THE RELATIONSHIP BETWEEN CO_2 EMISSION AND TRADE OPENNESS IN TURKEY

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Abstract: This study investigates the relationship between CO_2 emissions and trade openness in Turkish economy during 1974-2013 by using Hsiao, Sims and VAR causality methods. It has been determined that there is a causality relationship between CO_2 emission and trade openness in Turkey for the period 1974-2013 in econometric analyzes. These results indicate that trade openness and CO_2 emissions affect each other.

Keywords: CO_2 Emission, Trade Openness, Causality.

TÜRKİYE'DE CO_2 EMİSYONU İLE DIŞA AÇIKLIK ARASINDAKİ İLİŞKİ

Öz: Bu çalışmada, 1974-2013 dönemi Türkiye ekonomisinde CO_2 emisyonu ile dışa açıklık arasındaki ilişki Hsiao, Sims ve VAR nedensellik yöntemleri yardımıyla araştırılmıştır. Ekonometrik analizlerde, 1974-2013 dönemi Türkiye'de CO_2 emisyonu ile dışa açıklık düzeyi arasında nedensellik ilişkisinin var olduğu tespit edilmiştir. Bulgular, dışa açıklık ile CO_2 emisyonunun birbirini etkilediğini göstermektedir.

Anahtar Kelimeler: CO_2 Emisyonu, Dışa Açıklık, Nedensellik.

I. Introduction

The relationship between foreign trade and environment has become one of the topics of debate in recent years due to the international trade developed with globalization. International trade is an important tool for increasing economic growth and welfare level of societies by meeting the demands of individuals and governments. However, there are also some negative externalities of international trade. Environmentalist economists suggest that international trade is not bad for the growth of an economy, but they also fear that it will lead to the extinction of natural resources which eventually will affect the environmental quality (Ali et al., 2015: 289).

Environmental damages caused by trade liberalization that increases with globalization have become an important threat to sustainable development which should be taken into account. Economic activities including foreign trade have an important role in environmental problems. From this point of view, it is not possible to think international economic activities independently from environmental damages. Therefore, economists recently have been investigating

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the relationship between foreign trade and environment (Fotros and Maaboudi, 2011, 74; Seymen; 2005:101).

Increasing number of studies in the literature on trade and environment suggests the existence of a great number of potential interactions between trade liberalization and pollution. For instance, some studies in the literature argued that trade openness can reduce pollution emissions since the countries with very high levels of competitiveness are able to manage their resources more effectively. Some others examined the actual implementation of trade liberalization by means of *General Agreement on Tariffs and Trade/ World Trade Organization* (GATT/WTO) and investigated to what extent countries restrict the import of environmentally hazardous goods. Besides, a more systematic analysis of the relationship between trade and environment was also conducted by Grossman and Krueger (1991) who proposed the Environmental Kuznets Curve (EKC) (Cole; 2004: 72). The economists began to use the Environmental Kuznets Curve (EKC) hypothesis to better understand the environmental consequences of foreign trade (Artan et al., 2015: 310).

With the EKC hypothesis, Grossman and Krueger (1991) exhibited a more comprehensive point of view toward the relationship between foreign trade and environment. Similar to the relationship between growth and environment, they focused on the scale, technology (technical) and composition effects to explain how liberalization of trade and foreign investments affect the environmental quality. According to the scale effect, liberalization of trade and investments increases economic activities and these activities cause environmental pollution unless the production style changes. Economic growth increases energy demand, and increased energy demand causes an increase in the use of fossil fuels, thus leading to environmental pollution (Çetin and Şeker; 2014: 217; Kızılkaya et al. 2016: 259). To Cole et al. (2004), scale effect means that markets will expand together with trade and the consequent increase in production and consumption might increase the level of pollution. The technological effect creates a more positive impact since technology allows for the use of more developed production techniques and environmental arrangements, thus leading to cleaner technologies or production processes. The composition effect stems from the changes in production caused by specialization. Trade openness is effective in the composition effect. The extent of trade openness will determine the composition effect (Çetin and Şeker, 2014: 214; Yıldırım, 2013: 1614). Reducing pollution depends on the relative volume of the technology and composition effects (Choi et al., 2010:5).

To Grossman and Krueger (1991), environmental pollution increases due to the scale effect in the first stages of increasing trade volume and economic growth, but it will begin to decrease in the following stages with the emergence of composition and technological effects (Ertuğrul et al., 2016 :545; Artan et al., 2015: 309). According to the Environmental Kuznets Curve (EKC) hypothesis, CO_2 emissions have a positive relationship with income level and/or trade liberalization before the threshold level, but then have a negative relationship with them beyond the threshold level. According to the Environmental Kuznets Curve: if there is a negative relationship between CO_2 emissions and trade liberalization, then CO_2 emissions will decrease as a country is more exposed to open markets. If there is a positive relationship between CO_2 emissions and trade liberalization, then trade liberalization of the country is not likely to have experienced its optimal level of trade liberalization. (Choi et al., 2010:2). In this sense, this study aims to find out whether there is a causality relationship between CO_2 emissions and trade openness in Turkish economy during 1974-2013, and if so, whether this relationship is positive or negative. For this purpose, this study is comprised of four sections. Following the introduction, Section 2 includes the literature review. Section three presents the data set and methodology as well as the empirical findings. Finally, the conclusion includes the evaluation of the findings together with some suggestions.

II. Literature Review

There are various empirical studies in the literature on the relationship between trade openness and CO_2 emissions. Table 1 shows the summary of some empirical studies conducted in Turkey and abroad on the relationship between trade openness and CO_2 emissions.

Table 1: *Relationship between Trade Openness and CO_2 Emissions: Empirical*

Author(s)	Country/Country Groups	Period	Method	Empirical Findings
Grossman and Krueger(1991)	NAFTA	1977-1984	Panel Regression	OPEN→CO_2
Antweiler et al. (2001)	44 Countries	1975-1994	Panel Regression	OPEN →CO_2
Feridun (2006)	Nigeria	1980-2010	GLS	OPEN →CO_2 (Positive)
Atıcı and Kurt (2007)	Turkey	1968-2000	LS	OPEN →CO_2 (Positive)
Halıcıoğlu (2009)	Turkey	1960-2005	ARDL/ Granger	OPEN →CO_2
Choi et al. (2010)	China, Korea and Japan	1971-2006	VAR /VECM	OPEN →CO_2
Chebbi et al. (2010)	Tunisia	1961-2004	Cointegration Test	OPEN →CO_2 (Positive)
Sharma (2011)	69 Countries	1985-2005	Panel Regression	OPEN →CO_2 (Positive)
Fotros and Maaboudi (2011)	Iran	1971-2008	GMM/ Granger	OPEN →CO_2 (Positive)

Nasir and Rehman (2011)	Pakistan	1972-2008	VECM/VAR	OPEN →CO_2 (Positive)
Hossain (2011)	Brazil, China, India, Malaysia, Mexico, Philippines, South Africa, Thailand, Turkey	1971-2007	Johansen Fisher Panel Cointegration /Granger	OPEN →CO_2 (short-term)
Hossain (2012)	Japan	1960-2009	ARDL/VECM /Granger	OPEN →CO_2
Jayanthakumaran et al. (2012)	China and India	1971-2007	ARDL	OPEN →CO_2 (Negative)
Kohler (2013)	South Africa	1960-2009	ARDL/VECM /Granger	OPEN →CO_2
Farhani et al. (2013)	MENA Countries	1980-2009	Panel Cointegration/ Causality	OPEN →CO_2 (Positive)
Rahman (2013)	Bangladesh	1972-2009	VAR	OPEN →CO_2 (Positive)
Öztürk and Acaravcı (2013)	Turkey	1960-2007	ARDL	OPEN →CO_2 (Positive)
Shahbaz,Tiwari et al. (2013)	South Africa	1965-2008	ARDL/ Granger	OPEN →CO_2 (Negative)
Shahbaz, Solarin et al. (2013)	Malaysia	1971-2011	ARDL	OPEN →CO_2 (Negative)
Gu et al. (2013)	China	1981-2010	Granger/EG /JJ	OPEN →CO_2
Tiwari et al. (2013)	India	1966-2011	ARDL/JJ / VECM/ Granger	OPEN ↔CO_2
Ren et al. (2014)	China	2000-2010	GMM	OPEN →CO_2
Yazdı and Mastorakis (2014)	Iran	1975-2011	ARDL/VECM /Granger	OPEN →CO_2 (Positive)
Mehrara (2014)	Iran	1970-2011	ARDL	OPEN →CO_2
Çetin and Şeker (2014)	Turkey	1980-2010	ARDL	OPEN →CO_2 (Positive)

Akın (2014)	85 Countries	1990-2011	Panel Cointegration/ Granger	OPEN↑→CO_2↓ (Trade openness can reduce CO2 emissions in the long term) CO_2↑→OPEN↑ (CO2 emissions can increase trade openness in the short term
Mohapatra and Giri (2015)	India	1971-2012	ARDL/VECM/ Granger	OPEN →CO_2 (Positive)
Ali et al. (2015)	Pakistan	1980-2010	Granger	OPEN ↔CO_2
Artan et al. (2015)	Turkey	1981-2012	JJ/VAR/ VECM	OPEN →CO_2 (Pozitif)
Farhani and Öztürk (2015)	Tunisia	1971-2012	Granger/ ARDL/ VECM	OPEN →CO_2 (Long-term) CO_2→ OPEN (Short-term)
Alam and Paramati (2015)	18 Developing Countries	1980-2012	Panel VECM	OPEN ↔CO_2 (Long-term)
Bozkurt and Okumuş (2015)	Turkey	1966-2011	Hatemi-J	OPEN →CO_2 (Positive)
Keskingöz and Karamelikli (2015)	Turkey	1960-2011	ARDL	OPEN →CO_2 (Positive)
Doğan et al.(2015)	OECD	1995-2010	EKK	OPEN →CO_2 (Negative)
Kızılkaya et al. (2016)	Turkey	1967-2010	JJ	OPEN →CO_2 (Positive)
Lebe (2016)	Turkey	1960-2010	ARDL	OPEN →CO_2 (Positive)
Doğan and Şeker (2016)	23 Countries	1985-2011	Panel	OPEN →CO_2 (Negative)
Zerbo (2016)	8 Sub-Saharan Africa Countries	1971-2010	ARDL/TY	OPEN↑→CO_2↓ (Trade openness can reduce CO2 emissions in South Africa) OPEN↑→CO_2↑ (Trade openness can reduce CO2 emissions in Togo and Kenya)
Doğan and Türkekul (2016)	USA	1960-2010	ARDL, VECM Granger	No relationship
Charfeddine and Khedirr (2016)	United Arab Emirates	1975-2011	Gregory-Hansen/ Hatemi-J /VECM Granger	OPEN →CO_2 (Positive)

Ertuğrul et al. (2016)	Thailand, Turkey, India, Brazil, China, Indonesia, North Korea, Mexico, South Africa, Malaysia	1971-2011	VECM Granger	OPEN →CO_2 (Positive)

*Note: CO_2: Carbon dioxide emission, OPEN: Trade Openness, DL: Dolado-Lütkepohl causality, TY: Toda-Yamamoto causality, JJ: Johansen-Juselius Cointegration, ARDL: Autoregressive distributed lag model, VAR: Vector autoregressive model, VECM: Vector error correction model, GLS: Generalized least squares, LS: Least squares, GMM: Generalized method of moments, EG: Engle-Granger Cointegration.

III. Dataset, Method and Findings

Table 2 shows the information about the variables used while examining the relationship between CO_2 emissions and trade openness (OPEN) in Turkish economy between 1974 and 2013.

Table 2: *Variables*

Variables	Description	Source
CO_2	CO2 emission (kt)	WDI (World Bank Data)
OPEN	Foreign Trade-to-GDP ratio	WDI(World Bank Data)

After taking the logarithms of the variables, they were analyzed. Table 3 shows the descriptive statistics about CO_2 emission and OPEN and the results of the Pearson's correlation analysis performed to give preliminary information about the relationship between these variables.

Table 3: *Descriptive Statistics and Pearson's Correlation Analysis*

Descriptive Stat.	CO_2	OPEN	Pearson's Correlation Matrix		
Mean	5.184	1.438	Variables	CO_2	OPEN
Median	5.198	1.457	CO_2	1.000000	0.891
Std. Error	0.220	0.193	OPEN	0.891	1.000000
Skewness	-0.205	-0.3852	*Note: Pearson's correlation coefficient: $r_{gcey}=0.891^b$; b: significant at 5%*		
Kurtosis	1.826	3.104			
Jarque-Bera	2.578	4.686			
P value	0.275	0.108			

According to the results of the Pearson's correlation analysis shown in Table 3, Pearson's correlation coefficient is 0.891. There is a positive and statistically significant (at 5%) relationship between the variables. All variables are normally distributed.

In the study, we used Dickey Fuller – Generalized Least Square (DF-GLS) (1996) unit root test to determine whether variables are stationary, or not. According to Table 4, if the absolute values of t-statistics of series calculated by the DF-GLS test are smaller (greater) than the absolute value of Mac-

Kinnon (1996) critical values, the series are not stationary (stationary) and have a unit root (does not have a unit root).

Table 4: *DF-GLS Unit Root Test*

		DF-GLS Test	
Variables		C	C+T
CO_2		1.144	-2.290
OPEN		-0.657	-2.690
ΔCO_2		-5.800	-5.933
Δ OPEN		-5.320	-4.641
Significance Level	1%	-2.625	-3.770
	5%	-1.949	-3.190
	10%	-1.611	-2.890

Table 4 shows that CO_2 and OPEN series are stationary at first difference I(1). The relationship between the variables was analyzed using the Hsiao, Sims and VAR causality tests.

A. Hsiao's Granger Causality

Hsiao's (1981) procedure for testing Granger causality functions as the Standard Granger causality, but it is implemented differently. In the Standard Granger causality test, optimal lag lengths of independent and dependent variables are similar, while they are calculated differently for dependent and independent variables in Hsiao's causality test. Besides, the causality relationship among the variables was examined using an F test in Standard Granger method. But in Hsiao's causality test, the causality is examined using the FPE criteria calculated based on optimal lag lengths.

Hsiao's causality test is implemented in two steps. In the first step, optimal lag length *m* of the dependent variable in equation (1) is estimated using the FPE (m) criteria given in equation (2). In the second step, independent variable is added to equation (1) and the optimal lag length *n* of the independent variable in equation (3) is estimated using the FPE (m,n) criteria given in equation (4).

$$\Delta CO_{2_t} = \alpha + \sum_{i=1}^{m} \beta_i \Delta CO_{2_{t-i}} + u_{1t} \tag{1}$$

$$FPE(m) = \left(\frac{T+m+1}{T-m-1}\right)\left(\frac{ESS(m)}{T}\right) \tag{2}$$

$$\Delta CO_{2_t} = \alpha + \sum_{i=1}^{m} \beta_i \Delta CO_{2_{t-i}} + \sum_{j=1}^{n} \gamma_j \, \Delta OPEN_{t-j} + u_{2t} \tag{3}$$

$$FPE(m,n) = \left(\frac{T+m+n+1}{T-m-n-1}\right)\left(\frac{ESS(m,n)}{T}\right) \tag{4}$$

In Equations (2) and (4), T represents the number of observations; m and n represent the optimal lag lengths (that meet minimum FPE) of dependent and independent variables, respectively; ESS represents the error sum of squares.

In Hsiao's causality test, H_0 hypothesis assumes that $OPEN_t$ does not Granger cause CO_{2t}, while H_1 assumes $OPEN_t$ Granger causes CO_{2t}. If the calculated FPE (m) is larger than FPE (m,n), H_0 is rejected. In other words, $OPEN_t$ Granger causes CO_{2t}. Since Hsiao's causality test shows the existence of one-way relationships, the same steps are repeated by changing the place of variables to determine the direction of the causality.

Table 5 shows the results of the Hsiao's causality test for one-lagged values of the variables.

Table 5: *Results of Hsiao's Causality Test*

Model	FPE1	FPE2	Direction of Causality	LM value	BPG value
CO_2=f(CO_2 (-1),OPEN(-3))	0.000553	0.000515	OPEN → CO_2	0.869 (0.429)	0.360 (0.834)
OPEN =f(OPEN (-1),CO_2 (-3))	0.005542	0.004485	CO_2→ OPEN	0.846 (0.439)	0.003 (0.955)

*Not: BPG: Breusch-Pagan-Godfrey

According to the results of Hsiao's causality test, there is a bidirectional causality relationship between CO_2 and OPEN.

B. Sims Causality Test

The Sims (1972) causality test is different from the Standard Granger (1969) causality in that optimal lag lengths of dependent and independent variables are the same in the Standard Granger causality test. However, in the Sims causality test, optimal lag lengths of dependent and independent variables may be different. Besides, lagged values are included in the equations established for the standard Granger causality test. But in the Sims causality test, lead values are also included in the equations in addition to the lagged values. Moreover, H_0 hypothesis of the Sims causality test is different from that of the Standard Granger causality test. Equations (5) and (6) are used to determine the causality relationship between the variables while implementing the Sims causality test.

$$\Delta OPEN_t = \alpha_1 + \sum_{i=1}^{m} \beta_i \, \Delta OPEN_{t-i} + \sum_{i=1}^{n} \gamma_i \, \Delta CO_{2_{t-i}} + \sum_{i=1}^{p} \lambda_i \, \Delta CO_{2_{t+i}} + u_{1t} \quad (5) \qquad (5)$$

$$\Delta CO_{2_t} = \alpha_2 + \sum_{i=1}^{i=m} \delta_i \Delta CO_{2_{t-1}} + \sum_{i=1}^{i=n} \theta_i \Delta OPEN_{t-1} + \sum_{i=1}^{i=p} \omega_i \Delta OPEN_{t+1} + u_{2t} \quad (6) \tag{6}$$

In Equations (5) and (6), m and n denote the optimal lag lengths of the lagged values of variables and p denotes the optimal lag lengths of the lead values of independent variables.

After the optimal lag lengths in the equation are determined using the AIC or SIC criteria, equations are estimated using least squares (LS). After Equations (5) and (6) are estimated with the LS method, Wald test is used to test the hypotheses. H_0 of Equation (5): "OPEN does not Granger cause CO_2" ($\lambda_i = 0$) and H_0 of Equation (6): "CO_2 does not Granger cause OPEN" ($\omega_i = 0$). As a result of the Wald test applied to the coefficients for the lead values in equations: if $\lambda_i \neq 0$, there is a unidirectional causality running from OPEN to CO_2; if $\omega_i \neq 0$, there is a unidirectional causality running from CO_2 to OPEN. If the null hypotheses of Equations (5) and (6) are both rejected ($\lambda_i \neq 0$ ve $\omega_i \neq 0$), it means there is a bidirectional causality between the variables.

Table 6 shows the results of the Sims causality tests applied to the variables that are stationary at their first difference.

Table 6: *Results of the Sims Causality Test*

Model	F stat. (Wald stat.)	P value	Direction of Causality	LM value	BPG Value
OPEN =f(OPEN (-1), CO_2(-1), CO_2(3))	1.82 (5.48)	0.16	No causality	1.97 (0.15)	1.88 (0.12)
CO_2=f(CO_2(-1), OPEN (-1), OPEN (2))	5.98 (11.96)	0.00	CO_2→OPEN	0.98 (0.38)	0.80 (0.53)

*Not: BPG: Breusch-Pagan-Godfrey

According to the results of the Sims causality test, there is a unidirectional causality running from CO_2 to OPEN.

C. Unrestricted VAR

In the unrestricted VAR model, optimal lag lengths were estimated using such information criteria as AIC, SIC, HQ and FPE after stationarity of the variables has been determined. In doing so, a VAR model with a lag length k is estimated. To find out whether the VAR model is stable and trouble-free, AR unit root stability test and diagnostic tests (autocorrelation, heteroscedasticity, normality) are performed. In the second step, Wald test (MWALD) is applied to the first k VAR coefficient matrix to find out the Granger causality relationship between the variables.

Equation (7) shows the unrestricted VAR in matrix form used in this study.

$$\begin{bmatrix} \Delta CO_{2_t} \\ \Delta \mathrm{OPEN}_t \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \end{bmatrix} + \sum_{i=1}^{k} \begin{bmatrix} a_{11i} & a_{12i} \\ a_{21i} & a_{22i} \end{bmatrix} \begin{bmatrix} \Delta CO_{2_{t-i}} \\ \Delta \mathrm{OPEN}_{t-i} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \quad (7)$$

In the estimated VAR model, the null hypothesis $H_{0:}$ $a_{12i}=0$ is used to test whether there is a causality from OPEN to CO_2 and the null hypothesis H_0: $a_{21i}=0$ is used to test whether there is a causality from CO_2 to OPEN. As a result of the Wald test: if $a_{12i}\neq 0$, there is a unidirectional causality running from OPEN to $CO_{2;}$ if $a_{21i}\neq 0$, there is a unidirectional causality running from CO_2 to OPEN. If both hypotheses are rejected, then there is a bidirectional causality between the variables. In this study, we also used variance decomposition analysis to show how much of the percentage of variation is explained by the variable itself and by the other variables.

Table 7 shows that the optimal lag length (k) of the unrestricted VAR model established to examine the causality relationship between CO_2 and OPEN is 1 based on the SIC criteria and is 3 based on the LR, FPE, AIC and HQ criteria.

Table 7: *Optimal Lag Length*

Lag	LogL	LR	FPE	AIC	SC	HQ
0	44.24905	NA	0.000328	-2.347169	-2.259196	-2.316464
1	139.0574	173.8154	2.11e-06	-7.392080	-7.128160*	-7.299965
2	142.8799	6.583054	2.14e-06	-7.382215	-6.942348	-7.228689
3	149.3415	10.41043*	1.88e-06*	-7.518973*	-6.903160	-7.304037*
4	153.0559	5.571558	1.93e-06	-7.503104	-6.711345	-7.226759

In the VAR (1) model established for the VAR analysis using the optimal lag length of 1 includes autocorrelation. The VAR (3) model established with the optimal lag length of 3 does not include heteroscedasticity or autocorrelation and the error terms are normally distributed. Since it was not found to have any problem in the diagnostic tests, the VAR (3) model was preferred.

The VAR (3) model was estimated with the LS method. Table 8 shows the causality test results for the estimated VAR (3). Besides, Table 9 shows that: the VAR (3) model is stable; inverse roots of the characteristic AR polynomial are smaller than 1; the model does not include any heteroscedasticity or autocorrelation and the error terms are normally distributed.

Table 8: *Results of the VAR Analysis*

VAR (3) Model (OLS)	Wald stat.	P-value	Causality	Normality		LM	White	AR roots
OPEN→CO_2	6.491	0.09	OPEN→CO_2 (+0.22)	Doornik-Hansen	6.08 (0.19)	>0.35	0.35	<0.80
CO_2→OPEN	15.744	0.00	CO_2→OPEN (+0.18)	Urzua	11.31 (0.25)			

Table 8 shows that there is a bidirectional, positive and statistically significant causality relationship between CO_2 and OPEN. The error term correlation matrix of the variables was found to be 0.0035 <0.20 which means that the variables are not sensitive to arrays. Therefore, we used the Cholesky's method for variance decomposition. Figure 1 shows the results of the variance decomposition.

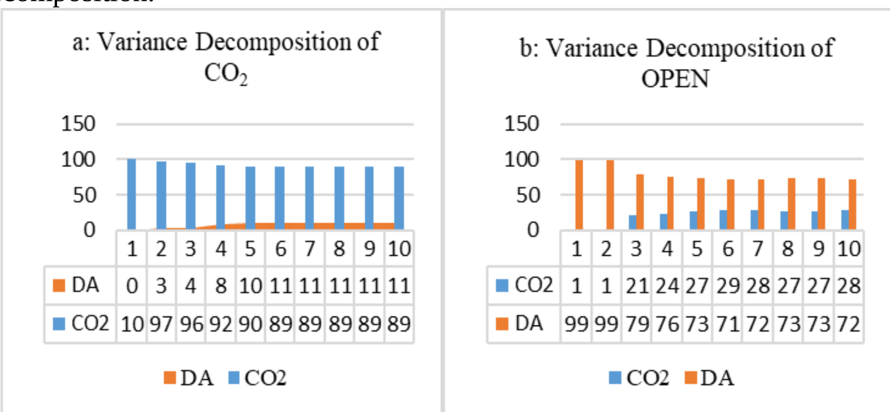

Figure 1: Variance Decomposition

As shown in Figure 1 (a), about 10% of any change in CO_2 is explained by OPEN throughout 10 periods. Panel b shows that about 25% of any change in OPEN is explained by CO2. The results of the variance decomposition given in Figure 1 shows that CO_2 and OPEN affect each other.

IV. Conclusion and Suggestions

In this study, we examined the relationship between CO_2 emissions and trade openness in Turkey using the Hsiao, Sims and VAR causality tests. The results of the tests showed that there is a causality relationship between CO_2 emissions and trade openness in Turkish economy during the years between 1974 and 2013. The Hsiao and VAR causality tests showed that there is a bidirectional causality between the variables, while the results of the Sims test revealed the existence of a unidirectional causality running from CO_2 emissions to trade openness.

The positive causality relationship from trade openness to CO_2 emissions for the Turkish economy found by econometric analyses is in compliance with the findings of Atıcı and Kurt (2007), Halıcıoğlu (2009), Öztürk and Acaravcı (2013), Çetin and Şeker (2014), Artan et al., (2015), Bozkurt and Okumuş (2015), Keskingöz and Karamelikli (2015), Kızılkaya et al. (2016), Lebe (2016) and Ertuğrul et al. (2016). The positive causality from CO_2 emissions to trade openness is in compliance with the findings of the studies conducted by Akın (2014) and Farhani and Öztürk (2015).

The overall review of the findings shows that CO_2 emissions and trade openness affect each other in Turkey. Trade openness increases with increasing CO_2 emissions. As a developing country, Turkey is increasing trade openness more and more through the policies aiming for economic growth and neglects increasing levels of CO_2 emissions. The positive causality existing from trade openness to CO_2 emissions can be interpreted as that Turkey has not still experienced its optimal level of trade liberalization as proposed in the Environmental Kuznets Curve (EKC) hypothesis. Besides, the relationship between trade openness and CO_2 emissions in Turkish economy is not close to or beyond the EKC threshold. Moreover, it can also be said that Turkey may reduce CO_2 emissions by exceeding the certain threshold level proposed by the EKC hypothesis with the increasing trade openness.

In conclusion, the policies adopted by Turkey to achieve economic growth increase trade openness, leading to an increase in CO_2 emissions, too. However, Turkey can reduce CO_2 emissions in the next years by adopting commercial policies that will be in line with the sustainable growth goals and will take account of the scale, technology and composition effects proposed in the EKC hypothesis as well as aiming to increase country's international competitiveness and eliminate negative externalities caused by trade.

References

Alam, S. ve Paramati, S. R. (2015) "Do oil consumption and economic growth intensify environmental degradation? Evidence from developing economies", *Applied Economics*, 47 (48), 5186–5203.

Ali, Z., Zaman, Z. ve Ali, M. (2015) "The Effect of International Trade on Carbon Emissions: Evidence from Pakistan", *Journal of Economics and Sustainable Development*, 6(9), 289-300.

Akın, C. S. (2014) "The Impact of Foreign Trade, Energy Consumption and Income on Co2 Emissions", *International Journal of Energy Economics and Policy*, 4(3), 465-475.

Antweiler, W., Copeland, B. R. ve Taylor, M. S. (2001) "Is Free Trade Good for The Environment?", *The American Economic Review*, 91(4), 877-908.

Artan, S., Hayaloğlu, P. ve Seyhan, B. (2015) "Türkiye'de Çevre Kirliliği, Dışa Açıklık ve Ekonomik Büyüme İlişkisi", *Yönetim ve Ekonomi*

Araştırmaları Dergisi, 13(1), 308-325, Doi: http://dx.doi.org/10.11611/JMER435.

Atıcı, C. ve Kurt, F. (2007) "Türkiye'nin Dış Ticareti ve Çevre Kirliliği: Çevresel Kuznets Eğrisi Yaklaşımı", *Tarım Ekonomisi Dergisi*, 13(2): 61-69.

Bozkurt, C. ve Okumuş, İ. (2015) "Türkiye'de Ekonomik Büyüme, Enerji Tüketimi, Ticari Serbestleşme ve Nüfus Yoğunluğunun CO_2 Emisyonu Üzerindeki Etkileri: Yapısal Kırılmalı Eşbütünleşme Analizi", *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 12832, 23-35.

Charfeddine, L. ve Khediri, K. B. (2016) "Financial Development and Environmental Quality in UAE: Cointegration with Structural Breaks", *Renewable and Sustainable Energy Reviews*, 55,1322–1335.

Chebbi, H. E., Olarreaga, M. ve Zitouna, H. (2010) "Trade Openness and CO2 Emissions in Tunisia", *Economic Research Forum*, 518, 1-18.

Choi, E., Heshmati, A. ve Cho, Y. (2010) "An Empirical Study of the Relationship between CO2 Emissions, Economic Growth and Openness", *IZA Discussion Paper Series*, 5304, 1-29.

Cole, M. A. (2004) "Trade, The Pollution Haven Hypothesis and The Environmental Kuznets Curve: Examining The Linkages", *Ecological Economics*, 48,71-81.

Cole, M. A., Elliot, R. J. R. ve Fredriksson, P. G. (2004) "Endogenous pollution havens: Does FDI influence environmental regulations?", *The Scandinavian Journal of Economics*, 108 (1), pp. 157-178, DOI: 10.1111/j.1467-9442.2006.00439.x.

Çetin, M. ve Şeker, F. (2014) "Ekonomik Büyüme ve Dış Ticaretin Çevre Kirliliği Üzerindeki Etkisi: Türkiye için Bir ARDL Sınır Testi Yaklaşımı", *Celal Bayar Üniversitesi İİBF Yönetim ve Ekonomi Dergisi*, 21(2), 213-230.

Doğan, E. ve Turkekul, B. (2016) "CO2 Emissions, Real Output, Energy Consumption, Trade, Urbanization and Financial Development: Testing The EKC Hypothesis for The USA", *Environmental Science Pollution Research*, 23(2), 1203–1213, DOI 10.1007/s11356-015-5323-8.

Doğan, E. ve Şeker, F. (2016) "The İnfluence of Real Output, Renewable and Non-Renewableenergy, Trade and Financial Development on Carbon Emissions in the top Renewable Energy Countries", *Renewable and Sustainable Energy Reviews*, 60, 1074–1085.

Doğan, E., Şeker, F. ve Bülbül, S. (2015) "Investigating The İmpacts of Energy Consumption, Real GDP, Tourism and Trade on CO2 Emissions by Accounting for Cross-Sectional Dependence: A Panel Study of OECD Countries", *Current Issues in Tourism*, DOI: 10.1080/13683500.2015.1119103.

Elliott, G., Rothenberg, T. J. ve Stock, J. H. (1996) "Efficient Tests for an Autoregressive Unit Root", Econometrica, 64 (4), 813–836.

Ertuğrul H. M., Çetin, M., Şeker, F. ve Doğan, E. (2016). "The Impact of Trade Openness on Global Carbon Dioxide Emissions: Evidence from the top ten Emitters among Developing Countries", *Ecological Indıcators*, 67, 543-555.

Farhani, S. ve Özturk, İ. (2015) "Causal Relationship between CO_2 Emissions, Real GDP, Energy Consumption, Financial Development, Trade Openness, and Urbanizationin Tunisia", *Environmental Science Pollution Research,* 22, 15663–15676, DOI 10.1007/s11356-015-4767-1.

Farhani, S., Shahbaz, M. ve Arouri, M. E. H. (2013) "Panel analysis of CO2 Emissions, GDP, Energy Consumption, Trade Openness and Urbanization for MENA countries", *MPRA Paper 49258,* 1-19, http://mpra.ub.uni-muenchen.de/49258.

Feridun, M. (2006) "Impact of Trade Liberalization on the Environment in Developing Countries: The Case of Nigeria", *MPRA Paper 731*, 39-56, http://mpra.ub.uni-muenchen.de/731, (15.06.2016).

Fotros, M. H. ve Maaboudi, R. (2011) "Trade Openness and CO2 Emissions in Iran, 1971-2008", *International Journal of Business and Development Studies*, 3(1), 73-84.

Grossman, G. M. ve Krueger, A. B. (1991) "Environmental Impacts of a North American Free Trade Agreement", *National Bureau of Economic Research (NBER) Working Paper*, 3914, 1-39.

Gökalp F. M. ve Yıldırım, A. (2004) "Dış Ticaret ve Çevre: Kirlilik Sığınakları Hipotezi Türkiye Uygulaması", *Yönetim ve Ekonomi*, 11(2), 100.

Gu, Z., Gao, Y. ve Li, C. (2013) "An Empirical Research on Trade Liberalization and CO2 Emissions in China", *International Conference on Education Technology and Information System* (ICETIS), 243-246.

Halıcıoğlu, F. (2009), "An Econometric Study of CO2 emissions, Energy Consumption, Income and Foreign Trade in Turkey", *Energy Policy*, 37, 1156-1164.

Hsiao, C. (1981) "Autoregressive Modelling and Money-Income Causality Detection", *Journal of Monetary Economics*, 7(1), 85-106.

Hossain S. M. (2011) "Panel estimation for CO2 Emissions, Energy Consumption, Economic Growth, Trade Openness and Urbanization of Newly Industrialized Countries", *Energy Policy*, 39, 6991–6999.

Hossain, S. (2012) "An Econometric Analysis for CO2 Emissions, Energy Consumption, Economic Growth, Foreign Trade and Urbanization of Japan", *Low Carbon Economy,* 3, 92-105.

Jayanthakumaran, K., Verma, R. ve Liu, Y. (2012) "CO2emissions, Energy Consumption, Trade and Income: A comparative analysis of China and India", *Energy Policy*, 42, 450–460.

Keskingöz, H. ve Karamelikli, H. (2015) "Dış Ticaret- Enerji Tüketimi ve Ekonomik Büyümenin CO2 Emisyonu Üzerine Etkisi", *Kastamonu Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, 9, 7-17.

Kızılkaya, O., Sofuoğlu, E. ve Çoban, O. (2016) "Ekonomik Büyüme, Enerji Tüketimi ve Çevre Kirliliği Analizi: Türkiye Örneği", *Kırıkkale Üniversitesi Sosyal Bilimler Dergisi*, 6(2), 255-272.

Kohler, M. (2013) "CO2 Emissions, Energy Consumption, Income and Foreign Trade: A South African Perspective", *ERSA Working Paper*, 356, 1-19.

Lebe, F. (2016) "Çevresel Kuznets Eğrisi Hipotezi: Türkiye İçin Eşbütünleşme Ve Nedensellik Analizi", *Doğuş Üniversitesi Dergisi*, 17(2), 177-194.

Mehrara, M. (2014) "The Relationship between GDP, Globalization and Environment", *International Journal of Applied Economic Studies*, 2(3), ISSN: 2345-5721, 1-6, http://sijournals.com/IJAE (22.06.2016).

Mohapatra, G. ve Gri, A. K. (2015) "Energy Consumption, Economic Growth and CO2 Emissions: Empirical evidence from India", *The Empirical Econometrics and Quantitative Economics Letters*, 4(1), 17-32.

Naranpanawa, A. (2011) "Does Trade Openness Promote Carbon Emissions? Empirical Evidence from Sri Lanka", *The Empirical Economics Letters*, 10(10), 974-986.

Nasir, M. ve Rehman, F. U. (2011) "Environmental Kuznets Curve for carbon emissions in Pakistan: An empirical investigation", *Energy Policy*, 39, 1857–1864.

Özturk, İ. ve Acaravci, A. (2013) "The Long-Run and Causal Analysis of Energy, Growth, Openness and Financial Development on Carbon Emissions in Turkey", *Energy Economics*, 36, 262–267.

Rahman, M. Z. (2013) "Relationship between Trade Openness and Carbon Emission: A Case of Bangladesh", *Journal of Empirical Economics*, 1(4),126-134.

Ren, S., Yuan, B., Ma, X. ve Chen, X. (2014) "International Trade, FDI (Foreign Direct Investment) and Embodied CO2 Emissions: A case study of Chinas Industrial Sectors", *China Economic Review*, 28, 123-134.

Seymen, D. (2005) "Dış Ticaret-Çevre İlişkilerinin Dengelenmesi: Sürdürülebilir Ticaret, Teori ve Türkiye Değerlendirmesi", *Dokuz Eylül Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, 7(3), 99-127.

Shahbaz, M., Tiwari, A.l K. ve Nasir, M. (2013) "The Effects of Financial Development, Economic Growth, Coal Consumption and Trade Openness on CO2 Emissions in South Africa, *Energy Policy*, 61, 1452-1459.

Shahbaz, M., Solarin, S. A., Mahmood, H. ve Arouri, M. (2013) "Does Financial Development reduce CO2 Emissions in Malaysian Economy? A Time Series Analysis", *Economic Modelling*, 35, 145–152.

Sharma, S. S. (2011) "Determinants of Carbon Dioxide Emissions: Empirical Evidence from 69 countries", *Applied Energy*, 88, 376-382.

Sims, C.A. (1972) "Money, Income and Causality", *American Economic Review*, 62(4), 540-552.

Tiwari, A. K., Shahbaz, M. ve Hye, Q. M. (2013) "The Environmental Kuznets Curve and the Role of Coal Consumption in India: Cointegration and Causality Analysis in an Open Economy". *Renewable and Sustainable Energy Reviews*, 8, 519–527.

Yazdı, S. K. ve Mastorakis, N. (2014) "Renewable, CO2 emissions, Trade Openness, and Economic Growth in Iran", *Latest Trends in Energy, Environment and Development*, ISBN: 978-960-474-375-9, 360-370.

Yıldırım, B. (2013) "Ticari Açıklık ve CO2 Emisyonu: Karşılaştırmalı Ülke Analizi", *International Journal of Social Science*, 6(1): 1611-1621.

Zerbo, E. (2016) "CO2 Emissions, Growth, Energy Consumption a Foreign Trade in Sub-Sahara African Countries", https://hal.archives-ouvertes.fr/hal-01110769, (15.10.2016).