An Empirical Analysis of the Relationship among Foreign Direct Investment, Gross Domestic Product, CO$_2$ Emissions, Renewable Energy Contribution in the context of the Environmental Kuznets Curve and Pollution Haven Hypothesis Regarding Turkey

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Abstract

This study examines the relationships between GDP per capita, CO$_2$ emission, Renewable Energy Contribution (REC) and Foreign Direct Investment (FDI) and evaluates the Environmental Kuznets Curve (EKC) and Pollution Haven Hypothesis (PHH) for Turkey. The EKC theory says that with increase in income per capita the pollution also increases but in a turning point when nation become richer pollution starts to decrease according to stringency of environmental regulations and implying advanced green technologies due to requirement of nation. In another hand the PHH assume that due to stringency of environmental regulations and high taxes the production become more expensive in developed countries, thus those dirty industries shifts from environmentally stricter developed countries to poor regulated developing countries. The aim of this study to analyze and investigate: which theory (EKC or PHH) does exist in Turkish economy and does FDI has positive impact on sustainable development. The time series datasets (FDI, GDP, CO2 and REC) , those were obtained from World Bank database, which covers the time period 1970-2014 were utilized in employed statistical models as the ADF Unit Root, Philips – Perron, Johansen co-integration, and the Granger Causality tests, to accomplish the empirical part of the paper. Based on the empirical results, it was approved that there wasn`t existence of the EKC theory in Turkish economy. But according to obtained empirical results it was affirmed that there was the presence of the PHH theory in Turkish economy which means the FDI has a negative impact on sustainable development of Turkish economy. Thus, the developed countries with stricter environmental regulations (mostly from Europe) relocate their heavily polluted dirty industries to Turkish economy.

Keywords: Foreign Direct Investment, CO$_2$ Emissions, Gross Domestic Product, Renewable Energy Contribution, Environmental Kuznets Curve, Pollution Haven Hypothesis, ADF and Philips-Perron Unit root tests, Johansen Co-integration test, Granger Causality test

1. Introduction

The protection of the World from environmental degradations has become one of the most important missions of nations. The one of the urgent cases among pollution is a carbon dioxide (CO2) emission which comes from human activities such as: cement production, deforestation as well as the burning of fossil fuels like coal, oil and natural gas. The first time this urgent issue came up on the agenda by United Nations Framework Convention on Climate Change in 1992, the international community has entrusted its secretariat with a growing responsibility to strengthen the global response to climate change and close the gap between ambition and achievement ("UN Climate Change Annual Report 2017 Website Now Live | UNFCCC," n.d.). In 1997, the world`s nations recognized the significance of environmental pollution with the increasing level of CO2 emissions, Parties to the Convention adopted the Kyoto Protocol, which created binding emission reduction targets for developed countries. During its first commitment period, 2008– 2012, 36 industrialized countries and the European Union pledged to reduce their emissions by an average of just over five per cent compared with 1990 levels ("UN Climate Change Annual Report 2017 Website Now Live | UNFCCC," n.d.). In Paris in December 2015, countries bound oneself to limit the rise of global average temperature to well below 2 °C and as close as possible to 1.5 °C above pre-industrial levels and to prevent dangerous human-induced climate change with signing the latest and ambitious Paris Agreement ("UN Climate Change Annual Report 2017 Website Now Live | UNFCCC," n.d.).

Furthermore, with globalization processes, liberalization and free movement of capital made foreign direct investment inflows to be rapidly intensified in 1980-1990s in the world arena. There is both a positive and negative impact of FDI for the host country. As a positive effect of FDI on the host country it can be considered the flow of finance, capital, new management and new advanced technology. Thus, they can encourage the country to replace old technologies with modern environmentally friendly technologies. But the environmental pollutions can also be raised through FDI (capital intensive dirty industries). We can take in consideration 2 hypotheses in this case, Environmental Kuznets Curve (EKC) and Pollution Haven Hypothesis (PHH). The EKC theory says that, with increase in income per capita pollution, also, increases but in a turning point when nation become rich they will require clean environment and the government will strengthen environmental regulations and due to this issue (to avoid high taxes) the companies will apply clean technologies for production. The PHH says that because of stringent environmental regulations and high taxes, the developed countries transfer their heavy-polluting industries to lax environmental regulated developing countries.

The main purpose of this study reconsider the relationship between Foreign Direct Investments, CO_2 emissions, Renewable Energy Contribution and Gross Domestic Product. Additionally, to investigate which theory (EKC or PHH) exists in economy of Turkey. The content of paper will be structured as follows: In section 2 literature reviews will be expounded, in section 3 data description will be shown, in section 4 methodology will be disclosed, in section 5 empirical results from employed statistical analysis will be expounded, in section 6 conclusion will be described and finally in section 7 references will be shown.

2. Literature review

2.1 Theoretical studies

#### 2.1.1 Environmental Kuznets Curve hypothesis (EKC) and FDI linkage

The Environmental Kuznets U-shaped Curve was invented by Simon Kuznets in 1955 (later was awarded with Nobel Prize in 1971), in which the relationship between growth in per capita income and environmental degradation illustrated by U-shaped Curve. Therefore, EKC hypothesis was introduced and became more popular with Grossman and Krueger`s publications (G. Grossman & Krueger, 1991; G. M. Grossman & Krueger, 1995) and World Bank Report (Shafik & Bandyopadhyay, 1992). According to EKC theory (opposite to PHH) the pollution is increased in poor nations with economic growth and is decreased when nation reaches higher income level, based on the relationship between income level and environmental degradation takes the inverted U-shape (Kerekes, Marjainé Szerényi, & Kocsis, 2018). This happens because developing (poor) countries don`t have enough advanced technologies or capital for implementing such kind of technologies for pollution abatement versus developed (rich) countries have enough level of technologies and capital for implementing these technologies (K. V. Murthy & Gambhir, 2018) (See Graph 1). Therefore, Foreign Direct Investment flows from developed countries which bear to uphold strict environmental standards, because of stringent regulations. Those companies can use energy-saving production which the developed countries transfer from home countries to invested country to influence for energy-efficiency in the host country. Thus, in the context of above mentioned claims, the Foreign Direct Investment can transfer new type of advanced environmentally friendly technologies and human capital, based on these the FDI can have positive effect on environmental performance and raise environmental standards through the transfer of cleaner technology and better management practices, which in turn leads to the incline in the usage of renewable energy and decreasing of CO_2 emissions (Marton & Hagert, 2017).

2.1.2 Pollution Haven Hypothesis (PHH) and FDI linkage

The Pollution Haven Hypothesis implies that polluting industries will relocate to environmentally poorly regulated administrations. The PHH was first postulated against of EKC theory by Copeland and Taylor (Copeland & Taylor, 1994) in the context of North-South trade under NAFTA. It was the first paper that links the environmental regulation stringency and trade patterns with the level of pollution in a country (Gill, Viswanathan, & Karim, 2018). The PHH argues that, the developed countries transfer the pollution intensive industries to less developed countries with unrestricted environmental regulations to avoid huge amount of taxes. Thus, if we will apply EKC U-curve for PHH we can see that till the developing country will reach to developed ones, the pollution will be increased parallel with economic growth, but after in a certain amount of costs of pollution the developed countries will shift pollution intensive industries to the developing countries with lax environment standards (See Graph 2). Afterwards developing countries will see increase in economic growth but parallel increase in pollution due to pollution intensive industries which were transferred from developed countries

(Levinson & Taylor, 2008). The countries that apparent to become pollution havens are capital intensive, thus will attract MNCs (Foreign Direct Investment) with capital-intensive industries. In the developing countries (host countries) capital is cheaper (capital intensive industries) therefore, by definition these kind of capital is more pollution intensive. Thus, it can affect negatively in the usage of renewable energy and increase of CO_2 emissions (Marton & Hagert, 2017).

Graph 1: Environmental Kuznets Curve
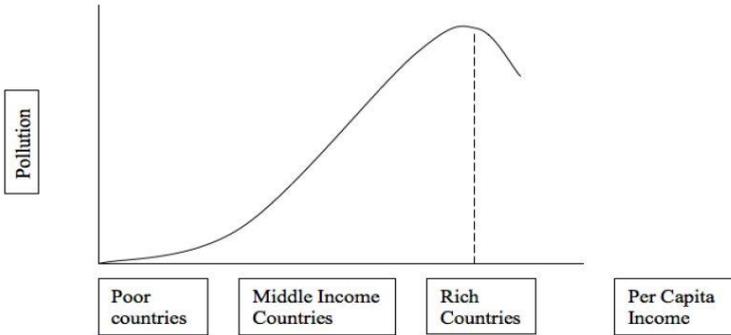
Source: **EKC** (K. B. Murthy & Bhasin, 2016)

Graph 2: Illustrating PHH in EKC Curve (A development- environment relationship)
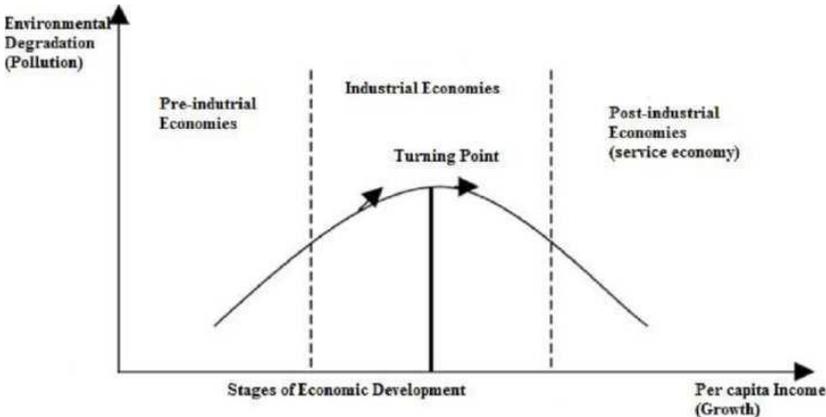
Source: (Panayotou, n.d.)

2.2 Empirical studies

The relationship between GDP, FDI and Environmental degradation has been the subject of intense research during the last decades. The empirical studies gave the various results due to analyzed country, amount of series and applied empirical models. Thus, some of those studies showed the existence of EKC and vice versa in analyzed region. In another hand some of those studies also showed existence of PHH and vice versa in examined country. Additionally, in some research it has been found that FDI has positive relationship with environmental degradation and vice versa. For instance, (Hitam & Borhan, 2012), analyzed the Gross Domestic Product (GDP) growth and the environmental degradation for the time period 1965 – 2010 in Malaysia. The relationship between foreign direct investment and environmental degradation has been examined by applying the non-linear model. The results indicated that environmental Kuznets curve existed and foreign direct investment increased environmental degradation. (Khandker, Amin, & Khan, 2018) explored the relationship between FDI and renewable energy consumption from 1980-2015 in the

context of Bangladesh. The Johansen`s co-integration test, Granger Causality test, VECM and Cusum test were applied to analyze series. The Johansen's co-integration test confirms that variables are co-integrated in the long run and Granger causality test reveals that there is bidirectional causality between those variables of interest. Through Vector Error Correction Model (VECM), they found no causality between the variables in the short run. The CUSUM test results show that variables were stable. According to results Policies regarding attracting more FDI should be considered to increase the investment in Renewable energy sector. In the another hand, (Aslanidis & Iranzo, 2009), examined the relationship between growth in per capita income and environmental degradation from 1971-1997. The smooth transition regression (STR) model has been applied for empirical part. The results supported EKC hypothesis. (Jbara, n.d.), examined whether to find evidence that these changes over time are consistent with the PHH or EKC for a three different year 1990, 1995, 2000 in 36 countries. The linear regression model and descriptive statistics were utilized for empirical part. According to the results, there was little evidence to suggest that an EKC existed. There was no evidence to support the PHH. (Cole, 2004), examined the extent to which the EKC inverted U relationship can be explained by trade and specifically the migration or displacement of 'dirty' industries from the developed regions to the developing regions (the pollution haven hypothesis (PHH)). According to results the PHH was existed. (Naz et al., 2019), examined the relationship between renewable energy consumption (REC), foreign direct investment (FDI) inflows, economic growth, and their resulting impact on CO_2 emissions for the time period 1975-2016 in Pakistan. The results show that economic growth and FDI inflows both increased CO_2 emissions, while REC substantially decreased CO_2 emissions during the studied time period. The results do not support the inverted U-shaped Environmental Kuznets Curve (EKC) hypothesis for per capita income (and FDI inflows) and per capita CO_2 emissions in a country. The results supported 'pollution haven hypotheses where FDI inflows damage the natural flora of the country. (Leitão, 2014) examined the correlation between economic growth, carbon dioxide emissions, renewable energy and globalization for the period 1970-2010, using time series (OLS, GMM, unit root test, VEC model, and Granger causality) in Portuguese economy. OLS estimator and GMM model demonstrated that carbon dioxide emissions and renewable energy are positively correlated with economic growth. The econometric models also show that the overall index of globalization had a positive effect on growth. The Granger causality reported a unidirectional causality between renewable energy and economic growth. (Balibey, 2015) examined 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. The causality relationships investigated by using the Johansen Co-integration test, The Granger Causality Test, Impulse-Response and Variance Decomposition Analysis of vector autoregression model (VAR) model. The causality relationships displayed that FDI (LFDI) and economic growth (LGDP) had a significant effect on carbon dioxide emissions (LCO2). Moreover, impulse-response functions and variance-decompositions of VAR model supported these relationships among LGDP, LCO2 and LFDI. The study investigated 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 leaded to degradation of environment and depletion of natural resources. (Pazienza, 2015) examined the relationship between Foreign Direct Investment (FDI) and the environment from 1981-2005 by using panel data analysis. The result of the analysis showed the existence of negative relationships characterizing the technique, scale and cumulative effects of FDI on CO_2. (Linh & Lin, 2014) examined the dynamic relationships between CO_2 emissions, energy consumption, FDI and economic growth for Vietnam in the period 1980-2010 based on Environmental Kuznets Curve (EKC) approach. The empirical results obtained from co-integration, and Granger causality tests didn`t supported the EKC theory in Vietnam. However, the co-integration and Granger causality test results indicate a dynamic relationship among CO_2 emissions, energy consumption, FDI and economic growth. The short-run bidirectional relationship between Vietnam's income and FDI inflows implied that the increase in Vietnam's income would attract more capital from overseas. (Mert & Bölük, 2016) examined the impact of foreign direct investment (FDI) and the potential of renewable energy consumption on carbon dioxide (CO_2) emissions in 21 Kyoto countries. Panel causality tests showed that there were significant long-run causalities from the variables to carbon emissions, renewable energy consumption, and fossil fuel energy consumption and inflow foreign direct investments. The results of their model supported the pollution haloes hypothesis which stated that FDI brought clean technology and improved the environmental standards. However, an inverted U-shaped relationship (EKC) was not supported by the estimated model for the 21 Kyoto countries. Another important finding was that renewable energy consumption decreased carbon emissions.

3. Data Description

This investigation considers the secondary time series dataset, which was obtained from the World Bank Database[1] for the period span from 1970 to 2014. All variables were converted into logarithms namely LnFDI, LnGDP, LnCO2 and LnREC. The Eviws-8 has been used for empirical part of paper. These four variables were utilized in the model:

FDI – Foreign direct investment: Inward and outward flows and stock, annual (current US$)

GDP – GDP per capita (US$)

CO2 – Carbon dioxide emissions (kt) are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced

REC - Renewable Energy (toe) contribution of renewables to total primary energy supply (TPES)

4. Methodology

4.1 Augmented Dickey-Fuller Unit Root Test

The Augmented Dickey-Fuller test was developed by David Dickey and Wayne Fuller, American statisticians, in 1979. The Dickey-Fuller test is used to determine whether a unit root, a feature that can cause issues in statistical inference, is present in an autoregressive model. [2] ADF test equation is[3] (1):

$y_t = c + \delta t + \phi y_{t-1} + \beta 1 \Delta y_{t-1} + \ldots + \beta p \Delta y_{t-p} + \varepsilon t \ldots\ldots\ldots(1)$

Where

Δ is the differencing operator, such that $\Delta y_t = y_t - y_{t-1}$.

The number of lagged difference terms, p, is user specified.

εt is a mean zero innovation process.

The null hypothesis of a unit root is

H0: ϕ =1.

Under the alternative hypothesis, ϕ <1.

Variants of the model allow for different growth characteristics. The model with $\delta = 0$ has no trend component, and the model with $c = 0$ and $\delta = 0$ has no drift or trend. The test that fails to reject the null hypothesis, fails to reject the possibility of a unit root.

To estimate the significance of the coefficients in focus, the modified T (Student)-statistic (known as Dickey-Fuller statistic) is computed and compared with the relevant critical value: if the test statistic is less than the critical value then the null hypothesis is rejected. Each version of the test has its own critical value which depends on the size of the sample[4].

4.2 Philips-Perron Unit Root Test

The Phillips-Perron (PP) unit root test was developed by statisticians, Peter C.B. Phillips and Pierre Perron, in1988. Though the PP unit root test is similar to the ADF test, the primary difference is in how the tests each manage serial

[1]World Bank Database

https://data.worldbank.org/country/turkey

[2] ThoughtCo, The Augmented Dickey-Fuller Test

https://www.thoughtco.com/the-augmented-dickey-fuller-test-1145985

[3] MathWorks, The Augmented Dickey-Fuller Test

https://www.mathworks.com/help/econ/adftest.html?s_tid=doc_ta

[4] RTMath, Mathematics experts in quantitative finance

https://rtmath.net/help/html/93a7b7b9-e3c3-4f19-8a57-49c3938d607d.htm

correlation. Where the PP test ignores any serial correlation, the ADF uses a parametric autoregression to approximate the structure of errors.[1] The mathematical equation of test is[2] (4)

$$yt = c + \delta t + a\, y_{t-1} + e(t) \ldots\ldots (4)$$

Where $e(t)$ is the innovations process.

The test assesses the null hypothesis under the model variant appropriate for series with different growth characteristics ($c = 0$ or $\delta = 0$). To estimate the significance of the coefficients in focus, the modified T (Student)-statistic (known as Phillips-Perron statistic) is computed and compared with the relevant critical value: if the test statistic is less than the critical value then the null hypothesis is rejected. Each version of the test has its own critical value which depends on the size of the sample.

4.3 Johansen Co-integration test

The Johansen co-integration test was developed by Danish statistician, Soren Johansen, in 1991. It is a statistical model for testing co-integration between several series those are integrated in order $I(1)$ at 1st difference through trace and eigenvalue tests. The mathematical equation of test is[3] (5):

$$y_t = \mu + A_1 y_{t-1} + \cdots + A_p y_{t-p} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

H_0= there is no co-integration between analyzed series.

H_1= there is at most 1 co-integration between analyzed series.

Null hypothesis or alternative hypothesis will be accepted if p-value > 0.05.

4.4 Granger Causality Test

The Granger causality test was developed by British statistician, Sir Clive William John Granger in 1969. It is a statistical concept of causality that is based on prediction. According to Granger causality, a variable X is causal to variable Y if X is the cause of Y *or* Y is the cause of X[4]. The mathematical equation of test is (6):

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \ldots + \alpha_m y_{t-m} + \mathrm{error}_t \ldots\ldots\ldots (6)$$

H_0= X doesn`t Granger Cause Y and Y doesn`t Granger Cause X.

Null hypothesizes will be accepted if p-values is more than 0.05.

5. Empirical Results

The time series plots for FDI, GDP, CO2 and REC were illustrated in Figure 1 for checking stationary of time series.

Figure 1: Time Series plots for FDI, GDP, CO2 and REC

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[1] ThoughtCo, The Augmented Dickey-Fuller Test
https://www.thoughtco.com/the-augmented-dickey-fuller-test-1145985
[2] MathWorks, Phillips-Perron test for one unit root
https://www.mathworks.com/help/econ/pptest.html
[3] IMF - International Monetary Fund, Testing for Co-integration Using the Johansen Methodology when Variables are Near-Integrated
https://www.imf.org/external/pubs/ft/wp/2007/wp07141.pdf
[4] Statistics How To, Granger Causality Test
https://www.statisticshowto.datasciencecentral.com/

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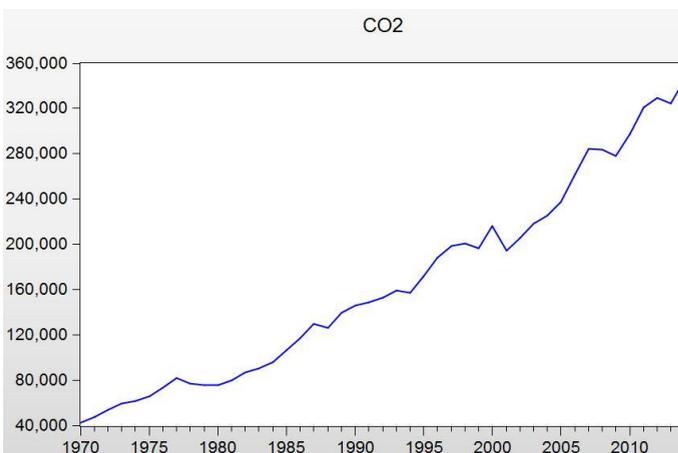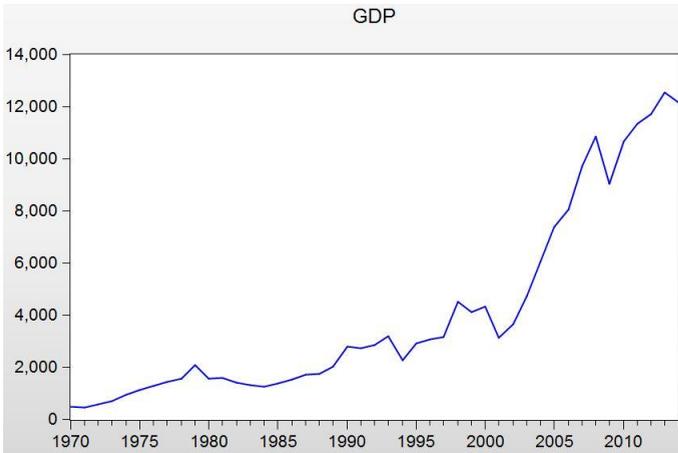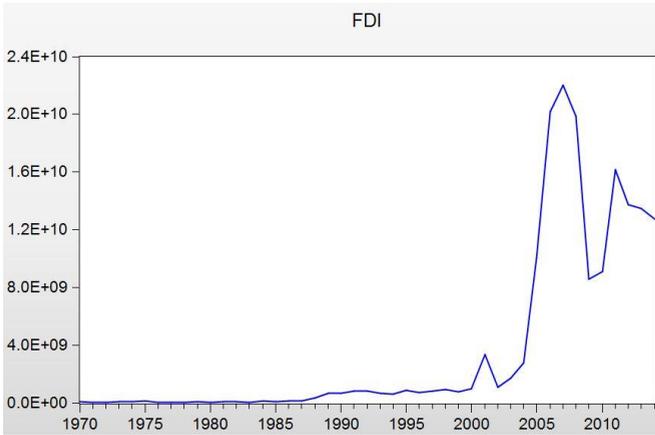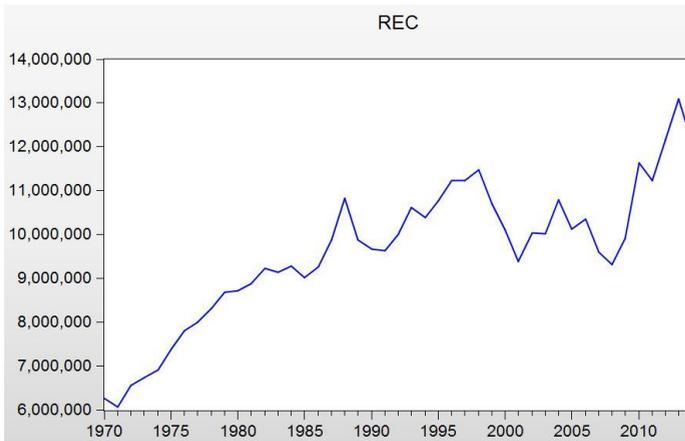
Source: Author`s own invention based on World Bank Database (E-views 8)

According to graphs it has been seen that all series are non-stationary. Furthermore, the Augmented Dickey-Fuller and Phillips-Perron Unit Root Tests have been applied to determine the stationary of time series.

5.1 Augmented Dickey-Fuller Unit Root Test

As the pre-condition of Johansen co-integration test proposes, selected time-series must be non-stationary at a level and stationary at the 1st difference. Thus, the ADF test individually has been performed on the variables. According to the result of ADF test, the null hypothesis that series has a unit root at levels should be accepted, because T-statistics are less than critical values at 1% and 5% level of significance and P-values of variables are more than 0.05. Thus, after taking the first difference, the series became stationary according to these outputs: T-statistics more than critical values at 5% level of significance and P-values less than 0.05. Based on results, the null hypothesizes that series have unit root at 1st difference should be rejected. Thus, ADF results showed that the observed series appeared to be integrated of order one (I (1)) (See Table 1).

Table1: Augmented Dickey Fuller unit root test results

Null Hypothesis: (LnCO2) has a unit root					
Variables	ADF Test Statistic	Level	Critical values	Prob*	Conclusion
LnCO2 at level	-1.475990	5%	-2.931404	0.5361	Non-stationary
Null Hypothesis: (DLnCO2) has a unit root					
Variables	ADF Test Statistic	Level	Critical values	Prob*	Conclusion
LnCO2 at 1st difference:	-5.517142	5%	-2.933158	0.0000	Stationary
Null Hypothesis: (LnGDP) has a unit root					
Variables	ADF Test Statistic	Level	Critical values	Prob*	Conclusion
LnGDP at level:	-1.294479	5%	-2.931404	0.6237	Non-stationary
Null Hypothesis: (DLnGDP) has a unit root					
Variables	ADF Test Statistic	Level	Critical values	Prob*	Conclusion
LnGDP at 1st difference:	-3.962755	5%	-2.933158	0.0037	Stationary
Null Hypothesis: (LnREC) has a unit root					
Variables	ADF Test Statistic	Level	Critical values	Prob*	Conclusion
LnREC at level:	-2.484286	5%	-2.931404	0.1262	Non-stationary
Null Hypothesis: (DLnREC) has a unit root					
Variables	ADF Test Statistic	Level	Critical values	Prob*	Conclusion
LnREC at 1st difference:	-4.464795	5%	-2.933158	0.0009	Stationary

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Null Hypothesis: (LnFDI) has a unit root					
Variables	ADF Test Statistic	Level	Critical values	Prob*	Conclusion
LnFDI at level:	-0.439081	5%	-2.931404	0.8930	Non-stationary
Null Hypothesis: (DLnFDI) has a unit root					
Variables	ADF Test Statistic	Level	Critical values	Prob*	Conclusion
LnFDI at 1st difference:	-5.518338	5%	-2.933158	0.0000	Stationary

Source: Author`s own calculations

5.2 Philips-Perron Unit Root Test

Additionally, Philips-Perron Unit Root Test was performed for checking stationary level of series. According to the result of PP test, the null hypothesis that series has a unit root at levels should be accepted, because T-statistics are less than critical values at 1% and 5% level of significance and P-values of variables are more than 0.05. Thus, after taking the first difference, the series became stationary according to these outputs: T-statistics more than critical values at 5% level of significance and P-values less than 0.05. Based on results, the null hypothesizes that series have unit root at 1st difference should be rejected. Thus, PP results showed that the observed series appeared to be integrated of order one (I (1)) (See Table 2).

Table 2: Philips – Perron Unit Root Test results

Null Hypothesis: (LnCO2) has a unit root					
Variables	PP Test Statistic	Level	Critical values	Prob*	Conclusion
LnCO2 at level LnCO2	-1.984542	5%	-2.929734	0.2923	Non-stationary
Null Hypothesis: (DLnCO2) has a unit root					
Variables	PP Test Statistic	Level	Critical values	Prob*	Conclusion
LnCO2 at 1st difference:	-6.089665	5%	-2.931404	0.0000	Stationary
Null Hypothesis: (LnGDP) has a unit root					
Variables	PP Test Statistic	Level	Critical values	Prob*	Conclusion
LnGDP at level:	-0.991199	5%	-2.929734	0.7483	Non-stationary
Null Hypothesis: (DLnGDP) has a unit root					
Variables	PP Test Statistic	Level	Critical values	Prob*	Conclusion
LnGDP at 1st difference:	-6.833714	5%	-2.931404	0.0000	Stationary
Null Hypothesis: (LnREC) has a unit root					
Variables	PP Test Statistic	Level	Critical values	Prob*	Conclusion
LnREC at level:	-2.050739	5%	-2.929734	0.2650	Non-stationary
Null Hypothesis: (DLnREC) has a unit root					
Variables	PP Test Statistic	Level	Critical values	Prob*	Conclusion
LnREC at 1st difference:	-6.465150	5%	-2.931404	0.0000	Stationary
Null Hypothesis: (LnFDI) has a unit root					
Variables	PP Test Statistic	Level	Critical values	Prob*	Conclusion
LnFDI at level:	-0.452175	5%	-2.929734	0.8907	Non-stationary
Null Hypothesis: (DLnFDI) has a unit root					
Variables	PP Test Statistic	Level	Critical values	Prob*	Conclusion
LnFDI at 1st difference:	-10.69451	5%	-2.931404	0.0000	Stationary

Source: Author`s own calculations

5.3 Johansen Co-integration Test

Based on the ADF unit root test our series are integrated of the same order, I(1) which means the Johansen co-integration test has been allowed to perform. Johansen co-integration test has been employed for LnCO2 and LnGDP to analyze the long-run relationship between these series. According to the obtained Johansen co-integration test results, those based on trace test and maximum eigenvalue test (p-values in both tests = 0.5472 and 0.7976>0.05), the null hypothesis that there is no co-integration between LnCO2 and LnGDP has been accepted. And the null hypothesis that there is at

most 1 co-integration between analyzed series is rejected. It has been confirmed that there is no co-integration between analyzed series (See Table 3).

Table 3: Johansen Co-integration test for LnCO2 and LnGDP

Johansen Co-integration test: Sample (adjusted): 1972-2014, Included obs.: 43, Series: LnCO2, LnGDP, Lags interval (in first differences):1 to 1.				
Unrestricted Co-integration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None*	0.115322	7.263637	15.49471	0.5472
At most 1	0.045331	1.994801	3.841466	0.1578
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None*	0.115322	5.268836	14.26460	0.7076
At most 1	0.045331	1.994801	3.841466	0.1578

Source: Author`s own calculations

The Johansen co-integration test was employed for the next step for LnREC and LnGDP to analyze the long-run relationship between them. According to the obtained Johansen co-integration test results, those based on trace test and maximum eigenvalue test(p-values in both tests = 0.1806 and 0.1793>0.05) the null hypothesis is that there is no co-integration between LnREC and LnGDP, has been accepted. And the null hypothesis that there is at most 1 co-integration between analyzed series is rejected. It has been confirmed that there is no co-integration between analyzed series (See Table 4).

Table 4: Johansen Co-integration test for LnREC and LnGDP

Johansen Co-integration test: Sample (adjusted): 1972-2014, Included obs.: 43, Series: LnREC, LnGDP, Lags interval (in first differences):1 to 1.				
Unrestricted Co-integration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None*	0.217252	11.53565	15.49471	0.1806
At most 1	0.023056	1.003023	3.841466	0.3166
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None*	0.217252	10.53263	14.26460	0.1793
At most 1	0.023056	1.003023	3.841466	0.3166

Source: Author`s own calculations

The Johansen co-integration test was employed for the further analyzing for LnCO2 and LnFDI to analyze the long-run relationship between them. According to the obtained Johansen co-integration test results, those based on trace test and maximum eigenvalue test (p-values in both tests = 0.0023 and 0.0077<0.05) the null hypothesis is that there is no co-integration between LnCO2 and LnFDI, has been rejected. It has been confirmed that there is at most 1 co-integration between analyzed series (p-values in both tests = 0.0740> 0.05) (See Table 5).

Table 5: Johansen Co-integration test for LnCO2 and LnFDI

Johansen Co-integration test: Sample (adjusted): 1972-2014, Included obs.: 43, Series: LnCO2, LnFDI, Lags interval (in first differences):1 to 1.				
Unrestricted Co-integration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None*	0.383898	29.08865	20.26184	0.0023
At most 1	0.174806	8.261897	9.164546	0.0740

Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None*	0.383898	20.82675	15.89210	0.0077
At most 1	0.174806	8.261897	9.164546	0.0740

Source: Author`s own calculations

The Johansen co-integration test was employed for the next step for LnREC and LnFDI to analyze the long-run relationship between them. According to the obtained Johansen co-integration test results, those based on trace test and maximum eigenvalue test (p-values in both tests = 0.2981 and 0.2940>0.05) the null hypothesis is that there is no co-integration between LnREC and LnFDI, has been accepted. And the null hypothesis that there is at most 1 co-integration between analyzed series is rejected. It has been confirmed that there is no co-integration between analyzed series (See Table 6).

Table 6: Johansen Co-integration test for LnREC and LnFDI

Johansen Co-integration test: Sample (adjusted): 1972-2014, Included obs.: 43, Series: LnREC, LnFDI, Lags interval (in first differences):1 to 1.				
Unrestricted Co-integration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None*	0.187088	9.779805	15.49471	0.2981
At most 1	0.020100	0.873119	3.841466	0.3501
Unrestricted Co-integration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None*	0.187088	8.906686	14.26460	0.2940
At most 1	0.020100	0.873119	3.841466	0.3501

Source: Author`s own calculations

5.4 Granger Causality test

In the next step the causal relationship will be checked between LnCO2 and LnGDP.

The null hypothesizes of the test:

H_0: LnGDP does not Granger Cause LnCO2, and

H_0: LnCO2 does not Granger Cause LnGDP

Null hypothesis will be rejected if the probability value is less than 0.05%.

Table 7: The Granger Causality Test Results for LnCO2 and LnGDP

Pairwise Granger causality test, Lags 2, Sample 1970-2014		
Null Hypothesis	F-statistic	Prob.
LnGDP does not Granger Cause LnCO2	1.14038	0.3304
LnCO2 does not Granger Cause LnGDP	1.87068	0.1679

Source: Author`s own calculations

According to the obtained results, the null hypothesis of no causal relationship from LnGDP to LnCO2 should be accepted (P-value=0.3304>0.05). Also, the second null hypothesis of no causal relationship from LnCO2 to LnGDP should be accepted (P-vlue=0.1679>0.05). Thus, the results of the causality test demonstrated that there is no causal relationship from LnGDP to LnCO2 and vice versa (See Table 6).

The later step is checking the causal relationship between LnREC and LnGDP.

The null hypothesizes of the test:

H_0: LnGDP does not Granger Cause LnREC, and

H_0: LnREC does not Granger Cause LnGDP

Null hypothesis will be rejected if the probability value is less than 0.05%.

Table 8: The Granger Causality Test Results for LnREC and LnGDP

Pairwise Granger causality test, Lags 2, Sample 1970-2014		
Null Hypothesis	F-statistic	Prob.
LnGDP does not Granger Cause LnREC	2.69157	0.0807
LnREC does not Granger Cause LnGDP	0.20702	0.8139

Source: Author`s own calculations

According to the obtained results, the null hypothesis of no causal relationship from LnGDP to LnREC should be accepted (P-value=0.0807>0.05). Also, the second null hypothesis of no causal relationship from LnREC to LnGDP should be accepted (P-vlue=0.8139>0.05). Thus, the results of the causality test demonstrated that there is no causal relationship from LnGDP to LnREC and vice versa (See Table 8).

The next step is checking the causal relationship between LnCO2 and LnFDI.

The null hypothesizes of the test:

H_0: LnFDI does not Granger Cause LnCO2, and

H_0: LnCO2 does not Granger Cause LnFDI

Null hypothesis will be rejected if the probability value is less than 0.05%.

Table 9: The Granger Causality Test Results for LnCO2 and LnFDI

Pairwise Granger causality test, Lags 2, Sample 1970-2014		
Null Hypothesis	F-statistic	Prob.
LnFDI does not Granger Cause LnCO2	1.86025	0.1695
LnCO2 does not Granger Cause LnFDI	4.17188	0.0230

Source: Author`s own calculations

According to the obtained results, from Granger causality test, the null hypothesis of no causal relationship from FDI to CO2 should be accepted (P-value=0.9478>0.05). But based on P-value= 0.0230<0.05%, the second null hypothesis of no causal relationship from CO2 to FDI should be rejected. Thus, the results of the causality test demonstrated the unidirectional causal relationship from CO2 to FDI (See Table 9).

The next step is checking the causal relationship between LnREC and LnFDI.

The null hypothesizes of the test:

H_0: LnFDI does not Granger Cause LnREC, and

H_0: LnREC does not Granger Cause LnFDI

Null hypothesis will be rejected if the probability value is less than 0.05%.

Table 10: The Granger Causality Test Results for LnREC and LnFDI

Pairwise Granger causality test, Lags 2, Sample 1970-2014		
Null Hypothesis	F-statistic	Prob.
LnFDI does not Granger Cause LnREC	1.01164	0.3732

LnREC does not Granger Cause LnFDI	1.61336	0.2126

Source: Author`s own calculations

According to the obtained results, the null hypothesis of no causal relationship from LnFDI to LnREC should be accepted (P-value=0.3732>0.05). Also, the second null hypothesis of no causal relationship from LnREC to LnGDP should be accepted (P-vlue=0.2126>0.05). Thus, the results of the causality test demonstrated that there is no causal relationship from LnGDP to LnREC and vice versa (See Table 10).

6. Conclusion

According to findings from empirical analysis the results can be summarized as follows. The Johansen co-integration and Causality test results indicate that, there was not co-integration and causality between GDP per capita and CO_2 emissions; also there was not co-integration and causality between GDP per capita and REC. As we know from above mentioned information the EKC theory says that environmental degradation increases with increasing of GDP per capita and when nation become richer (they require healthier life), the government applies strict environmental policies and utilize advanced environmentally technologies to decrease environmental degradation. But empirical results of this paper prove that the EKC theory doesn`t exist in Turkish economy. In another hand the empirical results based on the Johansen and Causality test results shows that there was co-integration and causality between FDI and CO_2 emissions; also there was not co-integration and causality between FDI and REC. Based on this results FDI which mostly comes from developed countries (United Kingdom (11.9%), Netherlands (11.6%), United States of America (9.3%), Spain (6.6%), Germany (6.5%), Austria (6.1%), Japan (2%), Switzerland (1.7%), China (1.26%), Others (44.31%)("FDI in Turkey - Invest in Turkey," n.d.)) applies heavy-polluted industries into Turkish economy. These results indicate the existence of PHH in Turkish economy. Which means, because of stringency of environmental policies the developed countries shift their capital intensive dirty industries to Turkey as a developing country.

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