1 After being differentiated once is said to be integrated of order 1. It has been showed by I (1). In Table 1, variables integrated of order I (1) are presented by D (.).

Table 1: The results of unit root tests

Tests	LCO_2	$DLCO_2$	LFDI	DLFDI	LGDP	DLGDP
ADF	–0.623087	–5.839374*	–0.755011	–8.637102*	0.093386	–5.857395*
PP	–0.549143	–6.080549*	–0.222207	–9.399018*	0.295239	–5.854142*
KPSS	0.733171	0.081123*	0.697916	0.354492*	0.734588	0.080526*

*Indicates the refusal of unit root null hypothesis in the significance level at %5. (McKinnon critical value is [–2.943427], Kwiatkowski critical value is [0.463000]), ADF: Augmented dickey fuller, PP: Phillips-Perron, KPSS: Kwiatkowski-Phillips-Schmidt-Shin, LCO_2: Carbon dioxide emissions, FDI: Foreign direct investment, GDP: Gross domestic product

Table 2: The results of unit root tests

Lag	LogL	LR	FPE	AIC	SC	HQ
0	27.36402	NA	4.99e-05	–1.392230	–1.258914	–1.346209
1	107.5922	142.1184*	8.54e-07*	–5.462410*	–4.929148*	–5.278328*
2	110.8422	5.200052	1.20e-06	–5.133841	–4.200632	–4.811697
3	112.3751	2.189841	1.90e-06	–4.707149	–3.373993	–4.246943

*Indicates lag order selected by the criterion, LR: Sequential modified LR test statistic (each test at 5% level), FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion

Table 3: The results of Johansen cointegration test

Hypothesis		Variables: LCO_2, LFDI, LGDP			
Null	Alternative	Eigenvalue	Trace statistic	Critical value 5%	p-value
r=0	r=1	0.435306	29.62094*	24.27596	0.0097
r≤1	r≥2	0.192720	9.047993	12.32090	0.1663
r≤2	r≥3	0.036563	1.340953	4.129906	0.2887
r=0	r=1	0.435306	20.57294*	17.79730	0.0186
r≤1	r≥2	0.192720	7.707039	11.22480	0.1941
r≤2	r≥3	0.036563	1.340953	4.129906	0.2887

*r value indicates the number of cointegrating vectors. (*) indicates rejection at the 5% critical value, LCO_2: Carbon dioxide emissions, FDI: Foreign direct investment, GDP: Gross domestic product

Table 4: VEC granger causality/block exogeneity wald tests

Excluded	Chi-square	df	Probability
Dependent variable: D (LCO_2)			
D (LFDI)	2.184325	1	0.1394
D (LGDP)	0.230166	1	0.6314
All	2.212405	2	0.3308
Dependent variable: D (LFDI)			
D (LCO_2)	0.069318	1	0.7923
D (LGDP)	0.150732	1	0.6978
All	0.151145	2	0.9272
Dependent variable: D (LGDP)			
D (LCO_2)	1.766753	1	0.1838
D (LFDI)	0.316883	1	0.5735
All	2.382403	2	0.3039

VEC: Vector error correction, LCO_2: Carbon dioxide emissions, FDI: Foreign direct investment, GDP: Gross domestic product

Table 5: VAR granger causality/block exogeneity wald tests

Excluded	Chi-square	df	Probability
Dependent variable: LCO_2			
LFDI	4.223234	1	0.0399
LGDP	2.979391	1	0.0843
All	6.731664	2	0.0345
Dependent variable: LFDI			
LCO_2	14.78222	1	0.0001
LGDP	15.67529	1	0.0001
All	17.18603	2	0.0002
Dependent variable: LGDP			
LCO_2	0.824190	1	0.3640
LFDI	1.242881	1	0.2649
All	1.263442	2	0.5317

VAR: Vector autoregression model, LCO_2: Carbon dioxide emissions, FDI: Foreign direct investment, GDP: Gross domestic product

significant level. Similarly, there is a unidirectional causality relationship from LGDP to LCO_2. The causality relationships displays that FDI (LFDI) and economic growth (LGDP) have a significant effect on carbon dioxide emissions (LCO_2). In addition, both LCO_2 and LGDP have a significant causal effect on LFDI at 5% significant level. However, both FDI (LFDI) and carbon dioxide emissions (LCO_2) do not have any causal effect on economic growth (LGDP).

Accordingly, the impulse-response functions of impact of variables by one standard deviation shock on each other are plotted for ten quarter horizon in Figure 3 for VAR (1) model.

The impulse-response functions of impact of variables by one standard deviation shock on each other are plotted for ten quarter horizon in Figure 3 for VAR (1) model. It can be seen from these figures that one standard deviation shock in FDI (LFDI) has a positive significant impact on carbon dioxide emission (LCO_2), and that one standard deviation shock in economic growth (LGDP) has a negative minor effect on carbon dioxide emission (LCO_2). Moreover, one standard deviation shock in economic growth (LGDP) and carbon dioxide emission (LCO_2) have a positive significant effect on FDI (LFDI).

Furthermore, the variance decomposition results of VAR (1) model are presented in Table 6.

According to Table 6, the variance decomposition results indicate %100 of LCO_2 variance can be expained by current LCO_2 in the first period, and the percentage is continuing at the end of the tenth periods by 84.16%. At the end of the tenth periods, FDI (LFDI) and economic growth (LGDP) affect the variation in the forecast error of carbon emissions (LCO_2) by 15.80% and 0.03% respectively.

The variance decompositions of FDI at the end of the tenth periods display that 49.87% of LFDI variance can be explained by current LFDI. In addition LCO_2 significantly contributes by 48.77% to variance of LFDI. However, the contribution of LGDP to LFDI variance is only 1.36% level.

Furthermore, the variance decompositions of economic growth (LGDP) present that 44.71% of the forecast error variance of

Figure 3: (a and b) The impulse-response functions of vector autoregression (1) model

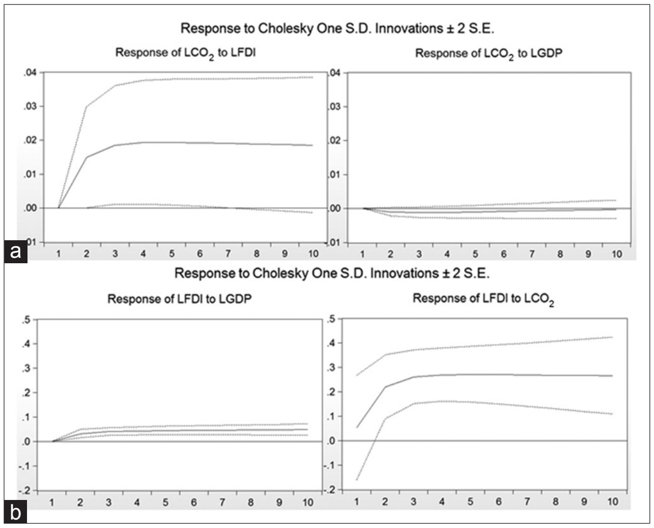


Table 6: The variance decompositions of VAR (1) model

Period	SE	LCO_2	LFDI	LGDP
Variance decomposition of LCO_2				
1	0.049812	100.0000	0.000000	0.000000
2	0.067372	95.06175	4.914045	0.024200
3	0.080913	91.29985	8.661361	0.038790
4	0.092300	88.92124	11.03400	0.044763
5	0.102252	87.37725	12.57668	0.046072
6	0.111156	86.31758	13.63741	0.045003
7	0.119250	85.55172	14.40553	0.042753
8	0.126694	84.97439	14.98564	0.039971
9	0.133599	84.52444	15.43853	0.037033
10	0.140049	84.16432	15.80152	0.034167
Variance decomposition of LFDI				
1	0.651444	0.667665	99.33233	0.000000
2	0.736822	9.418898	90.39904	0.182067
3	0.799867	18.61078	80.98436	0.404859
4	0.856808	26.14138	73.25572	0.602897
5	0.909618	32.08342	67.14539	0.771188
6	0.959077	36.81708	62.26700	0.915917
7	1.005704	40.65849	58.29836	1.043154
8	1.049892	43.83291	55.00969	1.157402
9	1.091949	46.49817	52.23999	1.261850
10	1.132125	48.76651	49.87472	1.358776
Variance decomposition of LGDP				
1	0.044006	53.02676	0.428369	46.54487
2	0.061442	50.17797	2.887877	46.93416
3	0.075042	48.69788	4.490782	46.81134
4	0.086702	47.94562	5.490560	46.56382
5	0.097135	47.57014	6.154891	46.27496
6	0.106705	47.40127	6.629428	45.96930
7	0.115628	47.35372	6.989880	45.65640
8	0.124045	47.38191	7.277282	45.34081
9	0.132055	47.45977	7.515243	45.02499
10	0.139727	47.57142	7.718161	44.71042

SE: Standard error, VAR: Vector auto regression, LCO_2: Carbon dioxide emissions, FDI: Foreign direct investment, GDP: Gross domestic product

economic growth (LGDP) is explained by current economic growth (LGDP) at the end of the tenth periods. In addition, LCO_2 and LFDI contribute at 47.57% and 7.72% levels for variance of economic growth (LGDP) respectively.

3.3. Statistical Model Estimation for Testing of the EKC Hypothesis

As mentioned earlier, the EKC hypothesis explains an inverted U-shaped relationship between economic growth (GDP) and environmental quality (CO_2). In econometric analysis, this relationship could be described as quadratic form. There is also a possibility that this relationship would be a linear relationship, if economic growth (GDP) is proportional to carbon dioxide emission (CO_2), or, that this relationship takes a cubic form in econometrics namely the N-shaped curve relationship. For this purpose, to evaluate if the two variables actually have the these forms of relationship described in literature, a statistical regression analysis by least square method can be performed. Finally, it will also help to determine whether the relationship between economic growth (GDP) and carbon dioxide emission (CO_2) is statistically significant in different forms.

The results of the three models for EKC hypothesis are presented in Table 7. All model parameters display the results to be statistically significant at 5% level. The EKC emissions reversal at higher incomes is clearly present in the data, with appropriate signs on the model coefficients. Firstly, the quadratic term ($LGDP^2$) of quadratic model is negative and statistically significant at 5% level, and the linear term (LGDP) is positive and statistically significant also. In this case, the estimated the EKC has a maximum turning point per capita income level calculated as $LGDP^* = (-LGDP/2LGDP^2) = (12.72614/2[-0.674319]) = -4{,}290739$ (Neumayer, 2003; Neumayer, 2004). In cubic model, the cubic term ($LGDP^3$) is also statistically significant and positive, indicating an N-shaped curve. This would indicate that emissions would begin to rise again once a second income turning point is passed. The estimated models have R-squares (R^2) values above 0.95. The results suggest a strong inverted U-shaped relation between carbon emissions (CO_2) and economic growth (GDP). In the cubic model, the parameters are also statistically significant, indicating an N-shaped relation. Both an inverted-U shaped and an N-shaped EKC mean that a higher income level and a faster economic development lead to a clearer display of the trend in pollution-income relations (Yang et al., 2010).

4. CONCLUSION AND REMARKS

This study aims to investigate the causal relationships between economic growth, carbon dioxide emission and FDI, and to evaluate the EKC hypothesis for Turkey in 1974-2011. Firstly, the causality relationships between the variables are examined by econometric methods. For this purpose, the methodology used in the study includes unit root tests based on ADF, PP and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Tests, the Johansen Cointegration Test, The Granger Causality Test in a VAR, Impulse-Response and Variance Decomposition Analysis of VAR model. The findings obtained display that a long term relationship exists among economic growth (GDP), carbon dioxide emission (CO_2) and FDI.

Table 7: The estimations of regression models

Dependent variable: LCO_2			
Independent variables	**Linear model coefficients**	**Quadratic model coefficients**	**Cubic model coefficients**
C (constant)	–8.854106**	–58.49850**	–10.6747**
	(0.286932)	(7.040325)	(281.2797)
	[0.0000]	[0.0000]	[0.0163]
LGDP	1.149412**	12.72614**	240.4722**
	(0.033515)	(1.641321)	(98.21036)
	[0.0000]	[0.0000]	[0.0197]
$LGDP^2$	-	–0.674319**	–27.17071**
		(0.095595)	(11.42491)
		[0.0000]	[0.0232]
$LGDP^3$	-	-	1.027006
			(0.442818)
			[0.0265]
R^2	0.970301	0.987736	0.989411
Adjusted R^2	0.969476	0.987035	0.988477
F-statistic	1176.149	1409.432	1058.971
Prob (F-statistic)	0.000000	0.000000	0.000000

**Indicates statistically significant at level 5%, ( ) indicates standard error, [ ] indicates p-values, LCO_2: Carbon dioxide emissions, FDI: Foreign direct investment, GDP: Gross domestic product

The results of the Granger Causality Test of VEC model display that any causality relationship does not exist in long run while the results of the Granger Causality Test of VAR model support that there is bidirectional causality relationship from FDI (LFDI) to carbon emissions (CO_2) at 5% significant level. In addition, there is a unidirectional causality relationship from economic growth (LGDP) to carbon dioxide emissions (LCO_2). In brief, the causality relationships show that FDI (LFDI) and economic growth (LGDP) have a significant effect on carbon dioxide emissions (LCO_2). In addition, both LCO_2 and LGDP have a significant causal effect on LFDI. Moreover, impulse-response functions and variance-decompositions of VAR model support these relationsips among LGDP, LCO_2 and LFDI. Carbon dioxide emission (CO_2) contributes for the variation in the forecast error of all other variables. Furthermore, FDI significantly affects variance of carbon dioxide emission (CO_2). According to impulse-response functions, the shocks in foreign direct investment (LFDI) have a positive significant impact on carbon dioxide emission (LCO_2) while the shocks in economic growth (LGDP) have a negative minor effect on carbon dioxide emission (LCO_2). Moreover, one standard deviation shock in economic growth (LGDP) and carbon dioxide emission (LCO_2) have a positive significant effect on foreign direct investment (LFDI). The findings indicate that in the long run foreign direct investment has an effect on CO_2 emission. Therefore, any increase in FDI have cause any problem to the environment. An increase in economic growth is negatively related with the environment as it can contribute for decreasing of CO_2 emissions.

The findings are very important in the environmental policies. Therefore, the countries should find the alternative energy such as natural gas that there is no effect on the environment. Secondly, the study examined the validity of EKC hypothesis in Turkey for the period 1974-2011 by using regression model approach. For this purpose, the various EKC model forms such as linear, quadratic, and cubic are estimated. All parameters of the three models for EKC hypothesis are statistically significant at 5% level. The EKC emissions reversal at higher incomes is clearly present in the data, with appropriate signs on the model coefficients. Firstly, the quadratic term ($LGDP^2$) of quadratic model is negative and statistically significant at 5% level, and the linear term (LGDP) is positive and statistically significant also. In this case, the estimated the EKC has a maximum turning point per capita income level. In cubic model, the cubic term ($LGDP^3$) is also statistically significant and positive, indicating an N-shaped curve. That means that emissions would begin to rise again once a second income turning point is passed.

Consequently, economic growth leads to degradation of environment and depletion of natural resources despite increasing life quality. The findings are significant in the environmental policies. Therefore, it must be the major aim to obtain a sustainable economic growth by less CO_2 emissions and consuming less energy. Furthermore, the policy makers may take account exogenous impacts such as foreign investments to plan energy policies, and to maintain economic growth for global climate warming.

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