“The role of foreign direct investment and trade on carbon emissions in Turkey”

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The role of foreign direct investment and trade on carbon emissions in Turkey

Abstract

This study aims to observe the long run and short run effects of gross domestic product, foreign direct investment inflows and trade on CO_2 emissions and causality relationships between these factors, using annual data for the period of 1974-2010. The empirical results demonstrate that the inverted U-shaped relationship of environmental Kuznets curve is valid for Turkey. In addition, there are positive long run effects of foreign direct investment and trade openness on CO_2 emissions. The authors also find a bidirectional causality relationship between CO_2 emission and FDI.

Keywords: GDP, investment, trade, Environmental Kuznets curve, carbon emissions, Turkey.
JEL Classification: Q53, Q56.

Introduction

The consequences of economic growth and income on environment have been widely discussed. One of the most common arguments in this concept is the environmental Kuznets curve (EKC) hypothesis that refers to the inverted U-shaped relationship between environmental indicators and income. This hypothesis asserts that after a certain period, the negative impact of economic development on environment reverses and economic growth compensates the deterioration caused by the early stages of economic development and improves environment (Stern, 1998). Although there are many studies testing the EKC hypothesis, they propound many different results mainly because of the sample range/region and environmental indicator used in their models. For example, the studies of Torras and Boys (1998) and Grossman and Krueger (1995) confirm the EKC hypothesis for sulfur dioxide (SO_2), but they suggest a monotonically decreasing relationship for heavy particles. Holtz-Eakin and Selden (1995) use the sample of 130 countries for the period 1951-1986. They find that carbon dioxide (CO_2) emissions initially increase with GDP and later decline. On the other hand, there are some studies that conflict with the EKC hypothesis for CO_2 emission, such as Roberts and Grimes (1997), Dijkgraaf and Vollebergh (2005), Galeotti et al. (2006) and for sulfur emission, such as Perman and Stern (2003), Stern and Common (2001). Besides these, Bagliani et al. (2008) use ecological footprint (EF) as an environmental indicator and examine the relationship between EF and GDP. According to their results, EF has a monotonically increasing relationship with GDP.

The impacts of trade liberalization on environment have been mainly discussed through three effects: (i) scale effect; (ii) composition effect; (iii) technique effect. Scale effect refers to the increasing production in order to meet increasing demand in international markets. Composition effect explains the allocation of resources, which depends on the comparative advantage of countries. Finally, technique effect shows the impact of technology used in production activities, such as cleaner or environmentally friendly technology. The net impact of trade on environment is determined in relation to the weights of these three effects (Barrett, 2000). Frankel and Rose (2005) extend EKC analyzis by adding openness variable (the ratio of export and import to GDP) in to the model to see the effect of trade liberalization. The results of cross-country analyzis confirm the EKC hypothesis and show positive impact of trade on air pollution. Similarly, Kacar and Kayalica (2014) use panel data analyzis for 42 countries over the period 1950-2000. They find an inverted U-shaped relationship between economic growth and sulfur emission in the presence of trade and population parameters. On the other hand, using the data of between 26 and 32 countries for the period 1975-1995, Cole and Elliot (2003) find that the technique effect can dominate the scale effect for SO_2 and biochemical oxygen demand (BOD), but it is dominated by scale effect for nitrogen oxides (NO_x) and CO_2. Suri and Chapman (1998) use the sample of 31 countries for 20-year period (1971-1991) and they observe that

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when trade variables are added to the model, the turning point of the curve for energy consumption increases. Therefore, trade also has an impact to raise the turning point for pollutant emission caused by energy consumption. Jayanthakumaran and Liu (2012) analyze the trade openness on growth and environment for China. Their results provide that the scale effect dominates the technique effect for SO_2 and the industrial per capita chemical oxygen demand (COD). Jalil and Mahmud (2009) also examine the relationship between carbon emission, income and foreign trade for China. They confirm EKC and find positive but insignificant impact of trade on CO_2 emissions. Similarly, Haisheng et al. (2005) find no direct impact of trade on EKC for China for the period 1990-2002.

Another approach for EKC analyzis is observing the impact of foreign direct investment (FDI) on the EKC model. The relationship between CO_2 emissions, energy consumption, FDI and GDP is discussed in several studies by including different combinations of these variables (such as He et al. (2012), Lee (2013), Linh and Lin (2015)). By using cointegration analyzis and Granger causality test, some studies show that there is a long run relationship between the aforementioned variables and CO_2 for Sub-Saharan African countries (Kivyiro and Arminen, 2014). This is also the case for Malaysia, Indonesia and Thailand of ASEAN-5 countries (Chandran and Tang, 2013). Furthermore, Pao and Tsai (2011) observe strong bidirectional causality between emission and FDI in BRIC (Brasil, Russia, India and China) countries for the period 1980-2007. On the other hand, Kim and Baek (2011) use the autoregressive distributed lag (ARDL) technique and cointegration test for a sample of 40 countries for the period 1971-2005. The results state that although income and energy have an impact on environment in the short run, FDI has no impact in the short run, yet a little impact in the long run. Similarly, Antweiler et al. (2001) use FDI as an additional explanatory variable and find a small effect of FDI on pollution level for 43 countries. However, Omri et al. (2014) develop a panel data model with a sample of 54 countries over the period 1990-2001. They observe a bidirectional causality between FDI inflows and CO_2 emissions.

Vast literature investigating the EKC hypothesis for Turkey includes the basic concept of EKC that refers to the relationship between the indicators of environment and income without taking other factors such as trade, foreign direct investment or factor endowment. Some of these papers use energy consumption as a dependent variable to test the causality relation with income, while others use CO_2 emissions. Soytas et al. (2001) search the causality relationships between energy consumption and GDP. Using the data for the period 1960-1995, they observe a unidirectional causality arising from energy consumption to GDP. Similarly, Lise and Van Montfort (2007) test the causality relationship between energy consumption and GDP. Their study shows a unidirectional causality running from GDP to energy consumption for the period 1970-2003, however, no support for EKC. Erdal et al. (2008) use the data of energy consumption and gross national product (GNP) for the period from 1970 to 2006 and they find a bidirectional causality between these two variables. On the other hand, Altinay and Karagol (2004) do not observe any causality between energy consumption and GDP in Turkey. Similarly, the study of Jobert and Karanfil (2007) also shows that there is not any linear cointegration relationship between energy consumption and real GNP in Turkey for the period 1960-2003. As another perspective for the relationship between energy consumption and economic growth, Say and Yucel (2006) develop a multi-linear regression model by using GNP and population growth. The results show that there are strong relationships between total energy consumption and these two variables. Basar and Temurlenk (2007) use CO_2 emissions and GDP data for the period 1950-2000 and they reject the EKC for Turkey, rather they find an inverted N-shaped relation. However, Omay (2013) observes N-shaped relation by using the same variables for the period 1980-2009. Similarly, Akbostancı et al. (2009) test the EKC hypothesis for 58 provinces in Turkey for the period 1992-2001. They find no evidence for EKC, but an N-shaped relationship. In addition, they observe a monotonically increasing relationship between CO_2 emissions and GDP.

Other studies extend EKC analyzis for Turkey by using additional variables in their models. Soytas and Sari (2009) analyze the effect of energy consumption and GDP on CO_2 emissions by controlling labor and gross fixed capital investment. According to their results, there is no long run causality between CO_2 emission and GDP. Moreover, Ozturk and Acaravcı (2010) investigate the causality relationships between CO_2 emissions, energy consumption and GDP. They find a long run relationship between these variables, and argue that EKC hypothesis is not valid for Turkey. Halicioglu (2008) also investigates these variables for the period 1960-2005. However, he adds the data of foreign trade to the model. He finds two Granger causality relationships. First one is between CO_2 emissions and energy consumption and second one is between CO_2 emissions and income. According to his results, although there are long run relationships between CO_2 emissions and all variables, income is the main determinant to explain the emissions in Turkey.

In 2001, Turkey has experienced the worst economic turbulence of her history. Starting with the post-crisis period, it has been one of the most attractive locations for foreign investment inflows due to its economic transformation that has been supported by dynamic market conditions and population, as well as regulations and standards (YOIKK, 2013). Furthermore, after 2008 global economic crisis, some regions of the world (especially European Union) have lost their attraction for investors because of the huge amount of debt stocks, while developing regions including Brazil, Russia, China have become the main engine for the global growth (YOIKK, 2013). Although, Turkey was affected by this global crisis and decreasing foreign investment inflows in these years, according to the Central Bank of the Republic of Turkey, FDI inflows to Turkey reached 12.5 USD billion in 2014. These FDI flows are generally unevenly distributed between sectors. In 2013, total share in manufacturing sector, electricity, gas and water supply, finance and real estate shows almost three quarters of total FDI (UNCTAD, 2014).

Based on the Kyoto Protocol, for protection of global environment, countries targeted to control emission at 5% between 1990 and 2008 as a first commitment period. Countries (including Turkey), which have not participated in the Kyoto Protocol, have reached 94.2% changes in CO_2 emissions from fuel combustion as a group, while others have accomplished -4.7% of Kyoto target. In Turkey, emission rose from 126.9 in 1990 to 285.7 $MtCO_2$ in 2011, an increase of 125.1% (IEA, 2013). Although there are some measures for environmental protection and important changes in energy supply, emissions are still increasing in Turkey due to economic growth. As a result, foreign investment inflows, especially in manufacturing and energy sectors, can be considered significant determinants for the emissions.

Our motivation sprouts exactly at this point. In this study, we attempt to test the EKC hypothesis for Turkey in the presence of FDI and trade indicators, which is the main contribution of this study. Although the literature on whether EKC is valid in Turkey is vast, it does not involve the potential effects of FDI and trade. Given that it has now been more than three decades since the country is liberalized the economy, it is crucial to see the impact of foreign investment and trade on the environment. Our study is based on Lau et al. (2014). In their study, they combine the variables of CO_2 emissions, GDP, FDI and trade openness in a time series model for Malaysia over the period 1970-2008. They use ARDL technique and Granger causality test to analyze the model. Their results show that the EKC hypothesis is valid in both the short and the long run. In addition, they show that FDI and trade affect CO_2 emissions directly and also indirectly through the economic growth in the short run. Following Lau et al. (2014), we examine the short and long run relationship and also causality relationship between these variables.

The exact structure of our econometric model and the data used will be described in the next section, with the scatter plots and other figures spelt out in the appendix. In section 2, we shall carry out discussing and evaluating the results. Finally, in last section, we shall make some concluding remarks.

1. Data and methodology

In this section, we shall present the data and the model framework and set up the appropriate tests to run. The first section will cover the Augmented Dickey Fuller test, cointegration test and regression analyzis. This will be followed by Granger causality test.

1.1. Model and data. We use annual data of GDP, FDI net inflows and trade openness to observe the relationship between CO_2 emissions and these variables. The data that are taken from the World Bank database and Central Bank of the Republic of Turkey include the period from 1974 to 2010 for Turkey. We take natural logarithmic form of GDP and FDI inflows to make differences smaller and reduce the effect of heteroscedasticity problem. By extending the EKC analyzis, we develop the following model.

$$ln\, CO_{2t} = \alpha + \beta_1 lnGDP_t + \beta_2 ln^2 GDP_t + \\ + \beta_3 lnFDI_t + \beta_4 Trade_t + e_t, \quad (1)$$

where $lnCO_{2t}$ is the logarithmic function of CO_2 emissions (metric tons per capita), $lnGDP_t$ and $lnGDP_t^2$ are the logarithmic functions of GDP (constant-price Turkish lira) and its square, $lnFDI_t$ is the logarithmic function of FDI net inflows (current US$) and finally, $Trade_t$ is trade openness which is represented by the total share of export and import in GDP.

When we look at the scatter plots (Figure 1 in Appendix) between CO_2 emissions and other explanatory variables, it is seen that CO_2 emissions are decreasingly growing when GDP increases. On the other hand, FDI inflows display a linear relationship with some deviations. Trade openness exhibits a positive linear relationship with more deviations than FDI does. According to Figure A.1 (see Appendix), when FDI flows, GDP and trade openness increase, CO_2 emission increases. Furthermore, we include GDP^2 into the model to check whether CO_2 emissions decrease after a certain point of GDP or not. In other words, we intend to check the existence of an inverse U-shaped relationship for Turkey stated by EKC theory. Hence, β_2 is expected to have a negative sign. Given the above structure, we attempt to explain the relationships between the variables for the short and long run by using the model given by equation (1).

Using equation (1) might result in a spurious regression because of the non-stationary variables. Therefore, unit root test, which is one of the most common stability testing techniques, should be performed in order to develop a more appropriate econometric model. The below tables show the unit root test analyzis for all variables in the model.

Table 1. Unit root test for all variables

Variables	Lag length	τ	τ_m	τ_t
$LnCO_2$	0	2.614	-0.822	-2.597
$D(LnCO_2)$	0	-4.823*	-5.829*	-5.737*
LnGDP	0	3.575	0.580	-1.723
D(LnGDP)	0	-4.509*	-5.891*	-6.036*
Ln^2GDP	0	3.581	0.632	-1.672
$D(Ln^2GDP)$	0	-4.494*	-5.874*	-6.039*
LnFDI	0	0.957	-0.908	-4.212*
D(LnFDI)	0	-8.311*	-8.535*	-8.489*
Trade	1	0.649	-1.269	-2.939
D(Trade)	1	-5.222*	-4.725*	-4.705*

*Significant according to MacKinnon (1996) one-sided 0.01% p-value.

Note: $LnCO_2$ LnGDP Ln^2GDP LnFD Trade are I(1).

We use Augmented Dickey Fuller test to prevent autocorrelation problem that is caused by using lagged variables in the model. According to the Augmented Dickey Fuller test results, the null hypothesis that claims that first-degree differences of all variables have unit root should be rejected. Therefore, the model should be developed by using the first-degree differences of the variables. If there is no cointegration, we get the following model:

$$\Delta(lnCO_{2t}) = \alpha + \beta_1 \Delta lnGDP_t + \beta_2 \Delta lnGDP_t{}^2 + \beta_3 \Delta lnFDI_t + \beta_4 \Delta Trade_t + e_t \quad (2)$$

The first-degree differences of variables that are obtained from equation (1) are denoted by the Greek letter "Δ". Having more than two variables can create a possibility of having more than one cointegration vector, i.e., the long run relationship. If there is cointegration between variables, we cannot use equation (2). Hence, we shall check long run and cointegration relationship. Before running any test for cointegration analyzis, we investigate appropriate lag length by using Vector Autoregressive (VAR) modeling techniques. Considering Akaike and Schwarz criteria, the optimal lag length is determined as "1".

GDP, FDI and CO_2 emissions may move together in the long run. That is why we shall now perform long run model. According to the results, long run equation is obtained as follows:

Table 2. Long run equation

Dependent variable: $LNCO_2$				
Method: least squares				
Sample: 1974 2010				
Included observations: 37				
White heteroskedasticity - consistent standard errors & covariance				
Variable	Coefficient	Std. Error	t-statistic	Prob.
C	-283.436	29.131	-9.730	0.000
LNGDP	30.755	3.236	9.505	0.000
$LNGDP^2$	-0.831	0.090	-9.246	0.000
LN(FDI)	0.011	0.010	1.107	0.277
TRADE	0.002	0.001	1.756	0.089
R-squared	0.982	Mean dependent var		0.969
Adjusted R-squared	0.980	S.D. dependent var		0.289
S.E. of regression	0.041	Akaike info criterion		-3.418
Sum squared resid	0.054	Schwarz criterion		-3.200
Log likelihood	68.227	Hannan-Quinncriter		-3.341
F-statistic	436.082	Durbin-Watson stat		1.171
Prob(F-statistic)	0.000			

Table 2 clearly shows long run relationship. It can be seen that GDP^2 has a negative sign as expected. In this case, are expected CO_2 emissions to increase when GDP, Trade and FDI increase, while GDP^2 decreases in the long run. Moreover, we calculate the turning point of environmental Kuznets curve from exp (30.755/(2*0.831)) and find approximately 108.777.327 Turkish lira.

This will be discussed in the next section.

After the estimation of long run model, we obtain residuals and test availability of unit root in accordance with the Engle-Granger (1969) cointegration method (see Table 3). The results of unit root test show that there is a cointegration relationship between variables.

Table 3. Cointegration test results

Null hypothesis: ER has a unitroot			
Exogenous: none			
Lag length: 0 (automatic - based on SIC, max lag=9)			
Augmented Dickey-Fuller test statistic		t-statistic	Prob.*
Test critical values:	1% level	-3.688	0.000
	5% level	-2.631	
	10% level	-1.950	
		-1.611	

Eventually, when we add the long run relationship into the short run relationship equation (2) and run this final model, we get the following model:

$$\Delta lnCO_{2t} = \alpha + ER(-1) + \sum_{i=0}^{k} \beta_{1i} \Delta lnGDP_{t-i} + \\ + \sum_{i=0}^{k} \beta_{2i} \Delta lnGDP_{t-i}{}^{2} \sum_{i=0}^{k} \beta_{3i} \Delta lnFDI_{t-i} + \\ + \sum_{i=0}^{k} \beta_{3i} \Delta Trade_{t-i} + e_t. \quad (3)$$

The results of this test will be shown and discussed in the following section.

2. Results and discussions

After unit root tests and cointegration analyzes, we find the general equation. Next, we run this equation for regression analyzes in E-views software program. The results are shown in Table 4.

According to the test results, model and coefficients of FDI, GDP and GDP^2 are statistically significant at 10% significance level. Trade has no significant effect on CO_2 emission in the short run. It is also seen that goodness of fit is sufficiently high. Based on the R^2 value, we see that the model with first difference levels of Trade, FDI, GDP and GDP^2 can explain 61% of the variation in CO_2 emissions. In addition, the error correction term (ER) is –0.37. This indicates that when there is a deviation in the equilibrium level of CO_2, this deviation adjusts at the level of 37% after one year. In this case, the total adjustment process takes almost three years. ER also represents the long run relationship. Since the coefficient of ER is negative and statistically significant, CO_2 emission has long run relationships with GDP, GDP^2, FDI and Trade.

Table 4. Regression test results

Dependent variable: D(LNCO2)				
Method: least squares				
Sample (adjusted): 1975 2010				
Included observations: 36 after adjustments				
White heteroskedasticity – consistent standard errors & covariance				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.020	0.010	1.994	0.055
D(LGSMH)	0.984	0.175	5.634	0.000
D(LGSMH)^2	-7.534	3.172	-2.375	0.024
D(LNFDI)	-0.012	0.006	-1.789	0.084
D(TRADE)	0.002	0.001	1.402	0.171
ER(-1)	-0.376	0.147	-2.556	0.016
R-squared	0.610	Mean dependent var		0.026
Adjusted R-squared	0.545	S.D. dependent var		0.052
S.E. of regression	0.035	Akaike info criterion		-3.709
Sum squared resid	0.037	Schwarz criterion		-3.446
Log likelihood	72.770	Hannan-Quinncriter		-3.617
F-statistic	9.388	Durbin-Watson stat		1.930
Prob(F-statistic)	0.000			

White Obs*R-squared 3.355 Prob. Chi-Square(5) 0.645.
ARCH Obs*R-squared 1.422Prob. Chi-Square(1) 0.233.
Jarque-Bera 0.220 Prob. 0.890.
Breusch-Godfrey Serial Correlation LM Chi-Square(2)0.189, Prob. 0.909.

We find that Trade affects the CO_2 emissions positively in long run, but insignificantly in short run. Moreover, it is found that FDI affects CO_2 emissions negatively in the short run, but positively in the long run. In the model, there are both GDP and GDP^2, so we use Wald test statistics to see the net short run effect. According to the Wald test results, there is also short run effect of GDP on CO_2 emissions (Chi-Square = 4.539, Pr. = 0.033). This means EKC is also valid in the short run. We also calculate the turning point of environmental Kuznets curve for the short run and find 0.065 (from 0.984/ (2* 7.534) formula).

We shall now carry on with the Granger test to see the causality relationship between variables.

2.1. Granger causality analyzis. We use Granger causality test technique to investigate the causality relationship between CO_2 emissions, GDP, FDI inflows and trade openness. The Granger causality test, first used by Granger (1969), is a statistical hypothesis test to see if one time series can forecast another. The test results of Granger causality test are shown below.

Table 5. Causality analysis test results

Pairwise Granger causality tests			
Sample: 1974 2010			
Lags: 1			
Null hypothesis:	Obs	F-statistic	Prob.
LNFDI does not Granger cause $LNCO_2$	36	4.310	0.046
$LNCO_2$ does not Granger cause LNFDI	36	13.757	0.001
LNGDP does not Granger cause $LNCO_2$	36	0.366	0.549
$LNCO_2$ does not Granger cause LNGDP	36	0.071	0.791
TRADE does not Granger cause $LNCO_2$	36	8.771	0.006
$LNCO_2$ does not Granger cause TRADE	36	1.181	0.285
DLNFDI does not Granger cause $DLNCO_2$	35	0.000	0.985
$DLNCO_2$ does not Granger cause DLNFDI	35	0.434	0.515
DLNGDP does not Granger cause $DLNCO_2$	35	0.247	0.623
$DLNCO_2$ does not Granger cause DLNGDP	35	1.161	0.289
DTRADE does not Granger cause $DLNCO_2$	35	0.227	0.637
$DLNCO_2$ does not Granger cause DTRADE	35	0.052	0.821

Analogous to Soytas and Sari (2009), we find no Granger causality relationship between CO_2 emissions and GDP. On the other hand, we find a bidirectional causality relationship between FDI and CO_2 emissions. As a result, when a shock occurs in one of these two variables, it is expected to affect the other variable. Moreover, there is a unidirectional causality running from Trade to CO_2 emissions. Therefore, a shock in Trade results in another shock in CO_2 emissions. Besides all these, there is not any short run causality relation in the model.

In his study, Halicioglu (2008) finds that the sign of the coefficient of GDP^2 is negative, hence, this may be an indication for the validity of the EKC hypothesis in Turkey. However, he refers to graphical representation of the data that show the relationship between CO_2 emissions and GDP; and he claims that there is no evidence for EKC, although his test results prove opposite. Like Halicioglu (2008), we use cointegration methods and find a negative coefficient for GDP^2 in our regression model. In addition, we use restriction method to see the total combined effect of GDP and GDP^2 on CO_2 emissions. According to the results, this total effect is not zero[1]. This supports the findings of our regression model, which show an inverted U-shaped relationship between CO_2 emissions and GDP. Therefore, our study provides an evidence for EKC hypothesis and we can say that after a certain point, CO_2 emissions decrease with GDP. These findings are also in line with Lau et al. (2015) and the references therein. For EKC to be realized in Turkey, the GDP should be 108.777.327 TL. After this level, we expect a reduction in emissions.

The turning point in the short run is 0.065. This means that EKC occurs in Turkey in the short run if the annual growth rate is 6.5%. The average growth rate in Turkey has been 4.52% during 2010-2015. Within our data period (i.e., 1974-2010), it was 4%.

Based on the CUSUM of Squares analyzis, we do not observe any situation that conflicts with the stability. Moreover, according to the Ramsey RESET tests statistics, there is no specification error in our model (for Ramsey RESET, F = 0.41, Pr. = 0.52). Therefore, it can be said that predictions and inferences are consistent. It would not be wrong to say that the final econometric model has quite explanatory effect.

According to the Granger causality test, there is a bidirectional causality between foreign direct investment and CO_2 emissions in the long run. This means that an increase in FDI leads to an increase in CO_2 emissions. Similarly, an increase in CO_2 emissions results in an increase in FDI. An increase in

[1]LR test for binding restrictions (rank = 1): Chi-square (1): 90.48, Probability: 0.000.

CO_2 emissions may create a perception of lack regulations for pollution. This represents an attractive environment image for foreign investment and, therefore, may increase FDI. In addition, the results show that there is a unidirectional causality coming from trade to CO_2 emissions. A natural proposition out of these results would be putting up environmentally stricter regulations to eliminate the social costs on welfare of increased amount of FDI activities and trade.

The foreign direct investment seeks countries in which they can perform production activities in more favorable conditions and achieve more profits. The location decision of foreign direct investment is influenced by structural features and policy decisions of the host countries. This may result in a race between countries to attract foreign direct investment. For this reason, countries may design their policies in favor of FDI and impose less strict environmental regulations. According to the study of Low and Yeates (1992), polluting industries have been moved through foreign direct investments to the countries with low level of environmental standards during the 1970s and 1980s[2]. Similarly, Xing and Kolstad (2002) analyze the relationship between FDI and environmental regulations. It is found that there is a negative relationship between FDI and strict environmental regulations for pollution-intensive industries such as chemical and metal. In addition, Kalamova and Johnstone (2011) also examine the FDI inflows by using the data from 27 OECD source countries and 99 host countries for the period 2001-2007. Their results show that there is an inverse U-shaped relationship between the lax environmental standards and FDI inflows for both developed and developing countries. It means that when the environmental standards fall below a certain level, countries lose their ability or attractiveness to attract investments. On the other hand, Jorgenson (2009) finds that there is a positive relationship between CO_2 emissions and foreign direct investment in the secondary sector in less developed countries by using the data of 1975-2000. This implies that foreign capitals especially operating in manufacturing industry are less eco-efficient and, hence, they tend to be more harmful for the environment in those countries. Basically, these studies show that many countries have faced the trade-off between attracting foreign direct investment and risking environment. According to our results, which present a significant and positive relationship between foreign direct investment inflows and CO_2 emission, Turkey seems to be one of these countries. Therefore, to protect environment and ensure sustainable growth, the government should take some measures in terms of compositions and operations of foreign investment. This concern also should be taken into account while designing trade policies, as there is a positive relationship between trade and CO_2 emissions in Turkey.

Conclusions

In this study, we extend the EKC analyzis by adding foreign direct investment and trade parameters for Turkey. By using annual data for the period 1974-2010, we apply cointegration and causality test techniques to analyze the short and long run effects and causality relationships. We find an inverted U-shaped relationship between CO_2 emissions and GDP. Therefore, our results support the EKC hypothesis for Turkey.

GDP, GDP^2, FDI and trade openness have an impact on CO_2 emissions in the long run. Trade affects CO_2 emissions positively in the long run, but insignificantly in the short run, while FDI affects CO_2 emissions negatively in the short run, but positively in the long run. We also find a bidirectional causality relationship between CO_2 emission and FDI, and a unidirectional causality running from trade openness to CO_2 emissions for Turkey.

Trade and investment liberalization are often thought to create pollution heavens by developing channels through which polluting industries may shift to less developed countries. Turkey, after almost two decades of import substitution industrialization period, turned its face to export oriented growth strategies in 1980 and gradually liberalized its markets throughout the years. Eventually, the trade volume has significantly increased. On the other hand, Turkey has not attracted a significant amount of foreign direct investment until after 2003. Since then, attracting foreign direct investment inflows has been a major issue for the government. Our results imply that the Turkish government needs to be cautious while designing policies regarding both trade and investment due to environmental externalities. Instead of more foreign direct investment and higher volume of trade, the government shall prefer an environmentally sustainable foreign direct investment and trade.

The bidirectional causality between foreign direct investment and CO_2 implies that not only foreign direct investment causes CO_2 emissions, but increased emissions also attract FDI. In addition,

[2]For a theoretical background, see Kayalica and Lahiri (2005) and the references there in.

bidirectional causality between trade and CO_2 shows that trade increases emissions. These results are in parallel with the view that trade and investment liberalization leads to pollution havens through the migration of polluting industries to less developed countries or to countries with lax environmental regulations in general. Together, these results imply that there is a room for stricter environmental-related policies in Turkey. The policy alternatives to improve the environment and achieve a greener economy that are dedicated to regulate trade and investment atmosphere in a country are paramount. From product standards to process standards, from taxes to subsidies one could name many of such policy tools. Besides these environmental policy tools, there are also trade and investment measures that could also improve the environment. Amongst others, liberalization of environmental goods and services, protection of investments in green market building activities through trade-related investment agreements are some of them. Obviously, these policies would need to be in coordination with international rules, policies and institutions, such as World Trade Organization (WTO), UNCTAD, United Nations Environment Programme (UNEP) and Multilateral Environmental Agreements (MEAs), etc.

The results of this study underline the importance of the need to further investigate the role of trade and foreign direct investment on the environment by focusing on the polluting industries in trade and investment rather than using the general figures of these parameters. Needless to say, this requires a more detailed data set, in particular regarding the foreign direct investment.

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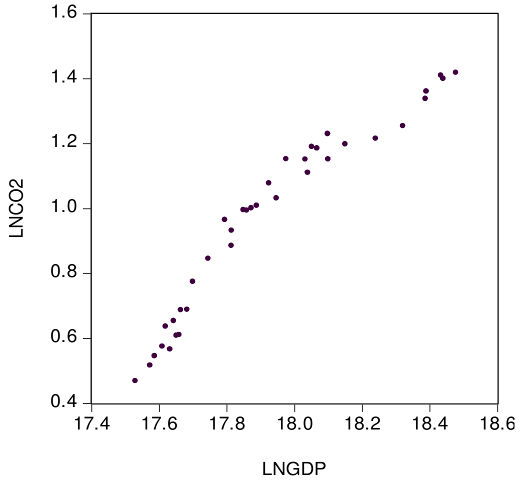
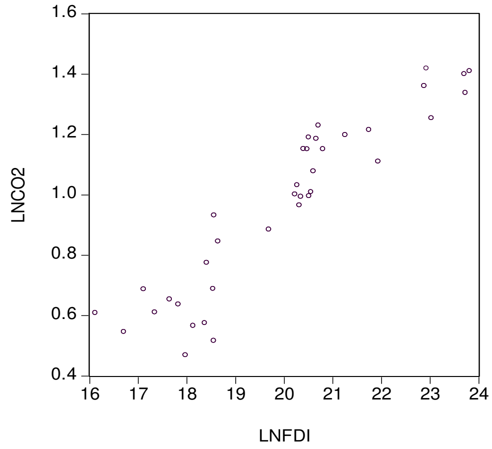
Appendix





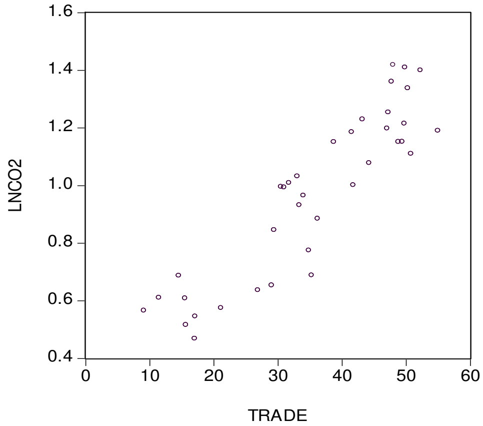


Fig. 1. Scatter plots for ln(CO_2) and explanatory variables