IMPACTS OF ECONOMIC INDICATORS ON ENVIRONMENTAL DEGRADATION: EVIDENCE FROM MENA COUNTRIES

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ABSTRACT

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The relationship between economics and environment has been studied for a few decades. Economists have tested Environmental Kuznets Curve (EKC) hypothesis and Pollution Haven Hypothesis (PHH) for emerging economies, particularly concentrating on Asian and Latin American countries. A new phenomenon is that such kinds of studies concentrating on the Middle East and North African (MENA) countries have recently gained momentum. But what is lacking in spite of this momentum is that the studies using recent panel data techniques are quite few. The main goal of this paper is to test these two hypotheses for nine middle-income MENA countries, that is, Algeria, Egypt, Iran, Jordan, Morocco, Pakistan, Sudan, Tunisia, and Turkey, during the period between 1980 and 2013. The dependent variable of this study is CO_2 emissions while independent variables are income per capita, its square, FDI inflows, and energy use per capita. Methodologically, the study uses panel cointegration tests and long-run panel data estimators to see whether the EKC hypothesis and the PHH do explain the relationship. Moreover, Dumitrescu-Hurlin panel causality test is employed to find causal relationships between all the variables. Empirical findings reveal that these variables are cointegrated in the long-run. In addition, long-run coefficients of the model are estimated by Pedroni's Dynamic Ordinary Least Squares estimator. Besides these, findings suggest that the EKC hypothesis is valid for only four countries, that is, Algeria, Egypt, Sudan, and Turkey but the threshold level is not reached yet. On the other hand, the coefficients of FDI have positive signs for all the countries, and they reveal that FDI inflows increase emission levels for the MENA region. Particularly, the coefficients of FDI inflows are very high in Algeria and Iran. It is clear that FDI inflows to Algeria and Iran mainly consisted of dirty industries. Lastly, energy use is the most polluting determinants of emission levels for most countries. Findings also support that only three one-way causal relationships exist, that is, from emission level to FDI, from emission level to income level, and from energy use to FDI.

Keywords: Environmental Kuznets Curve, MENA Countries, Panel Data Analysis, Pollution Haven Hypothesis, Sustainability.

ÖZET

EKONOMİK GÖSTERGELERİN ÇEVRESEL BOZULMA ÜZERİNDEKİ ETKİLERİ: MENA ÜLKELERİ ÖRNEĞİ

Görüş, Muhammed Şehid

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İktisat ve çevre arasındaki ilişki son yıllarda sıkça çalışılan konular arasında yer almaktadır. Gelişmekte olan ekonomiler için yapılan çalışmalarda, Çevresel Kuznets Eğrisi (ÇKE) hipotezinin ve Kirlilik Sığınağı Hipotezi (KSH)'nin geçerliliği genellikle Asya ve Latin Amerika ülkeleri için test edilmiştir. Fakat Orta Doğu ve Kuzey Afrika (MENA) ülkeleri için yapılan çalışmalar özellikle son yıllarda önem kazanmıştır. Bunun yanında, bu ülkeler için güncel panel veri teknikleri kullanılarak yapılan çalışmalar oldukça sınırlıdır. Bu çalışmanın amacı, bu iki hipotezin geçerliliğini dokuz orta gelirli MENA ülkesi – Cezayir, Mısır, İran, Ürdün, Fas, Pakistan, Sudan, Tunus ve Türkiye- için 1980-2013 döneminde incelemektir. Çalışmada kullanılan bağımlı değişken karbondioksit emisyonları iken bağımsız değişkenler ise kişi başı gelir, kişi başı gelirin karesi, doğrudan yabancı yatırımlar ve kişi başına düşen enerji tüketimidir. Panel eşbütünleşme testleri ve uzun dönem panel veri tahmincileri ÇKE ve KSH hipotezlerinin geçerliliğinin sınanması için kullanılmıştır. Buna ek olarak, Dumitrescu-Hurlin panel nedensellik testiyle değişkenler arasındaki nedensellik ilişkisi araştırılmıştır. Elde edilen sonuçlara göre, çalışmada kullanılan değişkenler uzun dönemde eşbütünleşiktir. Değişkenlere ait uzun dönem parametreler ise Pedroni'nin Dinamik En Küçük Kareler tahmincisiyle tahmin edilmiştir. Elde edilen bulgular, ÇKE hipotezinin sadece Cezayir, Mısır, Sudan ve Türkiye'de geçerli olduğunu fakat eşik değere daha ulaşılamadığını, diğer beş MENA ülkesinde ise bu hipotezin geçerli olmadığını göstermiştir. Diğer yandan, doğrudan yabancı yatırımların katsayısı bütün ülkeler için pozitif işaretli olarak tahmin edilmiştir. Özellikle Cezayir ve İran'a gelen doğrudan yabancı yatırımların çoğunlukla kirli endüstrilerden oluştuğu söylenebilir. Son olarak, enerji tüketiminin çoğu ülkede emisyonları artırıcı ana değişken olduğu sonucuna ulaşılmıştır. Elde edilen sonuçlar, aynı zamanda emisyonlardan doğrudan yabancı yatırımlara, emisyonlardan gelir seviyesine ve enerji tüketiminden doğrudan yabancı yatırımlara doğru tek yönlü üç adet nedensellik ilişkisinin varlığına işaret etmektedir.

Anahtar Kelimeler: Çevresel Kuznets Eğrisi, Kirlilik Sığınağı Hipotezi, MENA Ülkeleri, Panel Veri Analizi, Sürdürülebilirlik.

To My Family

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
ARDL	Autoregressive Distributed Lag
ASEAN	Association of Southeast Asian Nations
CADF	Cross-Sectionally Augmented Dickey-Fuller
CD	Cross-Section Dependency
CH_4	Nitrous Oxide
CO_2	Carbon Dioxide
DF	Dickey-Duller
ECM	Error Correction Model
EKC	Environmental Kuznets Curve
EU	Energy Use
FDI	Foreign Direct Investment
FMOLS	Fully Modified Least Squares
GDP	Gross Domestic Product
GHGs	Greenhouse Gasses
GMM	Generalized Methods of Moments
GNI	Gross National Income
H_2O	Water Vapor
HFCs	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
IPS	Im-Pesaran-Shin
KC	Kuznets Curve

KP	Kyoto Protocol
LLC	Levin-Lin-Chu
LM	Lower Middle-Income
MENA	Middle East and North African
NO_x	Nitrogen Oxide
O_3	Ozone
OLS	Ordinary Least Squares
PDOLS	Panel Dynamic Ordinary Least Squares
PFCs	Perfluorocarbons
PHH	Pollution Haven Hypothesis
R&D	Research and Development
SF_6	Sulfur Hexafluoride
SIC	Schwarz Information Criterion
SO_2	Sulfur Dioxide
SPM	Suspended Particular Matter
UM	Upper Middle-Income
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
VECM	Vector Error Correction Model

CHAPTER 1

1. INTRODUCTION

Global warming and climate change has been one of the most serious environmental problems in the world for the last two-three decades. These two have been here for a while because of the greenhouse effect, which in turn mainly results from carbon dioxide emission (CO_2). Negative developments concerning environmental issues have pushed the intergovernmental bodies to reduce greenhouse gasses (GHGs). The Kyoto Protocol (KP) has been one of the most significant international initiatives to reduce GHGs. The protocol aimed the reductions of these gasses to 5.2% lower than the 1990 level for the period between 2008 and 2012.

Scholar and experts of the field have been investigating environmental degradation and its determinants for a long time. Economists have analyzed the impact of economic growth on environmental degradation. Most of the studies found that there is an inverted-U type relationship between these two variables. In the literature, the inverted-U type relationship is labeled as "Environmental Kuznets Curve" (EKC, *henceforth*) hypothesis. It asserts that environmental degradation tends to get worse with increase in income per capita in the early stages, and then it decreases gradually after a turning point (Stern, 2004a). The preliminary studies about the EKC hypothesis were conducted by Grossman and Krueger (1991), Shafik and Bandyopadhyay (1992), Panayotou (1993), and Selden and Song (1994).

Although there are numerous studies examining causality and correlations between environmental variables and economic variables (i.e., economic growth, trade, energy consumption etc.), the number of studies attempting to see the effect of Foreign Direct Investment (FDI) on environmental pollution is very rare. It has been only recently that this issue has attracted the attention of some scholars, which has in turn pushed them to probe it. In particular, the studies analyzing the relationship between FDI and environmental issues have tended to focus on some specific areas. For example, one interesting area in this subtopic is about "The Pollution Haven Hypothesis" (PHH, *henceforth*). PHH asserts that liberalization of investment related regulations may have effects over the pollution levels of countries. Pollution-intensive production shifts from the countries having stringent environmental policies to the countries having relatively weak environmental regulations (Copeland, 2010). The pioneer studies on PHH were conducted by Low and Yeats (1992), Mani and Wheeler (1997), Suri and Chapman (1998), and Agras and Chapman (1999).

The main goal of this study is to analyze the impact of economic indicators on environmental degradation in the MENA (Middle East and North African) countries. Empirically, this study uses a recent dataset that covers the period between 1980 and 2013 for nine middle-income MENA countries. These countries are Algeria, Egypt, Iran, Jordan, Morocco, Pakistan, Sudan, Tunisia, and Turkey. The dependent variable of the study is CO_2 emissions per capita while the independent variables are income per capita, its square, FDI inflows, and energy use per capita.

Methodologically, this thesis employs 1st generation panel cointegration tests to check the long-run relationship between the variables. The study uses three panel cointegration tests for robustness check. Besides, the long-run coefficients of the model are estimated by Pedroni's PDOLS (Panel Dynamic Ordinary Least Squares) estimator. One of the main advantages of this estimator is that the variance is computed through the Newey-West heteroskedasticity-consistent and autocorrelation-consistent method with a Barlett kernel. This method provides both homogeneous and heterogeneous results for the coefficients of the model. Then, Dumitrescu-Hurlin panel causality test is used to determine the causal relationship between all the variables. Its testing procedure considers the heterogeneity of causal relationship and of regression model. To the best of our knowledge, there is not any study employing heterogeneous panel causality test to investigate environmental pollution-economic growth connection for the MENA countries.

Taking the MENA countries into consideration in this thesis has to do with Global Monitoring Report 2008 of World Bank. The report affirms that "a number of countries in the region remain on an unsustainable path, consuming profits on natural resource exploitation rather than investing these profits to ensure long-term economic sustainability." Besides, the report also argues that "the Middle East & North Africa region has increased its carbon dioxide emissions, faces diminishing critical per capita water resources, and is at risk on several fronts from climate variability" (Farhani et al., 2014a: 190). Moreover, most of the EKC studies regarding the emerging economies have focused on the Asian and Latin American countries. However, the number of studies on the MENA region is very few and these studies have just recently come into prominence (Al-Rawashdeh et al., 2014). What is more striking is that the studies using recent panel data techniques are very limited.

To our knowledge, there are few panel data studies about the relationship between environmental degradation variables (i.e., CO_2, SO_2, deforestation) and economic variables (i.e., income, FDI, trade) for the MENA countries. Al-mulali (2011), Arouri et al. (2012), Farhani and Rejeb (2012), Asghari (2013), and Farhani et al. (2014a) are the studies in which this relationship (especially, EKC hypothesis) is investigated for the MENA countries. Besides, Ozcan (2013) checked the presence of the EKC hypothesis for only Middle East countries. These scholars have concentrated on different aspects of this issue. Al-mulali (2011) and Farhani and Rejeb (2012) examined the causal relationship between energy consumption, economic growth, and CO_2 emissions while Arouri et al. (2012) and Farhani et al. (2014a) tested validity of the EKC hypothesis. Asghari (2013) examined the EKC hypothesis and PHH for the six MENA countries. These studies exclude the effect of FDI on emission level except Asghari (2013). What is missing in Asghari (2013), however, is that she did not investigate the long run relationship between variables, which is what the EKC hypothesis tries to find out.

In this study, the EKC hypothesis and the PHH are investigated through the use of recent panel data techniques for the MENA region. Since the PHH is only valid for developing countries, the study selects middle-income the MENA countries as a sample to test the PHH more accurately. These features distinguish this study from others.

The outline of this thesis is as follows: The chapter 2 firstly discusses sustainable development. Then, it presents brief information about types of pollution -that is, air pollution, water pollution, and soil pollution- and discusses its causes. The chapter also dwells on the greenhouse effect and gasses and climate change and its effects. Lastly, it gives the list of international initiatives regarding global climate change in a chronological order.

The chapter 3, at first, presents the ideas of classical economists, neo-classical economists, and ecological economists on environmental issues. Then, it discusses the theories behind the Environmental Kuznets Curve and Pollution Haven Hypotheses. And lastly it summarizes the empirical literature covering both studies for single country and for multiple countries regarding these themes separately.

The chapter 4, firstly, introduces data used in this study. Then, it gives the methodology of panel data techniques such as cross-section dependence tests (Breusch-Pagan LM test, Pesaran Scaled LM test, bias-corrected scaled LM test, Pesaran CD test, and bias-adjusted LM test), panel unit root tests (Levin-Lin-Chu test, Im-Pesaran-Shin test, Fisher-Type tests, and $CADF$ test), panel cointegration tests (Pedroni cointegration test, Kao cointegration test, and Johansen Fisher cointegration test), Pedroni's PDOLS estimator, slope homogeneity test, and panel causality test (Dumitrescu-Hurlin causality test). In the last part, all empirical findings of this study are presented. The chapter 5, discusses general results of empirical findings and gives policy recommendations to policy makers.

CHAPTER 2

2. SUSTAINABLE DEVELOPMENT AND CLIMATE CHANGE

Global warming, climate change, and environmental degradation are important issues. In this chapter, a definition of sustainable development and other key concepts will be explained. In particular, types of pollution that include air pollution, water pollution, and soil pollution call for clear definition. Moreover, the chapter will explain the effects of greenhouse gasses and international actions on global climate change.

2.1 Sustainable Development

Sustainable development can be described as a kind of economic growth which would fulfill the present's needs and desires without making any concessions of the system of economy-environment capacity for satisfying them in the future. This definition is made in Brundtland Report in 1987 (Common and Stagl, 2005). Sustainable development was defined in Brundtland Report as below:

> Sustainable development seeks to meet the needs and aspirations of the present without compromising the ability to meet those of the future. Far from requiring the cessation of economic growth, it recognizes that the problems of poverty and underdevelopment cannot be solved unless we have a new era of growth … policy makers guided by the concept of sustainable development will necessarily work to assure that growing economies remain firmly attached to their ecological roots and that these roots are protected and nurtured so that they may support growth over the long term. Environmental protection is thus inherent in the concept of sustainable development.
>
> (World Commission on Environment and Development, 1987: 40)

Brundtland Report highlighted two major issues; mass poverty and interdependency between economy and environment. According to report, economic growth could play immense role in alleviating global poverty problem. However, conventional economic growth policies might damage the environment, and moreover, these policies may significantly detoriarate future economic prospects (Common and Stagl, 2005) because conventional economic growth policies prioritize income growth and neglects issues related to economic development such as education and literacy, family planning, democratic empowerment, environment, etc. Thus, a new and more desirable economic growth pattern should be introduced which considers the interdependency between economy and environment (Hackett, 2006).

Technological progress may also contribute sustainable development efforts. Technological advancement may help to reduce materials and energy use per output. So, they lead reduction in environmental pollution. However, technology causes an economic burden to firms, and it requires investment and capital accumulation (Common and Stagl, 2005).

2.2 Types of Environmental Pollution

Environmental problems may arise from several factors including high population, industrial production, urbanization, tourism, etc. These factors could lead to environmental pollution and degradation. These factors can be classified in three groups according to their bases; namely, air pollution, water pollution, and soil pollution.

2.2.1 Air Pollution

Definition of air pollution has changed in the context of time, space, and circumstances for many years. For the last 50 years, environmental pollution has become a serious problem that is increasingly threatening human life. Air pollutants cause plenty of illness for people, especially respiratory diseases such as asthma and other allergic diseases. Also, air pollutants damage not only human health but also environment and property (Vallero, 2014).

Urbanization and industrialization are accepted as the major reasons for air pollution. Urbanization may trigger an increase in population and population density in cities, and these factors can lead to unplanned urbanization. Besides, types of fuel used in heating and polluting gasses emitted by cars, buses, and other transportation vehicles also pollute the air. On the other side, industrialization can be regarded as the main reason for air pollution. Production is the main part of industrialization, and fossil-fuel energy resources such as coal, oil, natural gas, etc. are mostly used in manufacturing process. Effects of these natural resources on emission levels are very high, and they pollute the air. However, air pollution due to industrialization is less common in developed countries because they use eco-friendly technologies in their production processes, and companies which have polluting industries move their operations to developing economies due to their less stringent environmental policies. Industries that cause air pollution can be listed as follows (Keleş et al., 2015):

- Energy production industry (steam power plants)
- Fertilizer industry
- Iron and steel industry
- Cement industry
- Paper and cellulose industry
- Sugar industry
- Textile industry
- Petroleum and chemical industry
- Leather industry
- Agricultural pesticide industry

2.2.2 Water Pollution

The second type of environmental pollution is water pollution. The water is divided into two main types; surface water and groundwater. Surface water consists of the rivers, lakes, and oceans. Surface water is used mostly for drinking water, swimming, fishing, and boating. On the other hand, groundwater is used for irrigation and drinking water (Tietenberg and Lewis, 2016).

The primary causes of water pollution arise from three major issues; agricultural activities, industrialization, and settlement. Firstly, agricultural activities consist of farming and husbandry. Agriculture and husbandry lead solid waste and liquid waste due to conventional farming, animal wastes, agricultural pesticides, etc. Secondly, industrialization pollutes not only air quality but also water quality. Liquid wastes of factories pollute water, directly. Pollution types due to factories can be listed as chemical pollution, physical contamination, physiological contamination, biological contamination, and radioactive contamination. Lastly, settlements can cause water pollution because of the population and high population density. Residential liquid wastes and sewages are left to rivers, lakes, and seas, directly. Industries which lead water pollution can be listed as follows (Keleş et al., 2015):

- Oil refineries
- Paper industry
- Textile industry
- Metal plating industry
- Detergent industry
- Plastic industry
- Leather industry
- Food industry
- Pharmaceutical industry

2.2.3 Soil Pollution

Rocks and organic matters have formed the soils for many years. Properties of soil vary from place to place, and bedrock compositions, climate, and other factors affect its properties. The number of soil elements and substances may exceed a critical level which is harmful to human health and nature (Shayler et al., 2009).

Soil pollution arises due to air pollution, water pollution, agricultural pesticides, and solid wastes. Reasons for air pollution and water pollution also damage the soil, indirectly. Moreover, bad farming practices, excessive usage of fertilizers, usage of agricultural pesticides, solid wastes, and toxic and hazardous substances which are left to nature pollute soil, significantly (Keleş et al., 2015).

2.3 Greenhouse Effect and Greenhouse Gases

Global warming and climate change are the major environmental issues of today’s world. Increasing amount of greenhouse gasses, especially CO_2, lead to environmental issues. These environmental problems have led scholars to consider reducing greenhouse gasses since the beginnings of the 1990s (Ozcan, 2013).

2.3.1 Greenhouse Effect

The atmosphere contains plenty of gasses and water vapor. 78.09% of the air is nitrogen, 20.95% is oxygen, 0.93% is argon, 0.04% is carbon dioxide, and the rest of it includes other gasses. These gasses are permeable to incoming solar radiation, and the world warms up with sunlight reflected from the world. These reflected rays are trapped and held by gasses in the atmosphere, and they heat the world. The holding of the rays by these gasses is named as the greenhouse effect (Çılgın Yamanoğlu, 2006; Türköz, 2015).

Figure 1 shows the physics of the greenhouse effect, simply. 60% of the solar radiation reaches the surface of the earth, and 18% of is reflected to back into space. The rest of it heats the surface of the earth. The surface of the earth emits infrared radiation when its heat increases. Then, some of the infrared radiation is absorbed by greenhouse gasses, and they re-emit this radiation in all directions (Common and Stagl, 2005).

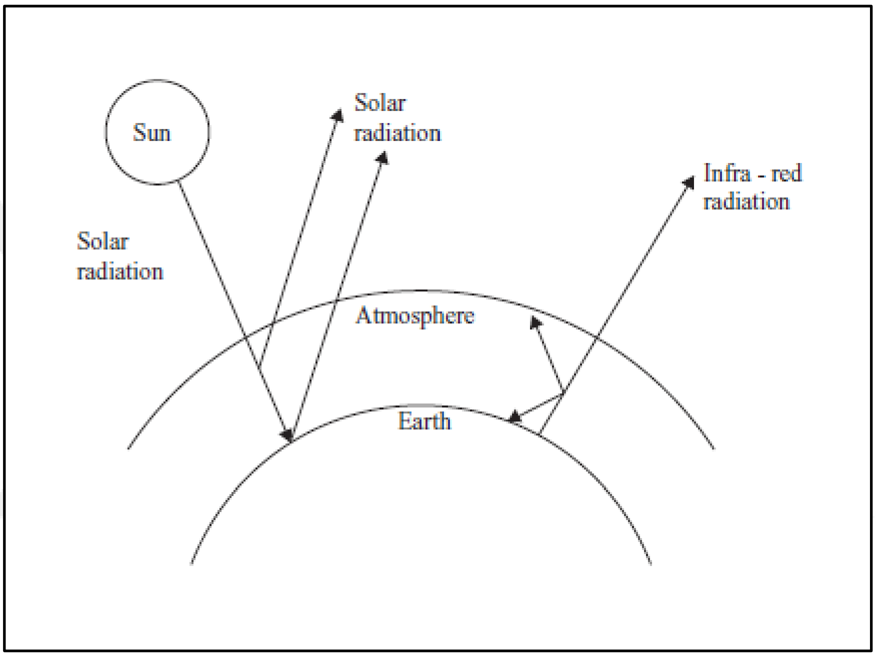

Figure 1: Physics of the Greenhouse Effect

Source: Common, M., & Stagl, S. (2005). Ecological Economics: An Introduction. Cambridge University Press.

2.3.2 Greenhouse Gasses

Greenhouse gasses can be classified as natural greenhouse gasses and man-made greenhouse gasses. Natural greenhouse gasses are water vapor (H_2O), carbon dioxide, methane (CH_4), nitrous oxide (N_2O), ozone (O_3), etc. On the other side, man-made greenhouse gasses are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), etc. Man-made greenhouse gasses arise from burning of the fossil fuels, industry, transportation, energy production, etc. (Çılgın Yamanoğlu, 2006).

Table 1 shows the basic greenhouse gasses, their anthropogenic sources, and their atmospheric lifetime. The table reveals that SF_6, N_2O, CCL_2F_2, and CO_2 have the longest atmospheric lifetime among the greenhouse gasses, and they remain in the atmosphere for more than 100 years. The main reasons for CO_2 are fossil-fuel combustion, land-use conversion, and cement production. On the other hand, fossil fuels, rice paddies, and waste dumps increase CH_4 emissions. In addition, fertilizers, industrial processes, and combustion lead to increase in N_2O emission in the air. Besides, fossil-fuel combustion, industrial emissions, and chemical solvents are the fundamental reasons for O_3 emissions. Still, increase in CCL_2F_2 emissions in the atmosphere are affected by liquid coolants and foams. Also, CCI_2F_2 and SF_6 emissions are negatively affected by refrigerants and dielectric fluids, respectively.

Table 1: Greenhouse Gasses

Greenhouse Gasses	**Chemical Formula**	**Anthropogenic Source**	**Atmospheric Lifetime (Years)**
Carbon Dioxide	CO_2	Fossil-fuel combustion, Lan-use conversion, Cement production.	~100
Methane	CH_4	Fossil fuels, Rice paddies, Waste dumps.	12
Nitrous Oxide	N_2O	Fertilizer, Industrial processes, Combustion.	114
Ozone	O_3	Fossil-fuel combustion, Industrial emissions, Chemical solvents.	Hours-days
CFC-12	CCL_2F_2	Liquid coolants, Foams.	100
HCFC-22	CCI_2F_2	Refrigerants.	12
Sulfur Hexafluoride	SF_6	Dielectric fluid.	3200

Source: Blasing, T. (2011). Recent greenhouse gas concentrations. US Department of Energy, Carbon Dioxide Information Analysis Center (CDIAC). http://cdiac.ornl.gov/pns/current_ghg.html. (23.03.2017); Center for Climate and Energy Solutions (2017). Main greenhouse gases. https://www.c2es.org/facts-figures/main-ghgs. (23.03.2017)

Total greenhouse gas emissions regarding kilotons of CO_2 equivalent in the world which cover the period from 1970 to 2012 are displayed in Figure 2. In 1970, total greenhouse gas emissions were 27,660,218.46 kilotons while it was 53,526,302.82 kilotons in 2012. So, there was a 93.5% increase in greenhouse gasses between these years. It is evident that there is an upward sloping in the figure.

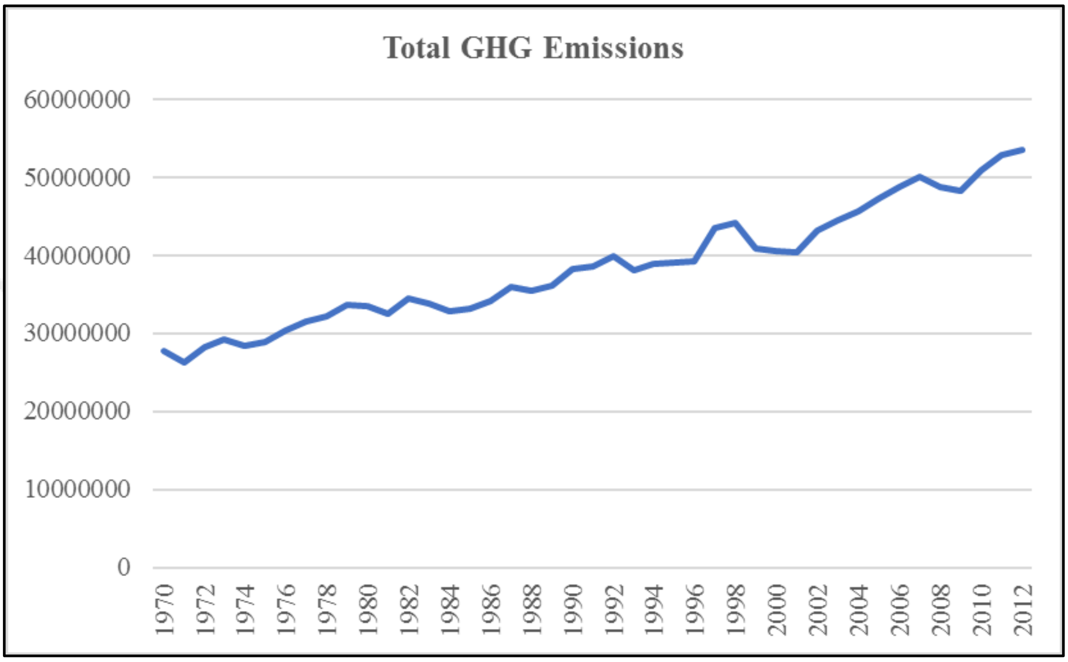

Figure 2: Total Greenhouse Gasses Emissions (kt of CO_2 equivalent)

Source: Compiled by author based on World Bank data.

2.4 Climate Change and Its Effects

Greenhouse gasses have negative effects on climate, and it can change the qualities of climate and ecosystem. Climate change was defined in United Nations Framework Convention on Climate Change (UNFCCC) (1992: 8) as “A change of climate which is attributed directly or indirectly to human activity that alters the composition of global atmosphere and which is in addition to natural climate variability observed over comparable time periods.”

Climate change is apparent, and it is one of the major issues in the world because air and ocean temperatures are increasing, snow and ice are melting, and average sea level is rising, globally. There are two main reasons for global warming and climate change; natural causes and man-made causes. Intergovernmental Panel on Climate Change (IPCC) reported that global climate change is mostly attributed to human activities. According to projected climate changes, they state that fossil-fuel use (i.e., coal, oil, natural gas, etc.) and land-use change increase CO_2 emissions in the world. On the other hand, CH_4 and N_2O emissions result from agricultural activities, and human-induced warming would continue for many years because of the past emission levels. Natural causes can be listed as the displacement of continents, changes in solar radiation, and changes in volcanic activities. Thus, climate change is inevitable even if these gasses were to be balanced (Özdan, 2014; Tietenberg and Lewis, 2016).

There are several significant consequences of climate change. It affects many physical and biological systems. Natural systems such as coral reefs, tropical forests, and mangroves are vulnerable to change in climate. Besides, their effects on these natural systems are irreversible (Tietenberg and Lewis, 2016).

2.5 The International Actions on Global Climate Change

The increase in greenhouse effect did not become a major subject of the scientific inquiry until the 1960s. The 1st World Climate Conference was held in 1979 (Common and Stagl, 2005). It focused on global warming and led the creation of World Climate Programme and World Climate Research Programme. In 1988, Intergovernmental Panel on Climate Change (IPCC) which is an international scientific committee about climate change was formed. Also, climate change problem first entered the agenda of United Nations (UN) in the decision on protection of global climate. Then, 2nd World Climate Conference was held in 1990. This conference led the creation of United Nations Framework Convention on Climate Change. In 1992, UNFCCC was opened for signature. This treaty was signed to prevent the effects of greenhouse gasses on the climate system (Arı, 2010).

Furthermore, Rio Conference which environmental problems and sustainability issues were discussed. In 1994, UNFCCC entered into force while Kyoto Protocol was adopted in 1997. Kyoto Protocol was the first international treaty to control and to reduce greenhouse gasses. Then, the functioning of the Flexibility Mechanisms, also known as Kyoto Mechanisms, were determined in Marrakech Accords, 2001. In 2005, Kyoto Protocol entered into force, and obligations of the countries begun. After that, Bali Action Plan was adopted, and Copenhagen Climate Change Conference was held in 2007 and 2009, respectively (Arı, 2010).

UNFCCC classified countries on differences in their commitments as Annex I, Annex II, and Non-Annex parties. Annex II parties consisted of the mainly OECD countries while Annex I parties were composed of Annex I parties and former Soviet countries. Annex II countries are responsible for financial and technical support to developing countries to reduce their emission levels. On the other hand, major commitment of the Annex I parties was reducing greenhouse gasses. Finally, Non-Annex parties which were low-income and developing countries did not have any commitment to environmental issues (Common and Stagl, 2005; Türköz, 2015)

The major action on climate change has been accepted as Kyoto Protocol which took place in Japan in 1997. It did not allow any new commitments for developing countries in comparison with UNFCCC while many industrialized countries made new commitments. These countries agreed to ensure that their GHGs emissions did not go beyond their assigned amounts by the commitment period which is between 2008 and 2012 (Common and Stagl, 2005). The KP entered into force in 2005 once at least 55 parties representing 55% of the total CO_2 emissions had approved. The aim of the KP is that to reduce annual average emission level by 5% below the 1990 levels for the participating parties (Tietenberg and Lewis, 2016).

The environmental issues have come into prominence for a few decades. Thus, the number of international treaties about environmental problems increases because governments focus on global warming and climate change issues for sustainable development.

CHAPTER 3

3. ENVIRONMENT AND ECONOMIC NEXUS

Scholars have shown specific interest to environmental issues from the period of classical economics to nowadays. Classical economists, neo-classical economists, and ecological economists have made plenty of theoretical and empirical studies on environmental economics.

3.1 History of Environmental Economic Thought

History of environmental economic thought can be categorized as follows: classical economics, neo-classical economics, and ecological economics. Besides, their ideas on environmental issues can be divided into two main groups: optimist and pessimist economists. Optimist economists (i.e., Marx, Marshall, Pigou) believe that the economic growth provides solutions to environmental problems while pessimists (i.e., Ricardo, Malthus, Mill) advocate that economic growth is one of the main reason of the environmental challenges. In addition, views of some of the optimist and pessimist economists on environment and economics nexus are listed in Table 2.

Table 2: Optimist and Pessimist Economists

Optimist Economists	**Pessimist Economists**
Karl Marx (1818-1883)	David Ricardo (1772-1823)
Alfred Marshall (1842-1924)	Thomas Malthus (1766-1834)
Arthur Cecil Pigou (1877-1959)	John Stuart Mill (1806-1873)
Ronald Harry Coase (1910-2013)	William Stanley Jevons (1835-1882)
Harold Hotelling (1895-1973)	Kenneth Boulding (1910-1993)
	Nicholas Georgescu-Roegen (1906-1994)
	Herman Edward Daly (1938-)

Source: Aslan, F. (2010). İktisadi büyümenin ekolojik sınırları ve kalkınmanın sürdürülebilirliği (Unpublished master's thesis). Ankara University, Ankara, Turkey.

3.1.1 Classical Economics

Classical economics was accepted as the dismal science due to pessimist ideas of the classical economists (especially, Malthusian view) for the future except for Adam Smith (1723-1790) who was the founder of classical economics. He stated that free-trade and the pursuit of self-interest lead to increase in wealth of society. Besides, he disregarded the environmental issues like scarcity of natural resources and environmental degradation (Kula, 2013). Thomas Malthus' (1766-1834) idea was based on the limited supply of agricultural lands and increase in human population. It states that the growth rate of the food supply increases arithmetically (1, 2, 3, 4, …) when the population growth increases exponentially (1, 2, 4, 8, …). Thus, it may lead to scarcity of food and starvation. Also, wages of workers come back to subsistence level in the long run. However, high economic growth and increase in population occurred since the beginning of the 19th century. Malthusian approach ignored the technological progress, and it assumed the fixed supply of agricultural lands. However, technology was advanced due to the industrial revolution. Moreover, new lands like America and Australasia provide new agricultural lands (Common and Stagl, 2005).

David Ricardo (1772-1823) had similar ideas with Malthus. He stated that the diminishing quality of natural resources due to increase in economic activities might cause to abolish population growth and economic growth in the long run (Kula, 2013). He also stated that agricultural needs of increasing population could be provided by cultivating less productive agricultural lands (Dağdemir, 2003). On the other hand, Karl Marx (1818-1883) expressed that fast industrialization and moving from rural life to urban life cause a threat for environmental pollution (Nakıpoğlu Özsoy, 2015).

3.1.2 Neo-Classical Economics

Neo-classical economics emerged at the end of the 1800s. Classical economics started to evolve neo-classical economics around 1870 (Common and Stagl, 2005). In the neo-classical economics, population growth, scarcity of resources, and social engineering issues were relatively ignored. The major interests of economists were marginal utility and the value of goods. In this period, two main developments appeared regarding environmental economics: limited resource economics and externalities (Kula, 2013). Alfred Marshall (1842-1924) introduced positive externalities to economics literature, firstly. Then, Arthur Cecil Pigou (1877-1954) emphasized the importance of negative externalities.

Neo-classical economists believed that the natural resources are finite, and they also believed that the finiteness of resources does not curb the economic growth. Their ideas are based on several main reasons (Hussen, 2004):

- Technology can meliorate scarcity of natural resources, and there is no upper bound of technological progress.
- Differences between ‘general’ and ‘specific’ natural resources’ scarcity are significant. The shortage of specific resources is more important than general ones.
- Relative scarcity does not curb the economic growth because of the factor substitution possibility.
- The increase in income per capita and technological progress lead to finding solutions for environmental problems and population issues.
- Fine-tuning of the market corrects price distortions due to externalities.

Neo-classical economics introduced two new sub-disciplines at the beginning of the 1970s: environmental economics and natural resource economics. Environmental economics mainly focuses on new additional topics of economics into the environment and environmental pollution issues while natural resource economics deal with the natural resources’ usage and problems with getting resources from nature (Common and Stagl, 2005).

3.1.3 Ecological Economics

Ecological economics was emerged due to economic sustainability and environmental protection issues around the 1990s. It mainly focuses on the ecological and the economic systems nexus (Hussen, 2004). Kenneth Boulding (1909-1993), Nicholas Georgescu-Roegen (1906-1194), and Herman Edward Daly (1938-) were the pioneers of the ecological economics. They used ecological principles and thermodynamics laws to show the existence of biophysical bounds of economic growth (Nakıpoğlu Özsoy, 2015).

There are several fundamental differences between ecological economics and neo-classical economics. Firstly, human economy is accepted as a subsystem of the natural ecosystem in ecological economics. Secondly, nature is viewed as the main source of the wealth because of natural resources such as wood, products, minerals, etc. are used as input in the production process. Lastly, all inputs which are used in production are regarded as complements, not substitutes (Hussen, 2004).

3.2 The Environmental Kuznets Curve Hypothesis

Environmental Kuznets Curve hypothesis asserts that there is an inverted U-shaped relationship between environmental degradation and economic growth in the long run. It claims that environmental degradation increases with income per capita, in the early stages but it decreases after the income reaches to a certain point. So, high income per capita will decrease damage in the environment (Stern, 2004a). EKC hypothesis has studied deeply since the beginning of the 1990s. *Environmental Impacts of North American Free Trade Agreement* by Grossman and Krueger (1991) was the first study over the hypothesis. However, the first name of the EKC was used at the work of Panayotou (1993).

The name of EKC comes from the Kuznets Curve (KC). Kuznets (1955) predicted the presence of meaningful relationship between income inequality and income per capita. He found an inverted-U relationship between these two variables. So, income distribution is unequal at the early stages of income growth. However, after a turning point, income inequality decreases while the income per capita increases.

After Grossman and Krueger’s (1991) work, Shafik and Bandyopadhyay (1992), Panayotou (1993), and Selden and Song (1994) also aimed at analyzing as to whether there is a nonlinear relationship between economic growth and environmental hazards. After these early studies, the EKC has been addressed by several subsequent researches.

One needs to understand the detail accounts of these early studies. As explained above, the first study over the EKC hypothesis was carried out by Grossman and Krueger (1991). They find that there is an inverted-U relationship between pollutants, sulfur dioxide (SO_2), fine smoke and suspended particles (SPM), and income per capita. They use a cubic form of the function for each regression and use data in level forms rather than logarithmic forms. Empirical results suggest that the turning points for both SO_2 and fine smoke are between the range of $4,000 and $5,000. However, the concentration of SPMs decreased even at low-income levels.

Shafik and Bandyopadhyay (1992) investigated the EKC hypothesis for up to 149 countries for the period of 1960-1990. They use 10 different environmental degradation indicators in their analysis. The indicators they employed include; lack of clean water, lack of urban sanitation, ambient level of suspended particulate matter, ambient sulfur oxides, change in forest area, rate of deforestation, dissolved oxygen in rivers, fecal coliforms in streams, municipal waste per capita, and carbon emissions per capita. In their regression model, they used three different functional forms: log-linear, log-quadratic and logarithmic cubic polynomial. Econometric results reveal that only two air pollution indicators are in line with the EKC hypothesis while they failed to found any statistically significant results for the remaining eight indicators. Moreover, they found that turning points for these two indicators lie around \$3,000-\$4,000.

Panayotou (1993) estimated the EKC hypothesis with the environmental data which are SO_2, Oxides of Nitrogen (NO_x), SPM, and deforestation, and income per capita in nominal term. The study includes data from 68 countries in deforestation and data of 54 countries in the pollution. All the results advocated the EKC hypothesis. Results suggest that turning points for deforestation, SO_2, NO_x, and SPM are around \$823, \$3,000, \$5,500 and \$4,500 per capita, respectively.

Lastly, Selden and Song (1994) investigated the validity of the EKC hypothesis for air pollution emissions using panel data method for 22 high-income countries, six middle-income countries, and two low-income countries. Air pollutants used in this study were SO_2, NO_x, SPM, and carbon monoxide (CO). They reveal that all the air pollutants have an inverted-U relationship with GDP per capita. Turning point of each model is higher than the other studies: SO_2, \$8,709; NO_x, \$11,217; SPM, \$10,289; and, CO, \$5,963.

3.2.1 Theory of the EKC Hypothesis

The EKC hypothesis postulates that there is an inverted U-relationship between pollution and economic development in the long run as mentioned above. Generally, Equation 1 is used to investigate the possible relationship between environmental degradation and income level (Dinda, 2004):

$$y_{it} = \alpha_i + \beta_1 x_{it} + \beta_2 x_{it}^2 + \beta_3 x_{it}^3 + \beta_4 z_{it} + \varepsilon_{it} \tag{1}$$

where y represents the environmental degradation indicators, x is income per capita, and z accounts for the other variables which affect the environment like population density, energy use, international trade/openness, etc. Moreover, the subscript i is a country, t is time, α is a constant term of the model and β_k states the coefficient of the k explanatory variables. This model can be used for testing seven different forms of relationships:

- $\beta_1 = \beta_2 = \beta_3 = 0$. This states that there is a flat pattern or no relationship between x and y.
- $\beta_1 > 0$, $\beta_2 = \beta_3 = 0$. There is a linear or monotonic increasing relationship between x and y.
- $\beta_1 < 0$, $\beta_2 = \beta_3 = 0$. This states that there is a monotonic decreasing relationship between x and y.
- $\beta_1 > 0$, $\beta_2 < 0$, $\beta_3 = 0$. It indicates that an inverted U-shaped relationship between variables. This result supports EKC hypothesis.
- $\beta_1 < 0$, $\beta_2 > 0$, $\beta_3 = 0$. It indicates that a U-shaped relationship between variables.
- $\beta_1 > 0$, $\beta_2 < 0$, $\beta_3 > 0$. There is a cubic polynomial or N-shaped relationship between variables.
- $\beta_1 < 0$, $\beta_2 > 0$, $\beta_3 < 0$. This states that there is an inverted N-shaped relationship between variables.

Only the fourth relationship asserts the EKC hypothesis. The turning point of the curve can be calculated as $\frac{-\beta_1}{2\beta_2}$. In some studies, cubic form of the income is excluded from the models.

The shape of the EKC is represented as Figure 3. On the vertical axis, there is environmental degradation level which is measured by different kind of pollutants, while there is income per capita which represents the stages of environmental development on the horizontal axis. Resource depletion and waste generation increase when the agricultural activities, the usage of raw materials (resources), and energy improve. Furthermore, when the industrialization starts, it also affects the resource depletion and the waste generation, negatively. However, after the turning point, environmental degradation decreases in the higher levels of development because the economy shifts to information-based industries and services. At this stage, manufacturing sector gets smaller, and service sector gets bigger. Also, using more efficient technologies is also beneficial for decreasing pollution level at the stage of post-industrial economies (Panayotou, 1993, 2003; Common and Stagl, 2005).

According to Maslow's hierarchy of needs, basic physiological needs like food, air, water, clothing, and shelter takes priority for human survival. At the low income per capita levels, people care these physiological needs, firstly (Maslow, 1943). As income rises, these needs are satisfied, and people reserve a share of their earnings to 'luxuries' like waste treatment facilities and improvement of environmental conditions for environmental quality. When the economic growth passes a turning point, people become more sensitive to environment and demand for higher environmental standards (Common and Stagl, 2005).

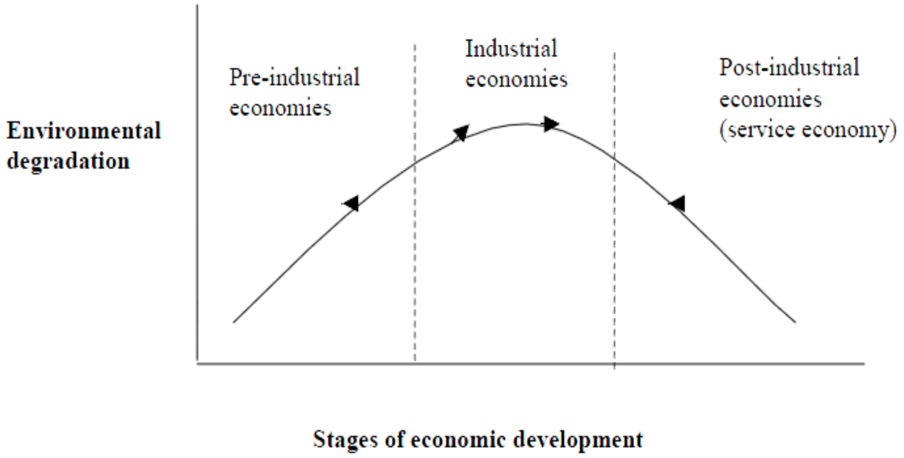

Figure 3: Environmental Kuznets Curve

Source: Panayotou, T. (2003). Economic growth and environment. Spring Seminar of the United Nations Economic Commission for Europe, Geneva.

According to Grossman and Krueger (1991), economic growth affects the environmental quality in three ways; *scale effect*, *composition effect*, and *technique effect.*

Scale effect expresses that expansion of economic activity which is mainly increase in output enhances pollution and environmental degradation when the structure of the economy and the technology level do not change. So, one can conclude that economic growth has a negative impact on the environment quality (Akbostancı et al., 2009).

Secondly, *composition effect* is related to the structure of the economy. In the pre-industrial stage, the economy is mainly based on agriculture. When the economy shifts from the pre-industrial stage to the industrial stage, pollution level increases because manufacturing process heavily based on natural resources. After that, beyond the turning point of the industrial stage, the structure of the economy shifts from the heavy manufacturing to the service sector and the light manufacturing industries. This effect decreases pollution level in the country, steadily (Grossman and Krueger, 1991).

The final one is *technique effect* covers development in productivity and moves toward to environment-friendly technologies. So, this effect also has a positive impact on environmental degradation. As a conclusion, scale effect forms the increasing part of the inverted-U shaped of the EKC while composition effect and technique effect constitute the decreasing part of the EKC (Akbostancı et al., 2009).

Dinda (2004) claims that besides the income elasticity of environmental quality, scale, composition, and technological effects, there are also other factors that form the shape of the EKC such as international trade, market mechanism, and regulations. Effects of international trade, market mechanism, and regulations on environmental degradation are explained below, in order.

International trade affects the shape of the EKC, and it is one of the most significant factors which can account for the curve. International trade can affect the size of the economy and output level in a country. The increase in the scale of the economy accelerates the rise in pollution level and leads to environmental degradation. However, some environmental economists such as Birdsall and Wheeler (1993), Jones and Rodolfo (1995), and Lee and Roland-Holst (1997) discussed that trade is not the primary cause of degradation of the environment. On the other side, free trade has both positive and negative impact on the environment. It damages the environment via scale effect as triggering especially export volume which increases the size of the economy. Reversely, trade can increase environmental quality through composition and/or technique effect. For instance, trade leads higher income per capita, and it causes a stronger demand on environmental regulations (Dinda, 2004).

On the market mechanism side, it takes the benefit from the economic development process. For instance, a developing country moves from the non-market energy sources to less polluting market energy sources (Kadekodi and Agarwal, 1999). Prices, economic agents, the transition to market economy, and access to information can influence the market mechanism. Firstly, prices can affect the use of natural resources which increases pollution. Unruh and Moomaw (1998) states that World Oil Crisis in the 1970s increases oil prices, sharply. Thus, it directs countries to alternative sources of electricity production.

Secondly, economic agents like citizens, businesses, policymakers, regulators, and non-governmental organizations play significant roles on pollutions. They can increase the environmental quality by their demands, decisions, and acts (Dinda, 2004). Financiers might restrict the supply of credit due to environmental liabilities. In addition, consumers might decrease demand for pollution-intensive products (Dasgupta et al., 2002).

Thirdly, moves from the centrally-planned economy to market-driven economy is consistent with a whole progress of quality of the environment. Transition economies' environment is cleaned up due to increasing energy prices etc. (Nilsson, 1993; Vukina et al., 1999). Lastly, access to information has a significant role in decreasing part of the curve via proper regulations. When the society gets easy access to information about polluters, damages of pollution, domestic environmental quality, and cost of pollution, their pressure toward environmental quality increases (Dasgupta et al., 2002; Dinda, 2004).

Regulations affect environmental quality through formal regulations, informal regulations, and proper rights. When the output level rises in a country, pollution level also increases. To curb the negative effects of economic growth, formal environmental regulations should be leveraged (Hettie et al., 2000). If the formal regulations are not sufficient to decrease emission levels, informal regularities are used by other economic agents (Pargal and Wheeler, 1996). In addition, if the property rights advanced in a country, its income per capita level rises, and environmental problems decrease (Cropper and Griffiths, 1994).

3.2.2 Critiques of the EKC Hypothesis

Economists criticize the EKC in respect to theory and methodology. Firstly, the EKC assumes that there is unidirectional relationship from the income to environmental degradation. It does not take account of the effects of the environmental quality on the income level (Zhang, 2014). Environmental degradation can affect income, negatively, and may cause to decrease in economic growth rate.

Secondly, the EKC asserts that pollution level decreases at the high stages of income levels. Studies generally take into account of only one pollutant, and it may cause a misinterpretation. Aggregate pollution level per capita does not change in many cases. Pollution may be just shifted from sulfur oxide and nitrogen oxide to carbon dioxide and solid waste. In other words, an effort to decrease the level of some pollutants may cause other environmental problems (Stern, 2004b).

The third critique is related to investments and regulations for the environment. According to the EKC hypothesis, the environmental quality increases when the income level rises after the turning point. However, it cannot happen automatically without any investments and regulations. Economic agents should demand higher environmental standards. Moreover, governments should pay particular attention to environmental problems for restricting ecological damage (Zhang, 2014).

Fourthly, developed countries reduce pollution intensive production, and import most of these kinds of goods from developing countries due to environmental issues. Thus, pollution level decreases in developed countries while it increases in developing economies. However, today's developing countries may not find a sufficient number of exporter countries which can produce pollution-intensive goods, when they become developed economies in the future. So, their pollution level would not decrease even if their income level rises (Stern et al., 1996; Öztürk, 2007).

On the econometric side, some of the EKC studies do not consider critical issues like heteroskedasticity problem. Efficiency problem exists when the variance is not homoscedastic although estimation is unbiased (Stern et al., 1996). In most of the studies, panel data is used rather than time series analysis as an econometric method. It may cause wrong results because the estimated relationship covers same period, same variables, same functional form, and the same turning point for all the countries. However, every single state has different individual growth and environmental relationship (Koop and Tole, 1999).

3.2.3 Empirical Literature

Economists have investigated the presence of the EKC hypothesis since at the beginnings of the 1990s. There are many studies about this hypothesis in the literature. Results of some studies provided supportive evidence for the EKC hypothesis while others not. The existence of the EKC hypothesis differs from country to country or region to region. In addition, sample period which is selected and econometric methodology that is conducted in the study affects the results significantly.

Recent studies on the EKC hypothesis for a single country and multiple countries are listed in the chronological order in section 3.2.3.1. and 3.2.3.2., respectively. Also, an overview of the literature is presented in Table 3.

3.2.3.1 Studies for Single Country

Ang (2007) estimated the EKC hypothesis for France for the period between 1960 and 2000. He examined the dynamic causal relationship between CO_2 emissions, energy consumption, and output. Cointegration and Error-Correction Model (ECM) were employed for testing the EKC. The empirical results supported that these variables are cointegrated in the long run. Causality results suggested that there is a unidirectional causality from economic growth to both growths of energy use and growth of pollution over the long term. Furthermore, unidirectional causality was found from growth of energy use to growth of output over the short term. Econometric results provided some evidence for the EKC hypothesis.

Wang et al. (2011) investigated the causal relationship between CO_2 emissions, energy consumption, and economic growth in China based on panel data for 28 provinces over the period between 1995 and 2007. Panel cointegration and panel Vector Error Correction Model (VECM) were utilized to analyze the relationship between these variables. The results demonstrated that these variables are cointegrated in the long run. On the other hand, bidirectional causality existed between both CO_2 emissions and energy consumption, and between energy use and economic growth. However, the study failed to find evidence supporting the EKC hypothesis for China

Esteve and Tamarit (2012) tested the validity of the EKC for Spain covering the period between 1857 and 2007. In the study, CO_2 emissions and per capita income were used as a dependent variable and an independent variable, respectively. Relative to previous studies, a non-linear relationship was utilized via Threshold VECM in this study. According to the results, there were two regimes in the sample which are lower than 8,266 Euros (includes 85% of the observations) and higher than 8,266 Euros (includes 15% of the observations). The empirical results indicated that there is an inverted U-relationship between these variables.

Shahbaz et al. (2012) examined the nexus between CO_2 emissions, energy consumption, economic growth, and trade openness in Pakistan for the period of 1971-2009.

Autoregressive Distributed Lag (ARDL) bound test and causality test are used to find a relationship between these variables. A cointegration relationship is found between these variables in the long run. So, this result reveals that the EKC hypothesis is supported in Pakistan. Also, a unidirectional causality is found from economic growth to CO_2 emissions. Moreover, an increase in energy consumption leads to increase in carbon dioxide emissions both in the short run and in the long-term. However, trade openness reduces CO_2 emissions in the long term.

The EKC hypothesis and causal relationship between financial development, trade, economic growth, energy consumption, and CO_2 emissions for Turkey during the period 1960-2007 were examined by Ozturk and Acaravci (2013). According to the ARDL test results, variables that mentioned above were cointegrated in the long run. An increase in foreign trade to GDP ratio had a positive impact on carbon emissions while the coefficient of financial development was statistically insignificant over the long term. Moreover, findings indicated that the validity of the EKC for the Turkish economy.

In the study of Tiwari et al. (2013), effects of economic growth, coal consumption, and trade openness on CO_2 emissions for India were estimated. Also, dynamic relationship and causal relations between variables were also investigated through ARDL bound test and VECM Granger causality over the period of 1966-2011. The empirical results pointed out that the presence of the EKC hypothesis for India both in the long run and in the short term. Coal consumption and trade openness had a positive impact on emissions in the long-term. On the other hand, the coefficient of coal consumption was positive while the coefficient of trade openness was negative in the near term.

Çil Yavuz (2014) analyzed the long run relationship between CO_2 emissions, income per capita, and energy consumption per capita in Turkey for the period between 1960 and 2007. Johansen cointegration test and Gregory-Hansen cointegration test which allows for a structural break were employed to check the EKC hypothesis in the Turkish economy. Results revealed that the EKC hypothesis existed for both models in the long run.

Farhani et al. (2014b) investigated the relationship between CO_2 emissions, GDP, energy consumption, and trade for Tunisia for the period which covers 1971-2008. ARDL bound test and VECM Granger causality were used as econometric methods in this study. In the short run, unidirectional causalities were running from GDP to CO_2, from GDP square to

CO_2, and from energy consumption to CO_2. Econometric results demonstrated that there was an inverted-U shape relationship between emission level and income level for Tunisian economy.

Lau et al. (2014) estimated the presence of the EKC hypothesis for Malaysia covers the period from 1970 to 2008. In addition, foreign direct investment and trade openness variables were also included to model for finding their effects on CO_2 emissions. ARDL bound test and VECM Granger causality were conducted to estimate the linkage between variables. Empirical findings supported the existence of the EKC hypothesis both in the long run and in the near term. Moreover, both foreign direct investment and trade had negative impacts on environmental quality.

The presence of the EKC hypothesis in Vietnam over the period between 1981 and 2011 was estimated by Al-mulali et al. (2015). ARDL methodology was utilized to find the long-run link between pollution level and GDP. The empirical results indicated that the EKC hypothesis was not valid for this country. There were positive effects of GDP on CO_2 emissions both in the long run and in the short term. Its economic development level has not reached a turning point where pollution level decreases when income level increases, yet.

3.2.3.2 Studies for Multiple Countries

Acaravci and Ozturk (2010) examined the correlation between energy consumption, CO_2 emissions, and economic growth in 19 European for the period 1960-2005 (1970-2005 for Germany and 1965-2005 for Hungary). ARDL bound test and VECM Granger causality were conducted to find a relationship between variables. Bound test results revealed that these variables are cointegrated in the long run only for Denmark, Germany, Greece, Iceland, Italy, Portugal, and Switzerland. Moreover, empirical results suggest that the EKC hypothesis existed for Denmark and Italy.

Lean and Smyth (2010) investigated the connection between CO_2 emissions, electricity consumption, and output for five Association of Southeast Asian Nations (ASEAN) countries for the period between 1980 and 2006. Fisher cointegration, dynamic OLS (DOLS), and VECM Granger causality were employed as econometric methods. The empirical findings pointed out that the EKC hypothesis was valid for these countries. In addition, causality tests suggested that there was unidirectional causality running from electricity consumption and CO_2 emissions to economic growth over the long term. Furthermore, there was also a one-way causal relationship from carbon dioxide emissions to electricity consumption over the short term.

The nexus between carbon dioxide emissions, energy consumption, and economic growth in BRIC (Brazil, Russia, India, and China) countries during the period 1971-2005 except for Russia (1990-2005) were studied by Pao and Tsai (2010). Three panel cointegration tests (Pedroni, Kao, Fisher tests) were employed in the study for investigating long-run relationship between variables. Moreover, OLS (Ordinary Least Squares) model and VECM causality were also employed in the study. According to the results, the EKC hypothesis was supported in the long run for these countries. In addition, energy consumption had a positive impact on CO_2 emissions. Panel cointegration tests revealed that there was a strong bidirectional causality between energy use and carbon dioxide emissions and there was a bidirectional long run causality between energy use and output. Furthermore, unidirectional strong causality and short run causality were running from carbon dioxide emissions and energy consumption to output respectively.

Orubu and Omotor (2011) examined the link between economic growth and environmental degradation indicators (suspended particulate matter and organic water pollutant) African countries covering the period from 1990 to 2002 for suspended particulate matter while from 1980 to 2002 for organic water pollutant. They employed panel OLS model, random effects model, and fixed effects model in the study. The empirical results pointed out that the EKC hypothesis was existed for only suspended particulate matter for quadratic form.

Arouri et al. (2012) tested the validity of the EKC hypothesis for 12 Middle East and North African countries during the period 1981-2005. Bootstrap panel unit root tests and cointegration techniques used to find a link between carbon dioxide emissions, energy consumption, and real GDP. The empirical results revealed that energy consumption affected CO_2 emissions in the long run, positively. Moreover, findings supported the presence of the EKC hypothesis in MENA region.

Ozcan (2013) investigated the relationship between carbon emissions, energy consumption, and economic growth in 12 Middle East countries, Bahrain, United Arab Emirates, Iran, Israel, Egypt, Syria, Saudi Arabia, Turkey, Oman, Jordan, Lebanon, and Yemen, over the period of 1990-2008 using panel data estimation. Results for the panel pointed out a U-shaped curve which was contrary to the EKC hypothesis. Also, there was a unidirectional causality running from economic growth to energy consumption in the near term while unidirectional causalities were found running from both energy consumption to CO_2 emissions and from economic growth to carbon dioxide emissions in the long run.

In applied field, scholars have studied many academic researches on standard EKC. Sinha Babu and Datta (2013) introduced some modifications to the standard EKC. They used environmental degradation index as a dependent variable instead of emission level while GDP, GDP^2, and GDP^3 used as independent variables. The relationship between these four variables were examined for 22 developing countries (Asian countries, Sub-Saharan African countries, and Latin American countries) covering the period 1980-2008 through fixed effects model. The empirical results suggested that there was an N-shaped relationship for all panel. Besides, there was also an N-shaped pattern between these variables for each country group. So, one can conclude that the EKC was not supported in this study.

Al-Rawashdeh et al. (2014) tested the EKC hypothesis which asserts the linkage between economic growth and environmental quality for 22 MENA countries over the period between 1960 and 2010. In the study, SO_2 emissions and CO_2 emissions were used as dependent variables while GDP determined as independent variable. According to the country level analysis, the EKC was valid for Algeria, Tunisia, Yemen, Morocco, Turkey, and Libya for SO_2 emissions; the EKC was valid for Tunisia, Morocco, Turkey, and Jordan for CO_2 emissions. However, it was not valid for the whole region for both SO_2 and carbon dioxide emissions.

Farhani et al. (2014a) tested the presence of the EKC and the modified EKC hypotheses for 10 MENA countries covering the period from 1990 to 2010. They used FMOLS (Fully Modified Least Squares) and DOLS for finding a long run relationship between variables. Firstly, the results demonstrated that there is an inverted U-shape relationship between environmental degradation and income. Secondly, there was also an inverted U-shape relationship between sustainability and human development.

Onafowora and Owoye (2014) studied the EKC hypothesis for Brazil, China, Egypt, Japan, Mexico, Nigeria, South Korea, and South Africa during the period 1970-2010. ARDL bounds test and variance decomposition were used to examine the EKC hypothesis for these countries. According to the empirical findings, EKC hypothesis was held in Japan and South Korea. On the other hand, the N-shaped curve was existed in other six countries: Brazil, China, Egypt, Mexico, Nigeria, and South Africa. Besides, the causality tests indicated that there was a one-way causality from energy consumption to CO_2 emissions and economic growth in all the countries included in the study.

The environmental pollution and development nexus for 50 African countries for the period from 1995 to 2010 was examined by Osabuohien et al. (2014) using Pedroni panel cointegration and panel DOLS. CO_2 emissions and particulate matter emissions were used as dependent variables which denote environmental pollution while per capita income, square of per capita income, institutional quality, and trade were used as independent variables in the study. The analyses supported that the presence of the EKC hypothesis for these 50 African countries.

There are plenty of empirical studies about the EKC hypothesis in the literature. Results of some studies provided supportive evidence for the validity of the EKC hypothesis while others not. The presence of the EKC hypothesis changes country to country or region to region, and the sample period which is chosen and econometric methodology that is conducted in the study affects the results, significantly. Empirical literature reveals that this hypothesis is generally valid in developed countries while it is invalid especially in low-income developing countries.

Table 3: Overview of the EKC Literature

Author(s)	Period	Country / Region	Methodology	Variables	EKC Hypothesis
Studies for single country					
Ang (2007)	1960-2000	France	Johansen cointegration test, ARDL bound test, VECM Granger causality.	CO_2 emissions, energy consumption, GDP, GDP square.	Yes
Wang et al. (2011)	1995-2007	China	Pedroni cointegration, VECM Granger Causality.	CO_2 emissions, GDP, GDP square, energy consumption.	No
Esteve and Tamarit (2012)	1857-2007	Spain	Threshold VECM.	CO_2 emissions, GDP, GDP square.	Yes
Shahbaz et al. (2012)	1971-2009	Pakistan	ARDL bound test, VECM Granger causality.	CO_2 emissions, energy consumption, GDP, GDP square.	Yes
Ozturk and Acaravci (2013)	1960-2007	Turkey	ARDL bound test.	Carbon emissions, financial development, trade openness, GDP, GDP square, energy consumption.	Yes
Tiwari et al. (2013)	1966-2011	India	ARDL bound test, VECM Granger causality.	CO_2 emissions, energy consumption, GDP, GDP square, trade openness.	Yes
Çil Yavuz (2014)	1960-2007	Turkey	Johansen cointegration test, Gregory Hansen cointegration test, OLS, FMOLS.	CO_2 emissions, energy consumption, GDP, GDP square.	Yes
Farhani et al. (2014b)	1971-2008	Tunisia	ARDL bound test, VECM Granger causality.	CO_2 emissions, energy consumption, GDP, GDP square, trade openness.	Yes
Lau et al. (2014)	1970-2008	Malaysia	ARDL bound test, VECM Granger causality.	CO_2 emissions, GDP, GDP square, foreign direct investments, trade openness.	Yes
Al-mulali et al. (2015)	1981-2011	Vietnam	ARDL bound test.	CO_2 emissions, GDP, capital, labor force, export, import, electricity consumption.	No

Studies for multiple countries					
Acaravci and Ozturk (2010)	1960-2005	Europe	ARDL bound test, VECM Granger causality.	CO_2 emissions, GDP, GDP square.	Yes, for Denmark and Italy.
Lean and Smyth (2010)	1980-2006	ASEAN	Fisher cointegration test, DOLS, VECM Granger causality.	CO_2 emissions, energy consumption, GDP, GDP square.	Yes
Pao and Tsai (2010)	1971-2005	BRIC	Pedroni, Kao, Fisher cointegration tests, OLS, VECM Granger causality.	CO_2 emissions, energy consumption, GDP, GDP square.	Yes
Orubu and Omotor (2011)	1990-2002 1980-2002	Africa	Panel OLS, fixed effect models, random effects model.	Environmental degradation indicators, GDP, GDP square.	Yes, for suspended particulate matter.
Arouri et al. (2012)	1981-2005	MENA	Panel cointegration techniques.	CO_2 emissions, energy consumption, GDP, GDP square.	Yes
Ozcan (2013)	1990-2008	Middle East	Pedroni cointegration test, FMOLS, VECM Granger causality.	CO_2 emissions, energy consumption, GDP, GDP square.	No for the whole region.
Sinha Babu and Datta (2013)	1980-2008	Developing countries	Fixed effects model.	Environmental degradation index, GDP, GDP square, GDP cubic, population	No
Al-Rawashdeh et al. (2014)	1960-2010	MENA	Johansen cointegration test.	CO_2 emissions, SO_2 emissions, GDP, GDP square.	No for the whole region.
Farhani et al. (2014a)	1990-2010	MENA	FMOLS, DOLS.	CO_2 emissions, GDP, GDP square, energy consumption, trade, manufacture value-added, modified human development index.	Yes
Onafowora and Owoye (2014)	1970-2010	Ten selected countries	ARDL bound test, Variance decomposition.	CO_2 emissions, GDP, GDP square, trade openness, energy consumption, population density.	Yes, for Japan and South Korea.
Osabuohien et al. (2014)	1995-2010	Africa	Pedroni cointegration test, DOLS	CO_2, PM, GDP, GDP square, institutional quality, trade.	Yes

3.3 The Pollution Haven Hypothesis

The Pollution Haven Hypothesis asserts that trade and/or investment liberalization affect the pollution levels of the countries. Pollution-intensive production shifts from countries with stringent environmental policies to countries that have relatively weak environmental regulations. This change can be occurred due to trade and foreign direct investment (Copeland, 2010).

Preliminary studies about the PHH were conducted by Low and Yeats (1992) and Mani and Wheeler (1997). Findings revealed that the share of dirty industries' goods in exports from developing countries increased when the trade was liberalized. On the other side, the proportion of dirty industries' goods in exports from OECD countries decreased during the same period. Besides, Suri and Chapman (1998) and Agras and Chapman (1999) demonstrated that production of pollution-intensive goods rose in developing countries while they decreased in developed countries (Manav, 2012).

3.3.1 Theory of the PHH

The PPH states the positive relationship between FDI inflows and pollution level. According to the PHH, pollution-intensive industries shift their production activities from developed countries to developing countries due to stringent environmental regulations and avoiding high environmental compliance costs (Leiter et al., 2011; Al-mulali and Tang, 2013). The PHH leads two main consequences: pollution level increases in the countries that use lax environmental regulation while decreases in the countries which have higher environmental standards; and overall pollution level increases with trade in the world (Taylor, 2004).

On the other side, some studies support that FDI inflows have a positive impact on environmental degradation in host countries because FDI inflows decrease pollution level, foreign companies from developed countries bring clean and environment-friendly technologies to less-developed countries (Al-mulali and Tang, 2013). That is called as *Pollution Halo Hypothesis*.

A schematic representation of unbundling the PHH is displayed in Figure 4. According to figure, country characteristics and world prices compose the income level of the country. It shapes the national environmental regulations and policies at step (a). Stringent environmental regulations lead to higher production costs at step (b). Relative prices determine the comparative advantage of the country. Moreover, it affects the trade flows and foreign direct investment's inflows and outflows at step (c). At step (d), trade and investment flow change the production patterns, then pollution level, national income, and world prices also affected by these flows. Also, pollution level, income, and prices cause to a change in characteristics of the country at step (e).

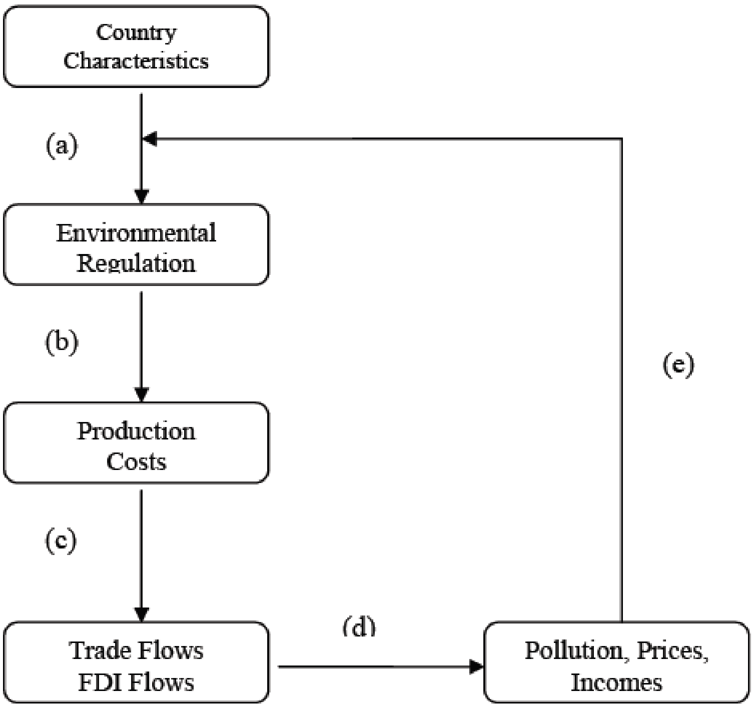

Figure 4: Unbundling the PHH

Source: Taylor, M. S. (2004). Unbundling the Pollution Haven Hypothesis. Advances in Economic Analysis & Policy, 3(2).

3.3.2 Empirical Literature

There are lots of studies about the PHH in the literature. Some studies produce results in line with the PHH while other empirical studies fail to do so. The variations in empirical results stem from four major factors. Firstly, the empirical results are very sensitive to the geographic location of the sample. That is, the empirical results change country to country or region to region. Secondly, data coverage and the selection of methodological device play major role in variations of the results. In addition, each empirical works tends to utilize different formal model in testing procedure. For instance, the studies tend to utilize different dependent and independent variables in regression models as well as they generally utilize different pairs of variables in formal causality testing procedures. Variations in theoretical settings in those empirical works cause difficulties in interpreting the results; and thus, it is almost impossible to compare finding on the basis of reasonable benchmark values.

Recent studies on the PHH for a single country and multiple countries are listed in the chronological order in section 3.3.2.1. and 3.3.2.2., respectively. Furthermore, an overview of the literature is presented in Table 4.

3.3.2.1 Studies for Single Country

Lee (2009) examined the long-run relationship between FDI inflows, pollution, and output level in Malaysia covering the period from 1970 to 2000 using ARDL bound test and VECM Granger causality. Six different models were set up to estimate the cointegration relationship between variables. However, among these six models, only one of them was reported as significant (i.e., cointegration exists between FDI and GDP). Causality results pointed out a unidirectional causality running from FDI inflows and pollution to output level both in the long term and in the short term. In addition, there were a causal relationship between output to FDI inflows in the long run.

Kirkulak et al. (2011) investigated the effects of FDI inflows on environmental degradation, air quality, in China over the period 2001-2007. The study used GDP, population, technical workforce, and proportion of FDIs' output in gross industrial output value as explanatory variables. Panel fixed effects and random effects models were employed to find the linkage between these variables. Data of 286 Chinese cities divided into three groups: East China, Central China, and West China. The findings revealed that FDI has no negative effect on the air quality. So, this result contradicted to the PHH for Chinese economy.

Shofwan and Fong (2011) tested the PHH in Indonesia for the period between 1975 and 2009. Spearman's correlation analysis was used to find correlations between CO_2 emissions, FDI, GDP, and population. The results demonstrated that there was a weak and statistically insignificant link between emissions and FDI. However, there was a negative-strong relationship between GDP and emissions while there was a positive-strong relationship between population and emissions. In other words, the results of the study were not consistent with the PHH.

The linkage between CO_2 emissions, FDI, and capital formation in Pakistan covering the period between 1974 and 2010 was investigated by Bukhari et al. (2014). ARDL bound test and pairwise Granger causality test were employed. According to the findings, FDI had statistically insignificant effects on emissions both in the short run and in the long-term. In addition to these findings, a unidirectional causality was found from FDI to CO_2 emissions.

The impact of FDI and foreign trade on carbon dioxide emissions in China during the period 1995-2011 were examined by Hao and Liu (2015) using provincial panel data. Panel fixed effects model, first-difference GMM (Generalized Methods of Moments), and system GMM methods were employed to estimate the linkage. The estimation results demonstrated that total impact FDI on emission levels was negative. On the other hand, the impact of foreign trade on emission level was statistically insignificant.

The nexus between CO_2 emissions, FDI, GDP, GDP square, and energy consumption in Turkey during the period 1974-2010 was studied by Seker et al. (2015). ARDL bound test, Hatemi-J test, and VECM Granger causality test were employed in the analysis. According to the empirical findings, the effect of FDI on CO_2 emissions was positive but weak in the long run. Besides, the impacts of GDP and energy consumption on CO_2 emissions were positive both in the short run and in the long run. The short run results were similar to findings in the long term. Causality result indicated that there was a unidirectional causality from all the independent variables to emissions in the long run. Results supported the PPH for the Turkish economy.

The effects of energy consumption, income, and foreign direct investment on CO_2 emissions in Vietnam over the period from 1976 to 2009 were studied by Tang and Tan (2015). The study tested both the EKC hypothesis and the PHH using Johansen cointegration test and Granger causality test based on VECM. The econometric results supported the EKC hypothesis both in the short run and in the long run. In addition, there was some evidence for the Pollution Halo Hypothesis for Vietnamese economy. Over the long term, FDI affected CO_2 emissions, negatively. When the FDI flow increased, pollution level decreased in the country. Moreover, two-way causality relationship existed between FDI and carbon dioxide emissions.

Sarker et al. (2016) examined the nexus between FDI, economic growth, energy consumption, natural gas usage, and CO_2 emissions in Bangladesh covers the period 1978-2010. Johansen cointegration and VECM Granger causality were employed as econometric methods. The results demonstrated that the variables were cointegrated in the long run. Also, Granger causality test results indicated one-way causality from emissions to FDI and both in the short term and over the long term.

3.3.2.2 Studies for Multiple Countries

Aliyu (2005) investigated the effect of environmental policy on location decision for 11 developed countries - Canada, Denmark, Finland, Germany, Iceland, Italy, Japan, Netherlands, Sweden, Switzerland, United Kingdom - and inflow of *dirty* FDIs for developing countries - Argentina, Armenia, Brazil, Chile, Colombia, Indonesia, Kazakhstan, Mexico, Pakistan, Paraguay, Poland, Slovenia, Thailand, Trinidad and Tobago- covering the period 1990-2000. The study utilized panel OLS and GLS methods. The *dirty* FDI outflow was detected to be correlated with environmental policy in developed countries and the sign of correlation coefficient was positive. Furthermore, FDI inflow was statistically significant in explaining the level of CO_2 emissions. However, it was insignificant to explain the total concentration of known pollutants, energy use, and temperature level.

Hoffmann et al. (2005) studied the FDI inflow and CO_2 emissions nexus for 112 countries over the period 1971-1999 (time length varies between 15 to 28 years) using Panel Granger Causality test. These countries were classified into three groups: low-income, middle-income, and high-income countries. According to the results, emissions were Granger cause of FDI in low-income countries, while FDIs were Granger cause of emissions in middle-income countries. The study also discovered that there was no causal link between FDIs and CO_2 emissions in high-income countries.

The impact of FDIs on emissions in 5 Asian countries – Indonesia, Malaysia, Philippines, Singapore, Thailand– for the period of 1970-2001 were examined by Merican et al. (2007) using time series data. ARDL bound test was used to find a link between FDI and emissions. The empirical results revealed that the variables were cointegrated in the long run for all five countries. In the long term, there was a positive impact of FDI on emissions in Malaysia, Philippines, and Thailand while there was a negative effect in Indonesia. In the short run, the impact of FDI on emissions was positive in Malaysia, Philippines, and Thailand; negative in Indonesia like in the long term estimation.

Jorgenson (2009) examined the impact of FDI on industrial organic water pollution intensity in 30 less-developed countries during the period 1980-2000 using Prais-Winsten regression and panel random effects model. The findings suggested that there was a positive and statistically significant linkage between industrial organic water pollution and FDI in the manufacturing sector in less-developed countries.

Granger causality link between CO_2 emissions, energy consumption, FDI, and GDP in BRIC countries covers the period 1980-2007 except for Russia (1992-2007) were studied by Pao and Tsai (2011). Johansen Fisher, Kao, and Pedroni cointegration tests and panel VECM causality test were employed to find the relationships between variables. In the long run, the effect of FDI on CO_2 emissions was found as 0.041. Causality results revealed that there was a strong bi-directional causality between emissions and FDI, in the short run.

Atici (2012) estimated the relationship between trade and environmental degradation for ASEAN countries during the period from 1970 to 2006 using panel fixed effects model and panel fixed effects model. The ASEAN countries divided into three groups: the developed group, the developing group, and the late developing group. The empirical findings showed that CO_2 emissions had an inverted-S shape in all three groups. Moreover, findings revealed that there was no evidence for the FDI had an adverse impact on environmental degradation.

Blanco et al. (2013) studied the effects of sector specific FDI on CO_2 emissions for 18 Latin American countries for the period 1980-2007. Panel Granger causality test results pointed out a unidirectional causality from FDI in pollution-intensive industries to emissions per capita. Also, there was no causal link from FDI in pollution-intensive industries to emissions in other sectors different than dirty sectors.

Asghari (2013) tested the validity of the PHH and the Pollution Halo hypothesis for 6 MENA countries - Bahrain, Iran, Jordan, Kuwait, Oman, Saudi Arabia- for the period between 1980 and 2011. CO_2 emissions determined as the dependent variable of the model while GDP, GDP square, share of industry in GDP, trade openness, FDI inflow, population, environmental regulation, and corruption perception index were used as independent variables. Random effects and fixed effects models were used to test these hypotheses. Empirical findings pointed out that FDI inflow affected CO_2 emissions negatively and weakly. This result revealed that there was a weak support of the Pollution Halo Hypothesis for MENA region.

Linh and Lin (2015) estimated the dynamic causal relationship between CO_2 emissions, energy consumption, GDP, and FDI in 12 most crowded countries in Asia - Bangladesh, China, India, Indonesia, Iran, Japan, Myanmar, Pakistan, Philippines, South Korea, Thailand, Vietnam – covering the period 1980-2010. Johansen cointegration and panel VECM Granger causality tests were used as econometric methods in this study. The estimation results pointed out that the effect of FDI on emissions calculated as -0,03. Moreover, a long run one-way causality was found from CO_2 emissions to FDI. Besides, the results also supported the EKC hypothesis for these 12 Asian countries.

The relationship between FDI, renewable energy consumption, and CO_2 emissions for 21 Kyoto Annex countries during the period 1970-2010 (time span was small for some countries) were investigated by Mert and Bölük (2016) using unbalanced panel data. Panel ARDL and panel causality were conducted to test the EKC hypothesis and the Pollution Halo hypothesis. Effect of FDI on emissions was negative and significant in the long run, but it was insignificant in the short term. The empirical findings supported the Pollution Halo hypothesis. FDIs brought clean technologies and increased environmental standards. However, the EKC hypothesis did not exist in these 21 Kyoto countries.

Shahbaz et al. (2016) studied the causal relationship between FDI, growth, and CO_2 emissions in 117 countries – high-income countries, middle-income countries, low-income countries – for the period from 1985 to 2010. Panel cointegration test and homogenous and non-homogenous Granger causality tests were conducted in the analysis. Homogenous causality test results indicated that a bidirectional causality existed between FDI and emissions for high income and middle-income countries, but not for low-income countries. On the non-homogenous causality side, there was two-way causality between FDI and emissions in high income and middle-income countries.

Zhu et al. (2016) examined the link between FDI, GDP, energy consumption, and carbon emissions in ASEAN 5 countries - Indonesia, Malaysia, Philippines, Singapore, Thailand – for the period of 1981-2011. Moreover, some other control variables were included to model for avoiding omitted variable bias. Panel quantile regression model was used in this paper. The empirical results showed that the effect of FDI on emissions was negative except at the 5th quantile. So, results suggested the existence of the Pollution Halo hypothesis in countries which had a higher emission.

According to the literature, some studies produce results in line with the PHH while others fail to do so. The variations in empirical results stem from several factors such as the geographic location of the sample, data coverage, and methodology. Generally, the empirical literature reveals that FDI inflows increase pollution level in developing countries which has weak environmental regulations.

Table 4: Overview of the PHH Literature

Author(s)	Period	Country / Region	Methodology	Results
Studies for single country				
Lee (2009)	1970-2000	Malaysia	ARDL bound test, VECM Granger causality.	FDI affected CO_2 emissions, positively in the LR. FDI → CO_2 emissions.
Kirkulak et al. (2011)	2001-2007	China	Random effects model, Fixed effects model.	FDI negatively affected SO_2 emissions.
Shofwan and Fong (2011)	1975-2009	Indonesia	Spearman’s correlation analysis.	The insignificant link between FDI and CO_2 emissions.
Bukhari et al. (2014)	1974-2010	Pakistan	ARDL bound test, Pairwise Granger causality.	FDI → CO_2 emissions.
Hao and Liu (2015)	1995-2011	China	Fixed effects model, first-difference GMM, System GMM.	The total impact of FDI on CO_2 emissions was negative.
Seker et al. (2015)	1974-2010	Turkey	ARDL bound test, Hatemi-J test, VECM Granger causality.	Effect of FDI on CO_2 emissions was positive. CO_2 emissions → FDI in the SR.
Tang and Tan (2015)	1976-2009	Vietnam	Johansen cointegration test, VECM Granger causality.	FDI affected CO_2 emissions, negatively. FDI ↔ CO_2 emissions.
Sarker et al. (2016)	1978-2010	Bangladesh	Johansen cointegration test, VECM Granger causality.	CO_2 emissions → FDI both in the SR and in the LR.
Studies for multiple countries				
Aliyu (2005)	1990-2000	Developed countries	Panel OLS, Panel GLS.	FDI affected CO_2 emissions, positively.
Hoffmann et al. (2005)	1971-1999	Low-, Middle-, High-income countries	Panel Granger causality.	CO_2 emissions → FDI in low-income countries. FDI → CO_2 emissions in middle-income countries.

Merican et al. (2007)	1970-2001	Asian countries	ARDL bound test.	FDI affected CO_2 emissions positively in Malaysia, Philippines, and Thailand both in the SR and in the LR; negative in Indonesia.
Jorgenson (2009)	1980-2000	Less-developed countries	Prais-Winsten regression, panel random effects model.	FDI affected industrial organic water pollution, positively.
Pao and Tsai (2011)	1980-2007	BRIC countries	Johansen Fisher, Kao, Pedroni cointegration tests, Panel VECM Granger causality.	FDI affected CO_2 emissions, positively. FDI ↔ CO_2 emissions in the SR.
Atici (2012)	1970-2006	ASEAN countries	Fixed effects model, random effects model.	FDI did not increase CO_2 emissions.
Blanco et al. (2013)	1980-2007	Latin American countries	Panel Granger causality.	FDI in pollution-intensive sectors → CO_2 emissions.
Asghari (2013)	1980-2011	MENA countries	Random effects model, fixed effects model.	FDI affected CO_2 emissions, negatively.
Linh and Lin (2015)	1980-2010	Asian countries	Johansen cointegration, panel VECM Granger causality.	The impact of FDI on CO_2 emissions was negative. CO_2 emissions → FDI in the LR.
Mert and Bölük (2016)	1970-2010	Kyoto Annex countries	Panel ARDL, panel causality.	Effect of FDI on CO_2 emissions was negative in the LR.
Shahbaz et al. (2016)	1985-2010	Low-, Middle-, High-income countries	Panel cointegration test, homogenous and non-homogenous Granger causality tests.	FDI ↔ CO_2 emissions in high- and middle-income countries for both homogenous and non-homogenous causality tests.
Zhu et al. (2016)	1981-2011	ASEAN countries	Panel quantile regression.	Effect of FDI on CO_2 emissions was negative.

Note: → denotes unidirectional causality, ↔ denotes bidirectional causality. SR shows short run, LR shows long run.

CHAPTER 4

4. EMPIRICAL ANALYSES

In this study, the validity of the EKC hypothesis and the PHH are tested by using a model proposed by Tang and Tan (2015). They investigated the effects of some economic variables (income, FDI, and energy consumption) on CO_2 emissions for Vietnam. Since our country sample mainly consists of developing countries, we shape our dataset and model outlined in Tang and Tan (2015). According to the study, the CO_2 emission is identified as a dependent variable and GDP, GDP^2, FDI, and EU are the independent variables of the model. GDP and GDP^2 are the determinants of the EKC hypothesis while FDI is a proxy for the PHH.

In Chapter 4, we will explain the dataset that we employ in the study. After that we will describe the methodological devices that we utilize in addressing the research question of the study. In particular, we will review panel techniques, including: panel unit root tests, panel cointegration tests, panel causality test, etc. are given. After reviewing the methodological tool, the last section of this part will present the results produced by the models.

4.1 Data

In this section, we will explain the dataset. Yearly data of nine middle-income countries in MENA region over the period 1980-2013 is utilized. These countries can be listed as Algeria, Egypt, Iran, Jordan, Morocco, Pakistan, Sudan, Tunisia, and Turkey. The income classification of countries is presented in World Bank Development Indicators, and they are grouped regarding GNI (Gross National Income) per capita in US$ on Atlas Methodology. Middle-income countries divided into two groups: lower middle income (LM) and upper middle income (UM) countries. GNI per capita of lower middle-income countries have 1,046$ - 4,125$ (Egypt, Morocco, Pakistan, Sudan) while upper middle-income countries' (Algeria, Iran, Jordan, Tunisia, Turkey) incomes are 4,126$ - 12,745$.

CO_2 emissions per capita (metrics ton), real GDP per capita (1,000 \$), FDI inflows (% of GDP), and energy use per capita (1,000 kg of oil equivalent) are the main variables of the model. Also, GDP^2 per capita is added to the model to investigate the EKC hypothesis. A few FDI data of Algeria and Iran are missing. However, they are filled by linear interpolation using Stata 14. So, our dataset is appropriate for balanced panel data analysis. All the data are gathered from World Development Indicators Database. Descriptive statistics of the variables that include mean, median, standard deviation, minimum value, and maximum value are displayed in Table 5.

Table 5: Descriptive Statistics of the Variables

Variable	Mean	Median	Std. Dev.	Minimum	Maximum
CO_2	2.267	2.070	1.627	0.106	8.454
GDP	3.095	2.775	2.122	0.556	11.102
GDP^2	14.072	7.703	20.486	0.309	123.268
FDI	1.721	0.818	2.599	-0.598	23.537
EU	0.821	0.751	0.504	0.264	2.960
ΔCO_2	0.043	0.023	0.186	-1.111	1.047
ΔGDP	0.055	0.041	0.169	-0.605	0.711
ΔGDP^2	0.536	0.151	2.335	-11.746	14.787
ΔFDI	0.035	-0.000	1.559	-8.212	8.858
ΔEU	0.017	0.011	0.046	-0.215	0.217

Note: Δ is the first difference operator.

4.2 Methodology

Methodologically, this study consists of six sequential steps. In the first step, several tests are conducted to determine residuals of the model and series have cross-section dependency or not. In the second step, stationarity properties of the series are investigated by 1st and 2nd generation unit root tests. Then, 1st generation Pedroni Cointegration, Kao Cointegration, and Johansen Fisher Cointegration tests are employed to find cointegration relationship between variables. In the fourth step, long run coefficients of the model are estimated by Pedroni's PDOLS estimators. After that, slope homogeneity test is conducted to determine slope of the variables are homogenous or not. In the last step, causality relationship between variables is analyzed by Dumitrescu-Hurlin panel causality test.

4.2.1 Cross-Section Dependence Tests

The literature of panel data econometrics demonstrates that panel data models are likely to illustrate substantial cross-section dependence in the error terms. This dependency might arise due to the presence of common shocks and unobserved components (De Hoyos and Sarafidis, 2006). If cross-sectional dependency is present, the results of the tests may be biased and inconsistent; and therefore, in the literature, it is common to carry out cross-sectional dependency test prior to check whether the data is in turn with mean reversion. (Breusch and Pagan, 1980; Pesaran, 2004).

If there is a cross-section dependency in the series, 2nd generation panel unit root tests should be used, otherwise 1st generation unit root tests can be employed to series. On the other hand, cross-section dependency tests are applicable to residuals of the model before investigating cointegration relationship between variables. If there is a cross-section dependency in the residuals, 2nd generation panel cointegration tests should be used, otherwise 1st generation cointegration tests can be conducted.

4.2.1.1 Cross-Section Dependence in the Series

To examine the Cross-section dependency (CD) in the series, Breusch-Pagan LM test (Breusch and Pagan, 1980), Pesaran Scaled LM test (Pesaran, 2004), Bias-corrected scaled LM test (Baltagi et al., 2012), and Pesaran CD test (Pesaran, 2004) are utilized in this study.

Breusch and Pagan (1980) proposed following LM test to check the cross-section dependency in the series (Nazlioglu et al., 2011):

$$Breusch-Pagan\ LM=\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}(T_{ij}\hat{\rho}_{ij}^{2}) \tag{2}$$

where N is number of cross sections, T is the time dimension, and $\hat{\rho}_{ij}$ is the pair-wise correlation coefficients among the residuals which are obtained from individual OLS estimations which is represented in Equation 3. Breusch-Pagan LM statistics has χ^2 distribution with $\frac{N(N-1)}{2}$ degrees of freedom. The null hypothesis of no cross-section dependency with a fixed N and time period $T_{ij} \rightarrow \infty$ is tested against the alternative hypothesis of cross-section dependency in this test. However, it is not applicable with large *N* setting.

$$y_{it} = \alpha_i + \beta_i' x_{it} + \varepsilon_{it} \tag{3}$$

where *i* represents the cross-sectional units, *t* is the time dimension, x_{it} is kx1 vector of regressors, $\alpha_{i,}$ and β_i are the individual intercepts and slope coefficients, respectively.

Pesaran (2004) proposed Pesaran Scaled LM test to overcome the shortcoming of Breusch-Pagan test:

$$Pesaran\ Scaled\ LM = \sqrt{\frac{1}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} (T_{ij}\hat{\rho}_{ij}^2 - 1) \tag{4}$$

where *N* is number of cross sections, *T* is the time dimension, and $\hat{\rho}_{ij}$ is the pair-wise correlation coefficients among the residuals. Pesaran Scaled LM test statistics has asymptotic standard normal distribution. In this test, the null hypothesis of no cross-section dependency with first $T_{ij} \rightarrow \infty$ and then $N \rightarrow \infty$ is tested against the alternative hypothesis of cross-section dependency. However, Pesaran (2004) stated that this statistic causes substantial size distortion when *N* is large relative to T_{ij} (Guloglu and Ivrendi, 2010). Thus, Pesaran (2004) offered Pesaran CD test where N is large and T_{ij} is small, and this test statistic can be calculated as below:

$$Pesaran\ CD = \sqrt{\frac{2}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} (T_{ij}\hat{\rho}_{ij}) \tag{5}$$

where *N* is number of cross sections, *T* is the time dimension, and $\hat{\rho}_{ij}$ is the pair-wise correlation coefficients among the residuals. Moreover, the test has asymptotic standard normal distribution for $T_{ij} \rightarrow \infty$ and $N \rightarrow \infty$ in any order. The null hypothesis of this test is also no cross-section dependency (Kar et al., 2011).

On the other hand, Baltagi et al. (2012) offered an alternative cross-section dependence test that is a bias-corrected scaled LM test, and it can be shown as follows:

$$Bias - Corrected\ Scaled\ LM = \sqrt{\frac{1}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} (T_{ij}\hat{\rho}_{ij}^2 - 1) - \frac{N}{2(T-1)} \tag{6}$$

where N is number of cross sections, T is the time dimension, and $\hat{\rho}_{ij}$ is the pair-wise correlation coefficients among the residuals. In addition, the test has asymptotic standard normal distribution. The null hypothesis of no cross-section dependency is tested against the alternative hypothesis of cross-section dependency in this test (Osman et al., 2016).

4.2.1.2 Cross-Section Dependence in the Residuals

The cross-section dependency in the residuals of the model can be investigated via Bias-adjusted LM test which is developed by Pesaran et al. (2008). This test is the bias adjusted version of the Breusch-Pagan LM test in the panel models with strictly exogenous regressors and normally distributed errors. It is constructed by adding mean and variance to the LM test statistics as below (Pesaran et al. 2008):

$$Bias - Adjusted\ LM = \sqrt{\frac{2}{N(N-1)}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}}\frac{(T-k)\hat{\rho}_{ij}^{2} - \mu_{T_{ij}}}{\mathcal{v}_{T_{ij}}} \tag{7}$$

where N is number of cross sections, T is the time dimension, and $\hat{\rho}_{ij}$ is the pair-wise correlation coefficients among the residuals, k is number of regressors, $\mu_{T_{ij}}$ shows mean, and $\mathcal{v}_{T_{ij}}$ represents variance. test statistic has asymptotically standard normal distribution. The null and alternative hypotheses are the same with Breusch-Pagan LM test which is the null hypothesis of no cross-section dependency is tested against the alternative hypothesis of cross-section dependency (Baltagi et al., 2016).

4.2.2 Panel Unit Root Tests

In the literature, there are two types of panel unit root tests; namely, 1st generation and 2nd generation. The 1st generation tests are chronologically earlier tests that were introduced into the literature and they are not equipped with controlling cross-sectional dependency in the panel. On the other hand, the 2nd generation tests have developed recently and they are able to examine the relevancy of cross-sectional dependency in the panel.

4.2.2.1 Levin-Lin-Chu Test

Levin-Lin-Chu (LLC) unit root test is developed by Levin et al. (2002). Firstly, the model is estimated below in this test:

$$\Delta y_{it} = \rho y_{it-1} + \sum_{L=1}^{P_i}\theta_{iL}\,\Delta y_{it-L} + \alpha_{mi}d_{mt} + \varepsilon_{it} \tag{8}$$

where ρ is autoregressive parameter, ε_{it} is error term, d_{mt} is the vector of deterministic variables, α_{mi} is the corresponding vector of coefficients for model m = 1, 2, 3, and they denote three different models (no intercepts or trends, individual-specific intercepts, and individual-specific intercepts and trends), respectively. Where P_i (lag order) is unknown. Three basic models and their null and alternative hypotheses are displayed below:

Model 1: $\Delta y_{it} = \rho y_{it-1} + \zeta_{it}$ (9)

H_0: $\rho = 0$, H_1: $\rho < 0$

Model 2: $\Delta y_{it} = \alpha_{0i} + \rho y_{it-1} + \zeta_{it}$ (10)

H_0: $\rho = 0$ and $\alpha_{0i} = 0$, H_1: $\rho < 0$ and $\alpha_{0i} \epsilon$ R

Model 3: $\Delta y_{it} = \alpha_{0i} + \alpha_{1i} t + \rho y_{it-1} + \zeta_{it}$ (11)

H_0: $\rho = 0$ and $\alpha_{1i} = 0$, H_1: $\rho < 0$ and $\alpha_{1i} \epsilon$ R

where $-2 < \rho \leq 0$ for i = 1, …, *N*. The error process ζ_{it} distributed independently across individuals. Moreover, α_{0i} is individual-specific intercepts and t is time trend. There are three basic steps to conduct this unit root test. Firstly, ADF (Augmented Dickey-Fuller) regression should be performed for each individual series, separately. Then, the ratio of long run to short run standard deviations should be calculated. Panel *t*-statistics should be estimated in the last step (Levin et al., 2002; Baltagi, 2008).

4.2.2.2 Im-Pesaran-Shin Test

Im-Pesaran-Shin (IPS) unit root test is developed by Im et al. (2003). They criticized LLC unit root test in respect to assumption of homogeneity of the autoregressive coefficient. It allows the heterogeneity of autoregressive coefficient. In addition, it introduces an alternative test, and this test calculated as taking an average of ADF unit root test statistics:

$$\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_{p_i} \tag{12}$$

where t_{p_i} denotes the individual *t*-statistics and *N* is number of cross sections. IPS test examines the null hypothesis of each series in the panel have unit root against the alternative hypothesis of some of the individual series contain unit root (Baltagi, 2008):

$$H_0: \rho_i = 0 \ for \ \forall i$$

$$H_1\colon \begin{Bmatrix} \rho_i < 0 \; for \; i = 1, 2, \ldots, N_1 \\ \rho_i = 0 \; for \; i = N_1 + 1, \ldots, N \end{Bmatrix}$$

4.2.2.3 Fisher-Type Tests

Maddala and Wu (1999) and Choi (2001) suggested Fisher-Type tests:

$$P = -2 \sum_{i=1}^{N} ln \, p_i \tag{13}$$

that combines the unit root tests for each individual's p-values (p_i). P is distributed as χ^2 with $2N$ degrees of freedom as $T_i \to \infty$ for finite N. Fisher test is used in ADF regression. Besides, it can be used in other unit root tests (Maddala and Wu, 1999; Baltagi, 2008). In this study, ADF and Phillips-Perron individual unit root tests are used for conducting Fisher-Type tests.

Choi (2001) suggested a modified P test when N is large:

$$P_m = \frac{1}{2\sqrt{N}} \sum_{i=1}^{N} (-2 \, ln \, p_i - 2) \tag{14}$$

where N is number of cross sections, P_m test is asymptotically normally distributed with mean *zero* and variance *one* as $T_i \to \infty$ followed by $N \to \infty$ (Baltagi, 2008). The null hypothesis and the alternative hypothesis of these tests are similar with IPS:

$$H_0\colon \rho_i = 0 \; for \; \forall i$$

$$H_1\colon \begin{Bmatrix} \rho_i < 0 \; for \; i = 1, 2, \ldots, N_1 \\ \rho_i = 0 \; for \; i = N_1 + 1, \ldots, N \end{Bmatrix}$$

4.2.2.4 CADF Test

CADF (Cross-Sectionally Augmented Dickey-Fuller) test is introduced to econometrics literature by Pesaran (2007). It takes into consideration of cross-section dependency in the series that provides an advantage over the 1st generation unit root tests such as LLC, IPS, and Fisher-Type tests. A simple CADF regression is constructed as below:

$$\Delta y_{it} = \alpha_i + \rho_i^* y_{i,t-1} + d_0 \bar{y}_{t-1} + d_1 \Delta \bar{y}_t + \varepsilon_{it} \tag{15}$$

where $\bar{y}_t$ is the average at time t of all N observations.

$$\Delta y_{it} = \alpha_i + \rho_i^* y_{i,t-1} + d_0 \bar{y}_{t-1} + \sum_{j=0}^{P} d_{j+1} \Delta \bar{y}_{t-j} + \sum_{k=1}^{P} c_k \, \Delta y_{i,t-k} + \varepsilon_{it} \tag{16}$$

where $\bar{y}_t$ is the average at time t of all N observations.

CADF regression gives the individual results in the panel. $\overline{CADF}$, CIPS (Cross-Sectionally Augmented IPS), statistics can be calculated when taking averages of the $CADF_i$ as follows:

$$\overline{CADF} = CIPS = \frac{1}{N} \sum_{i=1}^{N} CADF_i \tag{17}$$

The null hypothesis and the alternative hypothesis of CADF unit root test are presented below:

$$H_0 : \rho_i = 0 \; for \; \forall i$$

$$H_1 : \begin{Bmatrix} \rho_i < 0 \; for \; i = 1, 2, \ldots, N_1 \\ \rho_i = 0 \; for \; i = N_1 + 1, \ldots, N \end{Bmatrix}$$

After all steps, calculated CIPS statistics should be compared to critical values of Pesaran (2007) for testing stationarity of the series (Pesaran, 2007; Baltagi, 2008; Nazlıoğlu, 2010).

4.2.3 Cointegration Tests

Cointegration relationship between variables is investigated with Pedroni Cointegration, Kao Cointegration, and Johansen Fisher Cointegration tests. We use these three first generation cointegration tests for robustness check. In this part, the theory behind these tests is given.

4.2.3.1 Pedroni Cointegration Test

Seven test statistics were introduced by Pedroni (1999, 2004) for testing cointegration relationship between nonstationary panels. The null hypothesis (H_0) of no cointegration is tested against the alternative hypothesis (H_1) of cointegration. These test statistics allow heterogeneity in the panel. They are divided into two categories as group-mean statistics (group ρ, group t, and group ADF) and panel statistics (panel v, panel ρ, panel t, and panel ADF). All the statistics are based on residuals of the regressions below:

$$y_{i,t} = \alpha_i + \beta_{1i} x_{1i,t} + \beta_{2i} x_{2i,t} + \cdots + \beta_{Mi} x_{Mi,t} + e_{i,t} \tag{18}$$

for $t = 1, \ldots, T$; $i = 1, \ldots, N$; $m = 1, \ldots, M$

where T refers to the number of observations over time while N refers to the number of individual members in the panel. Besides, M refers to the number of regression variables while $e_{i,t}$ refers error term. Notice that the slope parameters, $\beta_{1i}x_{1i,t} + \beta_{2i}x_{2i,t} + \cdots + \beta_{Mi}x_{Mi,t}$, are permitted to change among individual members (Pedroni, 1999).

$$\Delta y_{i,t} = \sum_{m=1}^{M} \beta_{mi} \Delta x_{mi,t} + \eta_{i,t} \tag{19}$$

$$\hat{e}_{i,t} = \hat{\gamma}_i \hat{e}_{i,t-1} + \hat{\mu}_{i,t} \tag{20}$$

$$\hat{e}_{i,t} = \hat{\gamma}_i \hat{e}_{i,t-1} + \sum_{k=1}^{K} \hat{\gamma}_{i,k} \Delta \hat{e}_{i,t-k} + \hat{\mu}_{i,t}^{*} \tag{21}$$

where $\beta_{Mi}x_{Mi,t}$ denotes slope parameters, $i = 1, 2, 3, \ldots, N$ is the number of individuals while $t = 1, 2, 3, \ldots, T$ is the time period. $m = 1, 2, 3, \ldots, M$ is the number of regressors while $k = 1, 2, 3, \ldots, K$ is the number of lags in ADF regression (Neal, 2014). After that step, some series and parameters are estimated from the previous regressions to use in equations of test statistics. Then, equations of group-mean statistics and panel statistics are constructed. These mathematical steps are deeply discussed in Pedroni (1999) and (Neal, 2014).

Test statistics are distributed as $N(0,1)$ under the null. The panel v statistics goes to positive infinity while panel ρ, panel t, panel ADF, group ρ, group t, and group ADF goes to negative infinity (Neal, 2014). Test results may indicate different results. Pedroni (2004) demonstrate that group ADF and panel ADF test statistics provide better results when $T < 100$. In the empirical literature, the null hypothesis of no cointegration is rejected when at least 5 out of 7 tests and/or panel ADF and group ADF tests are statistically significant.

4.2.3.2 Kao Cointegration Test

Kao cointegration test was introduced by Kao (1999). It has a similar approach as the Pedroni cointegration test. However, cross-section specific intercepts and homogeneous coefficients are specified on the first-stage regressors (Al-mulali, 2011). Kao (1999) described the bivariate case as below:

$$y_{it} = \alpha_i + \beta x_{it} + e_{it} \tag{22}$$

$$y_{it} = y_{it-1} + u_{i,t} \tag{23}$$

$$x_{it} = x_{it-1} + e_{i,t} \tag{24}$$

for $t = 1, \ldots, T$ and $i = 1, \ldots, N$ where e_{it} is the residual series, and the pooled auxiliary regression or the augmented version of the pooled regression are performed:

$$e_{it} = \rho e_{it-1} + v_{it} \tag{25}$$

$$e_{it} = \bar{\rho} e_{it-1} + \sum_{j-1}^{P} \psi_j \Delta e_{it-1} + v_{it} \tag{26}$$

where p is the number of lags, v_{it} and e_{it} are the residuals. Kao (1999) offered four DF type and one ADF type statistics for testing the null of no cointegration (H_0: $\rho = 1$). ADF statistics of Kao cointegration test is displayed below:

$$ADF = \frac{t_{\bar{\rho}} + \sqrt{6N\hat{\sigma}_r}/(2\hat{\sigma}_{0r})}{\sqrt{\hat{\sigma}_{0r}^2/(2\hat{\sigma}_r^2) + 3\hat{\sigma}_r^2/(10\hat{\sigma}_{0r}^2)}} \tag{27}$$

where $t_{\bar{\rho}}$ is the t-statistics of ρ in Equation 26. This statistics converge to $N(0,1)$ by sequential limit theory. The estimated variance is σ_r^2 with estimated long-run variance σ_{0r}^2.

4.2.3.3 Johansen Fisher Cointegration Test

Johansen Fisher panel cointegration test was developed by Maddala and Wu (1999). It is panel version of the individual Johansen cointegration test. *p*-values of individual Johansen maximum eigenvalue and trace statistics are aggregated in the Johansen Fisher cointegration test. π_i is the *p*-value from an individual cointegration test for cross-section *i*, then under the null of no cointegration for the panel (Lean and Smyth, 2010; Al-mulali, 2011):

$$-2\sum_{i=1}^{N}\log(\pi_i) \rightarrow \chi^2_{2N} \tag{28}$$

The value of χ^2 statistics is based on MacKinnon et al. (1999) *p*-values for Johansen's cointegration trace and maximum eigenvalue test.

4.2.4 Pedroni's PDOLS Estimator

PDOLS estimator was developed by Pedroni (2001). It is an extension of the time-series dynamic ordinary least squares, and it can be carried out to I(1) data which are cointegrated in the long run. The main advantage of this estimator is that the variance is computed through the Newey-West heteroskedasticity-consistent and autocorrelation-consistent method with a Barlett kernel. Moreover, it provides not only homogeneous but also heterogeneous results of the model. Consider the following model:

$$y_{i,t} = \alpha_i + \beta_i x_{i,t} + \mu_{i,t} \tag{29}$$

DOLS regression on individuals are conducted as follows:

$$y_{i,t} = \alpha_i + \beta_i \mathrm{x}_{\mathrm{i,t}} + \sum_{j=-P}^{P}\gamma_{i,j}\Delta x_{i,t-j} + \mu_{i,t} \tag{30}$$

where i = 1, 2, 3, …, N is the number of individuals while t = 1, 2, 3, …, T is the period of time. Also, p = 1, 2, 3, …, *P* is the number of lags and leads in the regression of DOLS. Besides, β_i is the slope while $\mathrm{x}_{\mathrm{i,t}}$ is the independent variable. The slope and test statistics are averaged over the all panel via group mean method of Pedroni.

$$\hat{\beta}^*_{GM} = \left[\frac{1}{N}\sum_{i=1}^{N}\left(\sum_{t=1}^{T} z_{i,t}\, z'_{i,t}\right)^{-1}\left\{\sum_{t=1}^{T} z_{i,t}(y_{i,t}-\bar{y}_i)\right\}\right] \tag{31}$$

$$t_{\hat{\beta}^*_i} = (\hat{\beta}^*_i - \beta_0)\left\{\hat{\sigma}_i^{-2}\sum_{t=1}^{T}(x_{i,t}-\bar{x}_i)^2\right\}^{\frac{1}{2}} \tag{32}$$

$$t_{\hat{\beta}^*_i} = \frac{1}{\sqrt{N}}\sum_{i=1}^{N} t_{\hat{\beta}^*_i} \tag{33}$$

where $z_{i,t}$ is the 2 (p + 1) x 1 vector of regressors and σ_i^2 is the residuals of the long run variance μ_{it}^*. Moreover, panel test statistics test the null hypothesis of $\beta_i = \beta_0$ against the alternative hypothesis $\beta_i \neq \beta_0$ (Neal, 2014).

4.2.5 Slope Homogeneity Test

Slope homogeneity is a significant issue in panel data analysis. Pesaran and Yamagata (2008) developed delta ($\tilde{\Delta}$) test for checking whether the slope coefficients are homogenous. The null of slope homogeneity is tested against the alternative hypothesis of slope heterogeneity. This test is valid as (N, T) → ∞ without any restrictions on the relative expansion rates of N and T when the error terms are normally distributed. Firstly, one should compute the following modified version of Swamy's (1970) test in this approach:

$$\tilde{S} = \sum_{i=1}^{N} (\hat{\beta}_i - \tilde{\beta}_{WFE})' \frac{x_i{}' M_\tau x_i}{\tilde{\sigma}_i^2} (\hat{\beta}_i - \tilde{\beta}_{WFE}) \tag{34}$$

where $\hat{\beta}_i$ shows the pooled OLS estimator while $\tilde{\beta}_{WFE}$ denotes the weighted fixed effect pooled estimator. Besides, M_τ is an identity matrix of order T, the $\tilde{\sigma}_i^2$ is the estimator of σ_i^2. The standardized dispersion is developed as:

$$\tilde{\Delta} = \sqrt{N} \left(\frac{N^{-1}\tilde{S} - k}{\sqrt{2k}} \right) \tag{35}$$

Under the null hypothesis with the condition of (N, T) → ∞ so long as $\sqrt{N}/T \rightarrow \infty$ and error terms are normally distributed. Moreover, $\tilde{\Delta}$ test has asymptotic standard normal distribution. The small sample properties of this test can be improved under normally distributed errors by using the following bias adjusted version:

$$\tilde{\Delta}_{adj} = \sqrt{N} \left(\frac{N^{-1}\tilde{S} - E(\tilde{z}_{it})}{\sqrt{var(\tilde{z}_{it})}} \right) \tag{36}$$

where the mean $E(\tilde{z}_{it}) = k$ and the variance $var(\tilde{z}_{it}) = 2k(T - k - 1)/T + 1$ (Cowan et al., 2014; Menyah et al., 2014).

4.2.6 Dumitrescu-Hurlin Panel Causality Test

Dumitrescu and Hurlin (2012) introduced a non-causality test for heterogeneous panels. The main advantage of this test is that it accounts for two dimensions of heterogeneity: the heterogeneity of the regression model used to test the Granger causality and the heterogeneity of the causality relationships. Testing procedure takes into consideration of heterogeneity of causal relationship and heterogeneity of regression model (Zeren and Ari, 2013). In addition, there are also many advantages of conducting this causality test. Firstly, the implementation procedure of this test is very easy. Secondly, according to Monte Carlo simulations, their panel statistics cause a significant increase in the power of the Granger non-causality tests even for samples which are consisted of very small *T* and *N* dimensions. Thirdly, the test statistics of Dumitrescu-Hurlin non-causality test do not require any particular panel estimation. Lastly, this test can be implemented both in balanced and unbalanced panels (Dumitrescu and Hurlin, 2012; Pekkaya et al., 2017).

Dumitrescu-Hurlin non-causality test is based on following linear heterogeneous model (Dumitrescu and Hurlin, 2012; Zeren and Ari, 2013):

$$y_{i,t} = \alpha_i + \sum_{k=1}^{K} \gamma_i^{(k)} y_{i,t-k} + \sum_{k=1}^{K} \beta_i^{(k)} x_{i,t-k} + \varepsilon_{i,t} \tag{37}$$

where x and y are two stationary variables observed for N individuals in T periods. $\beta_i = \left(\beta_i^{(1)}, \dots, \beta_i^{(K)}\right)'$ and the individual effects α_i are assumed to be fixed in the time dimension.

This non-causality test examines the null hypothesis of no causal relationship for any of the cross-section units against the alternative hypothesis of at least one causal relationship exists in the cross-section units:

$$H_0 = \beta_i = 0 \; for \; \forall_i = 1, \dots, N$$

$$H_1 = \begin{Bmatrix} \beta_i = 0 \; for \; \forall_i = 1, \dots, N_1 \\ \beta_i \neq 0 \; for \; \forall_i = N_1 + 1, \dots, N \end{Bmatrix}$$

4.3 Empirical Findings

Empirical findings of this study are presented in this chapter. All the required information about the econometrics are also provided. EViews 9, Gauss 10, and Stata 14 are used to attain panel data results of this study.

4.3.1 Cross-Section Dependence Tests Results

Firstly, the presence of cross-section dependency of the series should be analyzed for deciding which kind of unit root test is proper for the data in this study. Cross-section dependence test results are displayed on Table 6. Breusch-Pagan LM test, Pesaran Scaled LM test, bias-corrected scaled LM test and Pesaran CD test results indicate the presence of cross-section dependency in the series. Thus, 2nd generation unit root test - $CADF$ - results are more appropriate means to analyze mean reversion property of the series. In order to enrich study, we also report the results of 1st generation unit root test results.

Table 6: Cross-Section Dependence Test for Series

Variable	Breusch-Pagan LM	Pesaran Scaled LM	Bias-Corrected Scaled LM	Pesaran CD
CO_2	736.441***	82.547***	82.411***	25.563***
GDP	926.456***	104.941***	104.804***	30.217***
GDP^2	981.863***	111.471***	111.334***	31.218***
FDI	405.161***	43.506***	43.369***	18.998***
EU	948.469***	107.535***	107.399***	18.107***

Note: *** and ** denote the 1% and 5% significance level, respectively.

4.3.2 Panel Unit Root Tests Results

In this study, although the results of cross-sectional dependency tests suggest the appropriateness of second generation unit root testing, we want to present the results of 1st generation unit root tests to enrich our methodological endeavor. We utilize three first generation unit root tests; namely, LLC, IPS, Fisher tests. Since cross-sectional dependency tests suggest second generation unit root testing, we employ CADF test to examine whether the series are stationary or not. Maximum lag length is determined automatically by Eviews for 1st generation unit root tests while it is taken as 4 for 2nd generation unit root test. Furthermore, optimal lag selection is decided by minimum t-statistics for LLC, IPS, and Fisher tests while it is decided by minimum Schwarz Information Criterion (SIC) for $CADF$ test.

LLC, IPS, Fisher - ADF, and Fisher - PP unit root tests results with intercept model and with intercept and trend model are presented in Table 7, Table 8, and Table 9.

Table 7: Levin-Lin-Chu Unit Root Test Results

Variables	LLC Unit Root Test	
	Intercept	Intercept and Trend
CO_2	-0.256	-0.939
GDP	3.968	0.750
GDP^2	6.148	-0.058
FDI	-0.761	-0.907
EU	0.664	-0.164
ΔCO_2	-13.789^{***}	-9.094^{***}
ΔGDP	-5.618^{***}	-3.479^{***}
ΔGDP^2	-4.149^{***}	-2.645^{***}
ΔFDI	-12.059^{***}	-6.913^{***}
ΔEU	-10.041^{***}	-9.499^{***}

Note: *** and ** denote the 1% and 5% significance level, respectively.

LLC unit root test results show that CO_2, GDP, GDP^2, FDI, and EU series all have unit root at their level. However, they are stationary at their first difference (I(1)) at 1% significance level for both with intercept model and with intercept and trend model.

Table 8: Im-Pesaran-Shin Unit Root Test Results

Variables	IPS Unit Root Test	
	Intercept	Intercept and Trend
CO_2	1.357	-2.302^{**}
GDP	6.595	0.750
GDP^2	8.046	2.022
FDI	-1.457	-4.463^{***}
EU	2.768	-0.112
ΔCO_2	-14.542^{***}	-11.205^{***}
ΔGDP	-6.115^{***}	-5.385^{***}
ΔGDP^2	-4.893^{***}	-5.944^{***}
ΔFDI	-12.584^{***}	-8.768^{***}
ΔEU	-10.534^{***}	-10.544^{***}

Note: *** and ** denote the 1% and 5% significance level, respectively.

IPS unit root test results show that CO2 and FDI series are stationary for a model with intercept and trend while they have unit root in level forms for a model with intercept. However, all of them are stationary at their first difference (I(1)) at 1% significance level for both with intercept model and with intercept and trend model.

Table 9: Fisher-Type Unit Root Tests Results

Variables	**Fisher – ADF Test**		**Fisher – PP Test**	
	Intercept	**Intercept and Trend**	**Intercept**	**Intercept and Trend**
CO_2	14.463	35.145^{***}	18.258	32.469^{**}
GDP	1.099	17.505	1.128	6.761
GDP^2	0.884	13.085	0.719	3.382
FDI	30.232^{**}	52.586^{***}	30.156^{**}	33.744^{**}
EU	13.249	25.323	14.698	32.653^{**}
ΔCO_2	187.137^{***}	136.567^{***}	237.111^{***}	438.031^{***}
ΔGDP	78.388^{***}	65.482^{***}	131.592^{***}	171.584^{***}
ΔGDP^2	69.045^{***}	73.058^{***}	107.649^{***}	123.591^{***}
ΔEU	139.382^{***}	129.720^{***}	198.314^{***}	575.776^{***}

Note: *** and ** denote the 1% and 5% significance level, respectively.

Fisher – ADF and Fisher – PP tests demonstrate that FDI variable is stationary at level (I(0)). However, all of the variables except FDI are stationary at their first difference (I(1)) at 1% significance level for both with intercept model and with intercept and trend model.

Table 10: CADF Unit Root Test Results

Variables	**CADF Unit Root Test**	
	Intercept	**Intercept and Trend**
CO_2	-2.466^{**}	-2.526
GDP	-1.954	-2.743
GDP^2	-1.840	-2.497
FDI	-1.940	-2.177
EU	-1.909	-2.320
Δ CO_2	-4.103^{***}	-4.210^{***}
Δ GDP	-3.268^{***}	-3.300^{***}
Δ GDP^2	-2.862^{***}	-3.115^{***}
Δ FDI	-3.561^{***}	-3.515^{***}
Δ EU	-4.311^{***}	-4.788^{***}

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively.

CIPS, mean of CADF, statistics are used as test statistics in Table 10. CADF unit root test results point out that all variables have unit root in their level forms. However, they are stationary at their first difference at 1% for both models. Since all the variables are I(1), cointegration relationship between variables can be investigated.

4.3.3 Cross-Section Dependency and Homogeneity Tests Results

Cross-section dependency of the model and homogeneity of the coefficients are tested before the cointegration analysis. The results of the tests are reported on Table 11. Results reveal that there is no cross-section dependency in the residuals of the model. Therefore, 1st generation cointegration tests are used in this study. Also, homogeneity test results indicate that coefficients of the model are heterogeneous. So, slopes of the variables change country to country. Thus, we must interpret the country specific parameters rather than parameters of whole panel.

Table 11: Cross-Section Dependency and Homogeneity Tests Results

Tests	**Statistic**	**p-value**
Cross-section dependence test		
Bias-adjusted LM	-0.155	0.876
Homogeneity tests		
$\tilde{\Delta}$	13.306^{***}	0.000
$\tilde{\Delta}_{adj}$	14.618^{***}	0.000

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively.

4.3.4 Panel Cointegration Tests Results

In this study, Pedroni, Kao, and Johansen Fisher cointegration tests are used to find a long run relationship between variables. Pedroni cointegration test provides 7 test statistics, panel *v*, panel *ρ*, panel *t*, panel ADF, group *ρ*, group *t*, and group ADF. In the empirical literature, if at least 5 out of 7 tests and/or panel ADF and group ADF tests are statistically significant, the null hypothesis of no cointegration is rejected. Pedroni cointegration test results are reported in Table 12. Also, results of Kao cointegration test and Johansen Fisher cointegration test for one lag are displayed in Table 13 and Table 14, respectively.

Table 12: Pedroni Cointegration Test Results

Test Statistics	**Statistic**	**Test Statistics**	**Statistic**
Panel *v*	1.687	-	-
Panel *ρ*	-3.352^{***}	Group *ρ*	-2.572^{***}
Panel *t*	-6.328^{***}	Group *t*	-7.178^{***}
Panel ADF	-5.949^{***}	Group ADF	-6.571^{***}

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively. The test statistics are normalized to be distributed under *N*(0,1). Panel *v* statistics is a right-tailed test while the other test statistics are left-tailed tests.

Table 13: Kao Cointegration Test Results

Test Statistics	**Statistic**
ADF	-6.112^{***}
Residual Variance	0.026
HAC Variance	0.018

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively.

Table 14: Johansen Fisher Cointegration Test Results

Null Hypothesis	Trace Test	Max-Eigen Test
r = 0	162.1***	93.52***
r ≤ 1	89.45***	60.32***
r ≤ 2	45.92***	35.77***
r ≤ 3	23.98	18.12

Note: r denotes the number of the cointegrating equation. *** and ** denote statistical significance at the 1% and 5% level, respectively.

Table 12 shows that panel ρ, panel *t*, panel ADF, group ρ, group *t*, and group ADF statistics are statistically significant at 1%. So, at least 5 out of 7 tests are statistically significant. Furthermore, panel ADF and group ADF statistics are also significant. Moreover, Kao and Johansen Fisher cointegration tests result also support that the variables are cointegrated in the long run. As a result, the null hypothesis of no cointegration is rejected in this study. Thus, one can conclude that there is a long-term relationship between carbon dioxide emissions, income, its square, FDI, and energy use.

4.3.5 PDOLS Results

Long-run coefficients are estimated by PDOLS estimators. Estimation results for all countries and individuals are presented below.

Table 15: PDOLS Results for All Countries

Variables	Coefficient	t-statistics
GDP	0.077	-0.312
GDP^2	0.065	-1.955
FDI	0.153***	13.530
EU	-0.850***	17.900

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively.

Results of group mean average for all the countries reveal that FDI increases pollution level while energy use decreases it. A one-unit increase in FDI leads to 0.153-unit increase in the emission level. On the other hand, a one-unit increase in energy consumption causes 0.850-unit decrease in emission level. However, income and income square are statistically insignificant at 5%. Therefore, the EKC hypothesis is not valid while there is some evidence for the PHH. Since the homogeneity tests indicate heterogeneity of coefficients, it is necessary to pay attention to the country specific results in this study.

Table 16: PDOLS Results for Algeria

Variables	**Coefficient**	**t-statistics**
GDP	8.363^{***}	6.886
GDP^2	-0.545^{***}	-4.527
FDI	0.588^{***}	6.869
EU	-15.69^{***}	6.103

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively.

Empirical findings reveal that all the coefficients are statistically significant at 1%. Slopes of income and FDI are positive while coefficients of income square and energy use are negative. The EKC hypothesis is valid for Algeria over the period between 1980 and 2013. Moreover, there is also some evidence for the PHH. The empirical findings points out that Algeria has experienced a rapid deindustrialization since the 1980s, and the weight of her manufacturing sector has decreased. This deindustrialization causes lower energy consumption and lower emission level in the country (Bouznit and Pablo-Romero, 2016). The EKC hypothesis seen to be working in Algeria may be attributed to Algeria's policies concerning environmental taxation and cleaner production technology (Latifa et al., 2014).

Table 17: PDOLS Results for Egypt

Variables	**Coefficient**	**t-statistics**
GDP	1.788^{***}	5.454
GDP^2	-0.121^{***}	-6.245
FDI	0.105	1.225
EU	-1.456	-0.630

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively.

PDOLS results demonstrate that income has a positive impact of 1.788 on emission level. Also, income square has a negative impact of -0.121 on emission level. Hence, the evidence shows that the EKC hypothesis works in Egypt. The inverted-U shaped relationship between CO_2 and income can be explained by its technological change in the manufacturing sector (Ben Youssef et al., 2014). On the other hand, FDI and energy use do not have any statistical impact on emission level.

Table 18: PDOLS Results for Iran

Variables	Coefficient	t-statistics
GDP	-5.819^{***}	-7.541
GDP^2	0.460^{***}	6.230
FDI	0.298^{***}	4.172
EU	2.778^{***}	31.840

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively.

Long run coefficients for Iran are presented in Table 18 above. Income has a negative effect while income square has a positive effect on emission level, a situation which is contrary to what the EKC hypothesis proposes. These findings mean that there is a U-shape relationship between income and emission level for the Iranian economy. Moreover, the slope of FDI is positive which supports the PHH. In addition, energy use affects emission level positively. A one-unit increase in energy consumption causes 2.778-unit increase in emission level. Iran is one of the leading carbon dioxide emitters in the world. The reasons behind the high CO_2 emission level in this developing country may be attributed to her rapid industrialization and urbanization. However, because Iran has not completed her transformation to service economy yet, her development process has been pollutive so far. In addition to this incomplete transformation, Iran has large oil and natural gas reserves and derives most of her income from the sale of these natural resources. So, the energy industry is very intense in Iran, which leads to environmental degradation.

Table 19: PDOLS Results for Jordan

Variables	Coefficient	t-statistics
GDP	-4.861^{***}	-11.740
GDP^2	0.885^{***}	11.220
FDI	0.137^{***}	10.420
EU	-3.389^{***}	-5.221

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively.

Impacts of income and income square on emission level are negative and positive, respectively. So, it means that there is a U-shape relationship between income and environmental degradation which is contrary to the EKC. Also, FDI inflows to Jordan increases the pollution level in the country. Thus, one may conclude that there is some evidence for the PHH in Jordan. Lastly, the coefficient of energy use is estimated as -3.389.

Table 20: PDOLS Results for Morocco

Variables	**Coefficient**	**t-statistics**
GDP	-0.322	-0.940
GDP^2	0.030	1.080
FDI	0.121^{***}	8.546
EU	-0.198	-0.248

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively.

PDOLS results for Morocco is presented in Table 20. All coefficients are found statistically insignificant at 5% except FDI. So, there is no evidence for the validity of the EKC hypothesis in Morocco. One may conclude that the Moroccan economy is still in the initial stages of economic development and she has not completed her economic transformation yet. On the other side, FDI inflows to Morocco affects emission level positively. One-unit increase in FDI increases emission level 0.121-unit. Thus, the empirical findings show that there is some evidence for the PHH in Morocco.

Table 21: PDOLS Results for Pakistan

Variables	**Coefficient**	**t-statistics**
GDP	0.053	0.267
GDP^2	0.020	0.693
FDI	0.033	1.335
EU	1.319	1.792

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively.

There is no long-run impact of economic indicators – that is, income level, FDI inflow, and energy use - on emission level in Pakistan. All coefficients are statistically insignificant at 5%. So, one may conclude that there is no evidence for the EKC hypothesis and the PHH in the Pakistan’s economy.

Table 22: PDOLS Results for Sudan

Variables	**Coefficient**	**t-statistics**
GDP	1.716^{***}	4.928
GDP^2	-0.116^{***}	-5.813
FDI	0.007	0.747
EU	2.392^{***}	18.630

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively.

Empirical findings show that income level, FDI, and EU have statistically significant effect on environmental degradation in Sudan. The long run coefficient of income is 1.716 while income square's is -0.116. These findings show that the EKC hypothesis works for Sudan during the period 1980-2013. FDI inflow has been one of the most significant contributors to the high economic performance of Sudan for a few decades. Domestic companies in Sudan may have transferred environment-friendly technologies from foreign companies, and this may be the reason behind the validity of the EKC hypothesis for Sudan. Moreover, energy use has a positive effect on emission level. A one-unit increase in energy consumption leads to a 2.392-unit increase in emission level. Also, the coefficient of FDI inflows is statistically insignificant at 5%. So, there is not any evidence for the PHH in Sudan.

Table 23: PDOLS Results for Tunisia

Variables	**Coefficient**	**t-statistics**
GDP	-0.612^{***}	-9.495
GDP^2	-0.014	-0.679
FDI	0.028	1.938
EU	4.304^{***}	6.890

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively.

PDOLS results indicate that income level affects emission level negatively. A one-unit increase in income causes a 0.612-unit decrease in emission level. However, this result seems economically meaningless despite being statistically significant because Tunisian economy is still in its early stage of development. Besides, the slope of energy use is estimated as 4.304. It is positive and statistically significant at 1%. It is obviously seen that energy consumption is the main determinant of emission level in Tunisia. The other coefficients are statistically insignificant at 5%. One may conclude that the EKC hypothesis and the PHH are invalid for Tunisia.

Table 24: PDOLS Results for Turkey

Variables	Coefficient	t-statistics
GDP	0.391^{***}	11.240
GDP^2	-0.012^{***}	-7.822
FDI	0.061^{***}	5.334
EU	2.289^{***}	6.764

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively.

Long run estimation results are reported in Table 24 for Turkey. The impact of income, income square, FDI inflow, and energy use on emission level have statistically significant at 1%. Income has a positive effect while income square has an adverse effect on emission level. These results show that the EKC hypothesis works for the period between 1980 and 2013. Furthermore, since Turkey is a candidate for European Union full membership, she launches some national environmental programs on climate change and global warming to curb her emission level. Besides, the coefficient of the FDI inflow is found as 0.061. The increase in FDI leads to environmental degradation in Turkey. This econometric finding gives some evidence for the PHH. Also, energy use affects emission level positively. A one-unit increase in energy consumption causes a 2.289-unit increase in pollution level.

Table 25 shows the overall results of PDOLS estimation in the long-run. Results suggest that effect of FDI on CO_2 emissions is positive and statistically significant for six countries (Algeria, Iran, Jordan, Morocco, Sudan, and Turkey) while it is positive and statistically insignificant for the three countries (Egypt, Pakistan, and Tunisia). In addition, it is expected that impact of energy use on CO_2 emissions should have a positive sign. Empirical results demonstrate that it is positive for the four countries (Iran, Sudan, Tunisia, and Turkey). However, it is negative only for Algeria and Jordan - that is, economically meaningless despite being statistically significant. Lastly, the table asserts that there is an inverted-U shaped relationship between income level and CO_2 emissions in Algeria, Egypt, Sudan, and Turkey. On the other hand, there is a U-shaped relationship in Iran and Jordan. In addition, the effect of GDP on CO_2 emissions is negative in Tunisia while there is not any statistically significant relationship in Morocco and Pakistan.

Table 25: Overall Results of PDOLS

Countries	GDP	GDP^2	FDI	EU
All Countries	0.077	0.065	0.153***	-0.850***
Algeria	8.363***	-0.545***	0.588***	-15.69***
Egypt	1.788***	-0.121***	0.105	-1.456
Iran	-5.819***	0.460***	0.298***	2.778***
Jordan	-4.861***	0.885***	0.137***	-3.389***
Morocco	-0.322	0.030	0.121***	-0.198
Pakistan	0.053	0.020	0.033	1.319
Sudan	1.716***	-0.116***	0.007	2.392***
Tunisia	-0.612***	-0.014	0.028	4.309***
Turkey	0.391***	-0.012***	0.061***	2.289***

Note: *** and ** denote statistical significance at the 1% and 5% level, respectively.

Overview of the EKC hypothesis and the PHH is reported in Table 26. The EKC hypothesis is valid only for Algeria, Egypt, Sudan, and Turkey even though the threshold level of income per capita has not been reached yet. Furthermore, the PHH holds for Algeria, Iran, Jordan, Morocco, and Turkey. The pollution level increases when the FDI inflow to these countries rises.

Table 26: Overview of the EKC Hypothesis and the PHH

Countries	EKC Hypothesis	Turning Point	PHH
Group	×	-	✓
Algeria	✓	$7,672	✓
Egypt	✓	$7,388	×
Iran	×	-	✓
Jordan	×	-	✓
Morocco	×	-	✓
Pakistan	×	-	×
Sudan	✓	$7,396	×
Tunisia	×	-	×
Turkey	✓	$16,291	✓

Note: ✓ denotes validity while × shows the invalidity of the hypotheses.

4.3.6 Panel Causality Test Results

Causality relationships between the variables are investigated with Dumitrescu-Hurlin panel causality test. The test examines the null hypothesis of no causal relationship for any of the cross-section units against the alternative hypothesis of at least one causal relationship exists in the cross-section units. Since there are no criteria for choosing an optimal lag length for Dumitrescu-Hurlin panel causality test, authors report up to 3 lag lengths or 5 lag lengths in their studies. If 2 out of 3 or 3 out of 5 findings indicate a causal relationship between two variables, one can conclude that there is a causality relationship between these variables. Panel causality test results up to 5 lag lengths are presented in Table 27, Table 28, Table 29, Table 30, and Table 31. The statistical significance level is taken as 5% until this empirical analysis. However, it is extended to 10% due to getting broad causal links between the variables.

Table 26: Dumitrescu-Hurlin Panel Causality Test Results (Lag = 1)

Direction	**W-stat**	**Zbar-stat**	**Prob. Value**	**Conclusion**
$\Delta CO_2 \rightarrow \Delta GDP$	1.985	1.700	0.089	Reject H_0
$\Delta GDP \rightarrow \Delta CO_2$	1.410	0.628	0.529	Do not reject H_0
$\Delta CO_2 \rightarrow \Delta FDI$	0.680	-0.733	0.463	Do not reject H_0
$\Delta FDI \rightarrow \Delta CO_2$	1.699	1.167	0.243	Do not reject H_0
$\Delta CO_2 \rightarrow \Delta EU$	1.902	1.546	0.122	Do not reject H_0
$\Delta EU \rightarrow \Delta CO_2$	2.378	2.434	0.014	Reject H_0
$\Delta GDP \rightarrow \Delta FDI$	2.042	1.807	0.070	Reject H_0
$\Delta FDI \rightarrow \Delta GDP$	0.994	-0.149	0.881	Do not reject H_0
$\Delta EU \rightarrow \Delta FDI$	2.249	2.193	0.028	Reject H_0
$\Delta FDI \rightarrow \Delta EU$	1.060	-0.024	0.980	Do not reject H_0
$\Delta GDP \rightarrow \Delta EU$	1.050	-0.043	0.965	Do not reject H_0
$\Delta EU \rightarrow \Delta GDP$	2.533	2.723	0.006	Reject H_0

Note: → denotes unidirectional causality relationship.

Causality test results for one lag is presented above. Unidirectional causal links are found from emission level to income level, from energy use to emission level, from income level to FDI, from energy use to FDI, and from energy use to income level. The other investigated causal links are statistically insignificant at 10%.

Table 27: Dumitrescu-Hurlin Panel Causality Test Results (Lag = 2)

Direction	**W-stat**	**Zbar-stat**	**Prob. Value**	**Conclusion**
$\Delta CO_2 \rightarrow \Delta GDP$	3.663	1.906	0.056	Reject H_0
$\Delta GDP \rightarrow \Delta CO_2$	2.843	0.861	0.388	Do not reject H_0
$\Delta CO_2 \rightarrow \Delta FDI$	2.672	0.644	0.519	Do not reject H_0
$\Delta FDI \rightarrow \Delta CO_2$	2.459	0.373	0.709	Do not reject H_0
$\Delta CO_2 \rightarrow \Delta EU$	1.797	-0.469	0.638	Do not reject H_0
$\Delta EU \rightarrow \Delta CO_2$	3.180	1.290	0.196	Do not reject H_0
$\Delta GDP \rightarrow \Delta FDI$	2.802	0.809	0.418	Do not reject H_0
$\Delta FDI \rightarrow \Delta GDP$	2.279	0.143	0.885	Do not reject H_0
$\Delta EU \rightarrow \Delta FDI$	5.463	4.199	0.000	Reject H_0
$\Delta FDI \rightarrow \Delta EU$	2.718	0.702	0.482	Do not reject H_0
$\Delta GDP \rightarrow \Delta EU$	3.029	1.098	0.272	Do not reject H_0
$\Delta EU \rightarrow \Delta GDP$	3.744	2.010	0.044	Reject H_0

Note: → denotes unidirectional causality relationship.

There are three unidirectional causal relationships between the variables for two lags. Findings point out that there are unidirectional causalities from emission level to income level, from energy use to FDI, and from energy use to income level. There is not any significant unidirectional or bidirectional causal links between the variables.

Table 28: Dumitrescu-Hurlin Panel Causality Test Results (Lag = 3)

Direction	**W-stat**	**Zbar-stat**	**Prob. Value**	**Conclusion**
$\Delta CO_2 \rightarrow \Delta GDP$	5.389	2.093	0.036	Reject H_0
$\Delta GDP \rightarrow \Delta CO_2$	4.579	1.287	0.198	Do not reject H_0
$\Delta CO_2 \rightarrow \Delta FDI$	5.173	1.878	0.060	Reject H_0
$\Delta FDI \rightarrow \Delta CO_2$	2.840	-0.443	0.657	Do not reject H_0
$\Delta CO_2 \rightarrow \Delta EU$	2.703	-0.579	0.562	Do not reject H_0
$\Delta EU \rightarrow \Delta CO_2$	3.618	0.331	0.740	Do not reject H_0
$\Delta GDP \rightarrow \Delta FDI$	3.330	0.044	0.964	Do not reject H_0
$\Delta FDI \rightarrow \Delta GDP$	2.193	-1.087	0.277	Do not reject H_0
$\Delta EU \rightarrow \Delta FDI$	6.587	3.284	0.001	Reject H_0
$\Delta FDI \rightarrow \Delta EU$	3.334	0.048	0.961	Do not reject H_0
$\Delta GDP \rightarrow \Delta EU$	5.612	2.314	0.020	Reject H_0
$\Delta EU \rightarrow \Delta GDP$	4.368	1.077	0.281	Do not reject H_0

Note: → denotes unidirectional causality relationship.

Dumitrescu-Hurlin panel causality test results for three lags support that one-way causal relationship are existed from emission level to income level, from emission level to FDI, from energy use to FDI, and from income level to energy use. According to other results, the null hypothesis of no one way causal relationship from independent variable to dependent variable is not rejected.

Table 29: Dumitrescu-Hurlin Panel Causality Test Results (Lag = 4)

Direction	**W-stat**	**Zbar-stat**	**Prob. Value**	**Conclusion**
$\Delta CO_2 \rightarrow \Delta GDP$	6.208	1.436	0.150	Do not reject H_0
$\Delta GDP \rightarrow \Delta CO_2$	5.146	0.571	0.567	Do not reject H_0
$\Delta CO_2 \rightarrow \Delta FDI$	7.056	2.126	0.033	Reject H_0
$\Delta FDI \rightarrow \Delta CO_2$	4.767	0.263	0.792	Do not reject H_0
$\Delta CO_2 \rightarrow \Delta EU$	4.998	0.450	0.652	Do not reject H_0
$\Delta EU \rightarrow \Delta CO_2$	4.848	0.328	0.742	Do not reject H_0
$\Delta GDP \rightarrow \Delta FDI$	3.863	-0.472	0.636	Do not reject H_0
$\Delta FDI \rightarrow \Delta GDP$	3.263	-0.961	0.336	Do not reject H_0
$\Delta EU \rightarrow \Delta FDI$	9.210	3.879	0.000	Reject H_0
$\Delta FDI \rightarrow \Delta EU$	3.633	-0.660	0.509	Do not reject H_0
$\Delta GDP \rightarrow \Delta EU$	5.854	1.147	0.251	Do not reject H_0
$\Delta EU \rightarrow \Delta GDP$	4.966	0.424	0.671	Do not reject H_0

Note: → denotes unidirectional causality relationship.

Panel causality test results for four lags demonstrate that only two one-way causal links exist between variables: unidirectional causality running from emission level to FDI and unidirectional causality running from energy use to FDI.

Table 30: Dumitrescu-Hurlin Panel Causality Test Results (Lag = 5)

Direction	W-stat	Zbar-stat	Prob. Value	Conclusion
$\Delta CO_2 \rightarrow \Delta GDP$	5.996	0.222	0.824	Do not reject H_0
$\Delta GDP \rightarrow \Delta CO_2$	5.830	0.110	0.911	Do not reject H_0
$\Delta CO_2 \rightarrow \Delta FDI$	9.780	2.776	0.005	Reject H_0
$\Delta FDI \rightarrow \Delta CO_2$	6.633	0.652	0.514	Do not reject H_0
$\Delta CO_2 \rightarrow \Delta EU$	4.927	-0.498	0.617	Do not reject H_0
$\Delta EU \rightarrow \Delta CO_2$	5.395	-0.183	0.854	Do not reject H_0
$\Delta GDP \rightarrow \Delta FDI$	5.973	0.207	0.835	Do not reject H_0
$\Delta FDI \rightarrow \Delta GDP$	3.784	-1.270	0.204	Do not reject H_0
$\Delta EU \rightarrow \Delta FDI$	9.749	2.755	0.005	Reject H_0
$\Delta FDI \rightarrow \Delta EU$	5.163	-0.339	0.734	Do not reject H_0
$\Delta GDP \rightarrow \Delta EU$	6.135	0.316	0.751	Do not reject H_0
$\Delta EU \rightarrow \Delta GDP$	6.614	0.639	0.522	Do not reject H_0

Note: → denotes unidirectional causality relationship.

Lastly, test results for five lags are reported in Table 31. Empirical findings reveal that there is one-way causality from emission level to FDI. Also, unidirectional causality is found from energy use to FDI. The other causal links between the variables are statistically insignificant at 10%. Also, the schema of Dumitrescu-Hurlin panel causality test results is set up in Figure 5. Panel causality test findings reveal that there is three unidirectional causal relationships between the variables of the study.

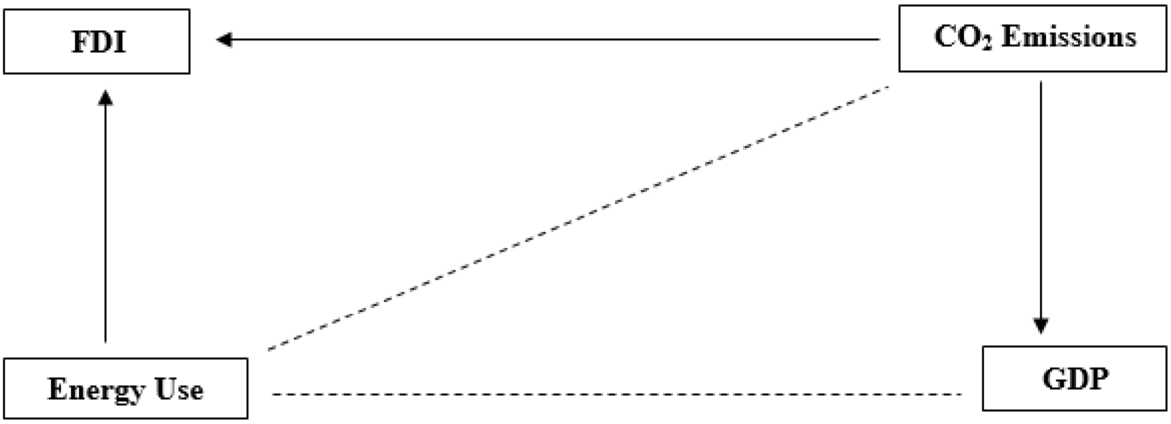

Figure 5: Schema of Causality Relationships

Note: → denotes unidirectional causality relationship while - - - denotes no causal relationship between variables.

4.4 Discussion

The empirical results show that the EKC hypothesis is supported by some of the countries while it is rejected by the others. According to the findings, the EKC hypothesis is valid only for Algeria, Egypt, Sudan, and Turkey even though the threshold level of income per capita has not been reached yet. In addition, the coefficients of FDI have positive signs for all the countries. These results support the view that FDI inflows increase emission levels in the countries, and it shows some evidence for the validity of the PHH. The pollutive effect of FDI is relatively higher in Algeria, Iran, Jordan, and Morocco than in Turkey. Particularly, its effect is very high in Algeria and Iran that one may conclude that FDI inflows to these countries mainly consisted of dirty industries. Lastly, energy use is the most polluting determinants of emission levels for most of the countries.

Our empirical findings differ from the other studies having a similar sample. We can compare our country-specific results with the empirical results of Arouri et al. (2012) and Ozcan (2013) as their country samples show some similarities to ours. Arouri et al. (2012) found an inverted U-shape relationship between emission level and income for Algeria, Egypt, and Jordan while a U-shape relationship for Morocco, and a monotonic relationship for Tunisia. Their findings for Algeria and Egypt are consistent with our empirical results. On the other hand, Ozcan (2013) detected an inverted-U shape for Egypt as in this study while a U-shape relationship for Turkey. Moreover, they did not find any relationship between emission level and income for Iran and Jordan. Their findings contradict to ours except the results for Egypt.

However, we cannot compare this thesis results with the works of Al-mulali (2011), Farhani and Rejeb (2012), Asghari (2013), and Farhani et al. (2014a) which have similar samples of countries to ours. Al-mulali (2011) and Farhani and Rejeb (2012) investigate the causal relationship between variables while Asghari (2013) did not estimate long run relationship between emission level and income. On the other hand, Farhani et al. (2014a) estimated homogenous results although they did not provide country-specific results. Furthermore, our results demonstrate that FDI inflows increase CO_2 emissions for most of the countries. That finding shows some evidence for the PHH. Besides, the effects of energy use on emission levels are estimated as positive and statistically significant for some of the countries, which is consistent with almost all the studies for developing countries in the literature.

The validity of the EKC hypothesis for countries in the MENA region arises from the country specific characteristics. According to the results, Algerian economy has experienced a rapid deindustrialization since the 1980s, the weight of her manufacturing sector has decreased, gradually. This deindustrialization leads to lower energy consumption and lower emission level (Bouznit and Pablo-Romero, 2016). In addition, the Algeria's policies on environmental taxation and cleaner production technology may be the reasons behind the validity of the EKC hypothesis in this country. Besides, because of being a signatory of the KP (she accepted the amendment in 2015), the government may have introduced new environmental programs regarding climate change and global warming to reduce emission level (Latifa et al., 2014).

Egypt, Sudan, and Turkey are some of the non-oil countries (or have limited oil reserves) in the region. Thus, their performance to shift toward a service economy is better than the other countries in the region and these countries are changing their structural economic composition. At the country level, the inverted-U relationship between CO_2 and income in Egypt can be attributed to its technological change in the manufacturing sector (Ben Youssef et al., 2014). In addition, since Turkey is a candidate for European Union full membership, she launches some national environmental programs concerning climate change and global warming to reduce her emission level. The economic outlook of Sudan reveals that her economic growth performance has increased since the 1990s while her CO_2 emission level has begun to decrease for a few years. One of the most significant triggers of her economic growth is FDI inflows. So, domestic companies in Sudan may have transferred environment-friendly technologies from foreign companies.

The validity of the EKC hypothesis in Algeria, Egypt, Sudan, and Turkey can be attributed to these factors. However, the threshold level of income per capita has not been reached for these countries yet. Therefore, they need to sustain and improve their performances so that they can decrease CO_2 emissions.

On the other hand, the EKC hypothesis does not hold for the rest of the countries (Iran, Jordan, Morocco, Pakistan, and Tunisia) in this study. Some of these countries are Rentier States which derive most of the national income from the sale of natural resources such as crude oil and natural gas. So, their transition period from industrial economy to service economy is slow (Arouri et al., 2012). The other countries have not completed their economic transformation to service economy yet. Moreover, some of these countries have economic instability due to military conflicts, Arab Spring, domestic and international political issues, and terrorism.

Causality test results suggest that only three one-way causal relationships exist between the variables in this study. The first causality is running from emission level to FDI. Secondly, there is a unidirectional causality from emission level to income level. Lastly, there is also one-way causality running from energy use to FDI. There is not any one-way or two-way causal relationship between these variables at 10% significance level. The policymakers may take these findings into consideration when making policies about foreign direct investment and gross domestic product per capita. Furthermore, they can use causality results to predict the future values of FDI and GDP.

CHAPTER 5

5. CONCLUSION

In this thesis, the impact of economic indicators on environmental degradation is analyzed by recent panel data techniques for nine middle-income MENA countries over the period between 1980 and 2013. These countries are Algeria, Egypt, Iran, Jordan, Morocco, Pakistan, Sudan, Tunisia, and Turkey. The dependent variable of the study is CO_2 emissions per capita while the independent variables are GDP per capita, GDP^2, FDI inflows, and energy use per capita. GDP and GDP^2 are used to test the EKC hypothesis while FDI is used as a proxy for the PHH.

To our knowledge, there are few panel data works about the relationship between environmental degradation and economic variables for the MENA countries. As far as we know, the studies of Al-mulali (2011), Arouri et al. (2012), Farhani and Rejeb (2012), Asghari (2013), and Farhani et al. (2014a) are the ones investigating this relationship for the MENA region. Besides these, Ozcan (2013) also tested whether the EKC hypothesis works for only Middle East countries.

Al-mulali (2011) and Farhani and Rejeb (2012) examined the causal relationship between energy consumption, economic growth, and CO_2 emissions while Arouri et al. (2012) and Farhani et al. (2014a) tested the validity of the EKC hypothesis. Asghari (2013) examined the validity of the EKC hypothesis and of the PHH for six MENA countries. These studies do not study the effect of FDI on emission level except Asghari (2013). However, although the EKC hypothesis is valid only in the long run, Asghari (2013) did not investigate the long-term relationship between variables.

By using recent panel data techniques, this study tests the EKC hypothesis and the PHH for the MENA region. Middle-income MENA countries are selected as a sample because the PHH is valid in developing countries. These features distinguish this study from other studies.

Methodologically, this thesis employs several cross-section dependency tests (Breusch-Pagan LM test, Pesaran Scaled LM test, Bias-corrected scaled LM test, and Pesaran CD) to determine which kind of unit root test is proper for the data. Then, 1st generation (LLC, IPS, Fisher-types) and 2nd generation (CADF) panel unit root tests are employed to series. Stationarity tests results point out that all the variables are stationary at their first differences. Thus, cointegration relationship between variables can be investigated. After that, 1st generation panel cointegration tests (Pedroni, Kao, Johansen Fisher cointegration tests) are employed to test the long-run relationship between variables for robustness check. Besides, Dumitrescu-Hurlin panel causality test is conducted to find the causal relationship between all the variables. In addition, cross-section dependence test (Bias-adjusted LM) for residuals of the model and slope homogeneity test (Delta Test) are used in the analyses.

The empirical findings reveal that all the series are stationary at their first differences (I(1)). Thus, cointegration relationship between variables can be investigated. Pedroni cointegration, Kao cointegration, Johansen Fisher cointegration tests state that these variables are cointegrated, and the long-run coefficients are estimated by PDOLS estimator. Slope homogeneity test indicates that coefficients of the model are heterogeneous, slope parameters of the variables differ from country to country. Then, Dumitrescu-Hurlin causality test that examines the null hypothesis of no causal relationship for any of the cross-section units against the alternative hypothesis of at least one causal relationship in the cross-section units is employed.

Long-run PDOLS results suggest that the EKC hypothesis is valid for four countries -that is, Algeria, Egypt, Sudan, and Turkey- but the threshold level of income has not been reached yet. The coefficients of FDI have positive signs for all the countries, and they reveal that FDI inflows increase emission levels in these countries. Especially, the coefficients of FDI inflows are very high in Algeria and Iran. It is understood that FDI inflows to Algeria and Iran mainly consisted of dirty industries. Finally, energy use is the most polluting determinants of emission levels for most of the countries.

Causality results show that there is only three one-way causal relationships between the CO_2 emissions per capita, GDP per capita, GDP^2, FDI inflows, and energy use. The first causality is running from emission level to FDI. The second is a one-way causality from emission level to income level. The last is also a unidirectional causality running from energy use to FDI. The policymakers may take these causality results into consideration when making policies about foreign direct investment and gross domestic product per capita.

We can compare our country-specific results with the empirical results of Arouri et al. (2012) and of Ozcan (2013) as their country sample show some similarities to ours. Arouri et al. (2012) detected an inverted U-shape relationship between emission level and income for Algeria, Egypt, and Jordan while finding a U-shape relationship for Morocco, and monotonic relationship for Tunisia. Their findings for Algeria and Egypt are consistent with our empirical results.

On the other hand, Ozcan (2013) found an inverted-U shape for Egypt as in this study and she found a U-shape relationship for Turkey. Moreover, she did not find any connection between emission level and income for Iran and Jordan. Their findings contradict to ours except the results for Egypt.

However, we could not compare this thesis's results with those of Al-mulali (2011), Farhani and Rejeb (2012), Asghari (2013), and Farhani et al. (2014a) that have similar samples of countries to ours. Al-mulali (2011) and Farhani and Rejeb (2012) investigated only short-run and long-run causal relationship between the variables. On the other side, Asghari (2013) did not investigate the long-run relationship between emission level and income. Also, Farhani et al. (2014a) did not give country-specific results in their work.

Our empirical findings also reveal that FDI inflows increases CO_2 emissions for most of the countries. This finding shows some evidence for the PHH for MENA countries. Moreover, the effects of energy use on emission levels are estimated positive and statistically significant for several countries, and this result is consistent with almost all the studies in the literature.

MENA region mainly consists of middle-income countries. But there are also some low-middle income countries in the region. Thus, the EKC hypothesis is not valid for most of the countries in the region. There are some crucial steps policymakers of these countries need to take to decrease emission level.

Firstly, they should have higher growth rates to meet their citizens' needs. But this growth should be through environment-friendly technologies. To this end, governments should subsidize research and development (R&D) operations of companies and oblige firms to use less-pollutive technologies.

Secondly, FDI inflows to these countries are very pollutive, especially for Algeria and Iran. National governments should put some environmental regularities and taxes to FDI inflows for reducing emission levels.

Lastly, this study has indicated that the main determinant of environmental degradation is energy use, especially fossil-fuel use such as coal, oil, natural gas, etc. Policy makers should focus on energy efficiency policies to decrease negative effects of energy use on carbon dioxide emissions. For this purpose, they should put some regulations on energy consumption by households, transportation, and industrial sectors. Besides, alternative energy sources such as hydroelectricity, solar energy, wind energy, biomass energy, and nuclear energy must be provided instead of fossil-fuel energy sources. To this end, alternative and renewable energy sources projects should be funded by governments.

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APPENDICES

Appendix A. List of Annex I and Annex II Parties to the Convention

Table 31: List of Annex I and Annex II Parties to the Convention

Australia$^{I, II}$	Hungary^{I}	Romania^{I}
Austria$^{I, II}$	Iceland$^{I, II}$	Russian Federation^{I}
Belarus^{I}	Ireland$^{I, II}$	Slovakia^{I}
Belgium$^{I, II}$	Italy$^{I, II}$	Slovenia^{I}
Bulgaria^{I}	Japan$^{I, II}$	Spain$^{I, II}$
Canada$^{I, II}$	Latvia^{I}	Sweden$^{I, II}$
Croatia^{I}	Liechtenstein^{I}	Switzerland$^{I, II}$
Czech Republic^{I}	Lithuania^{I}	Turkey^{I}
Denmark$^{I, II}$	Luxembourg$^{I, II}$	Ukraine^{I}
Estonia^{I}	Monaco^{I}	United Kingdom of Great Britain and Northern Ireland$^{I, II}$
European Union$^{I, II}$	Netherlands$^{I, II}$	United States of America$^{I, II}$
Finland$^{I, II}$	New Zealand$^{I, II}$	
France$^{I, II}$	Norway$^{I, II}$	
Germany$^{I, II}$	Poland^{I}	
Greece$^{I, II}$	Portugal$^{I, II}$	

Note: ^{I} denotes Annex I parties while ^{II} defines Annex II parties.

Source: UNFCCC (2017). https://unfccc.int/resource/docs/convkp/conveng.pdf (03.04.2017)

Appendix B. Overall Results of Panel Unit Root Tests

Table 32: Overall Results of Panel Unit Root Tests

Variables	**LLC**	**IPS**	**Fisher-Type**	$CADF$
CO_2	I(1)	I(1)	I(1)	I(1)
GDP	I(1)	I(1)	I(1)	I(1)
GDP^2	I(1)	I(1)	I(1)	I(1)
FDI	I(1)	I(1)	I(0)	I(1)
EU	I(1)	I(1)	I(1)	I(1)

Appendix C. Time Series Data of the Countries

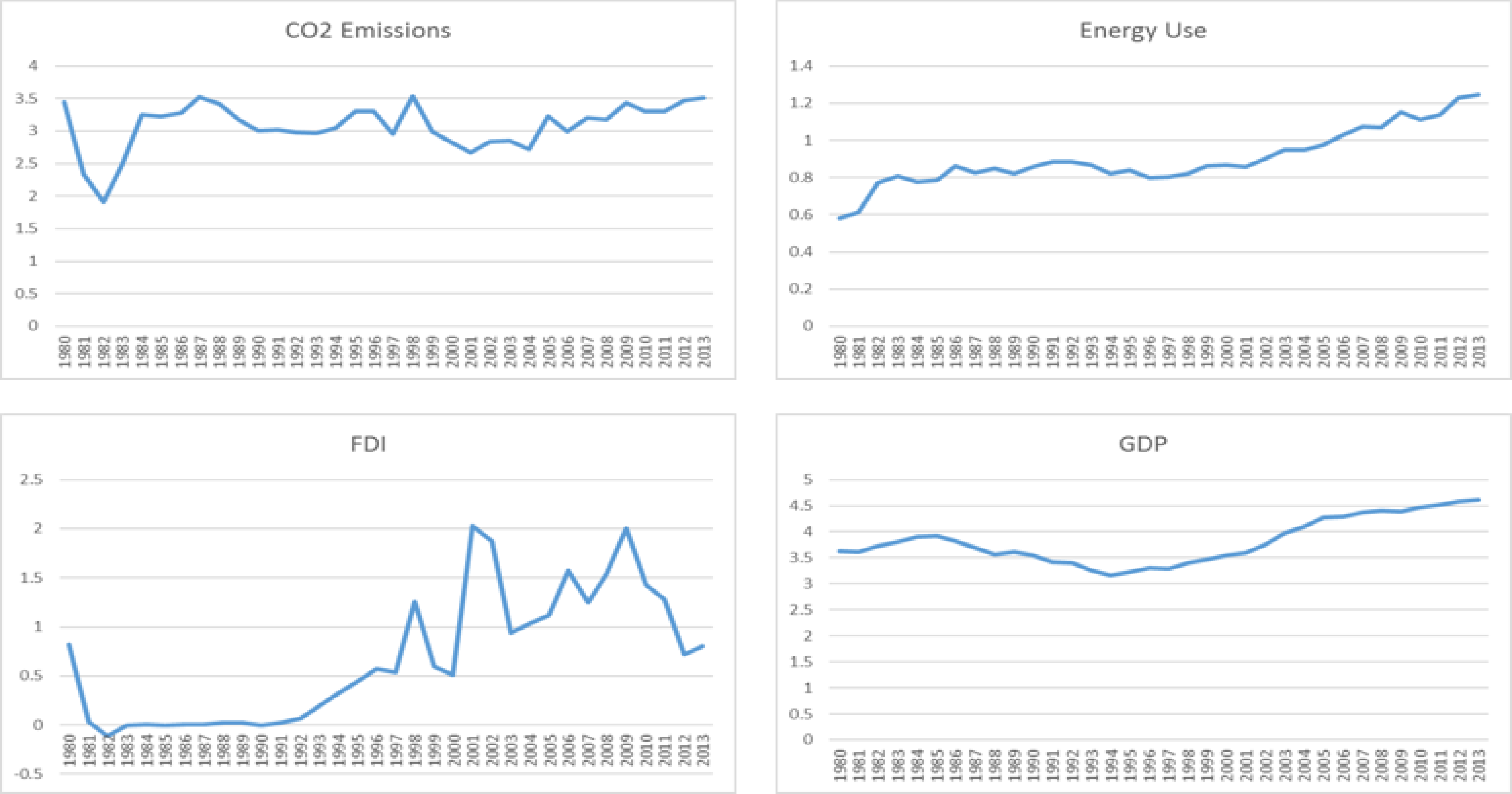
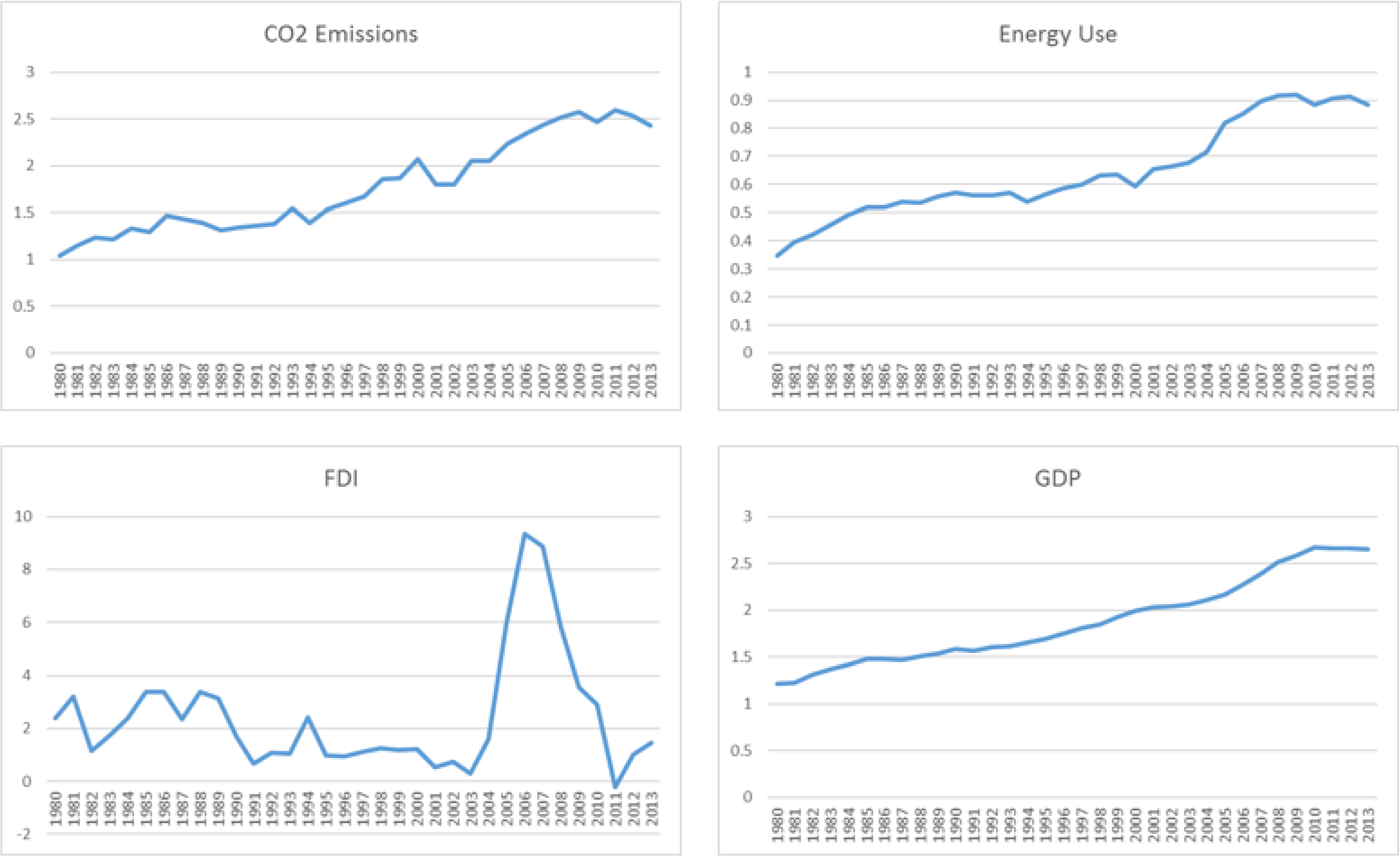


Figure 6: Time Series Data of Algeria



CO2 Emissions

Energy Use

FDI

GDP

Figure 7: Time Series Data of Egypt

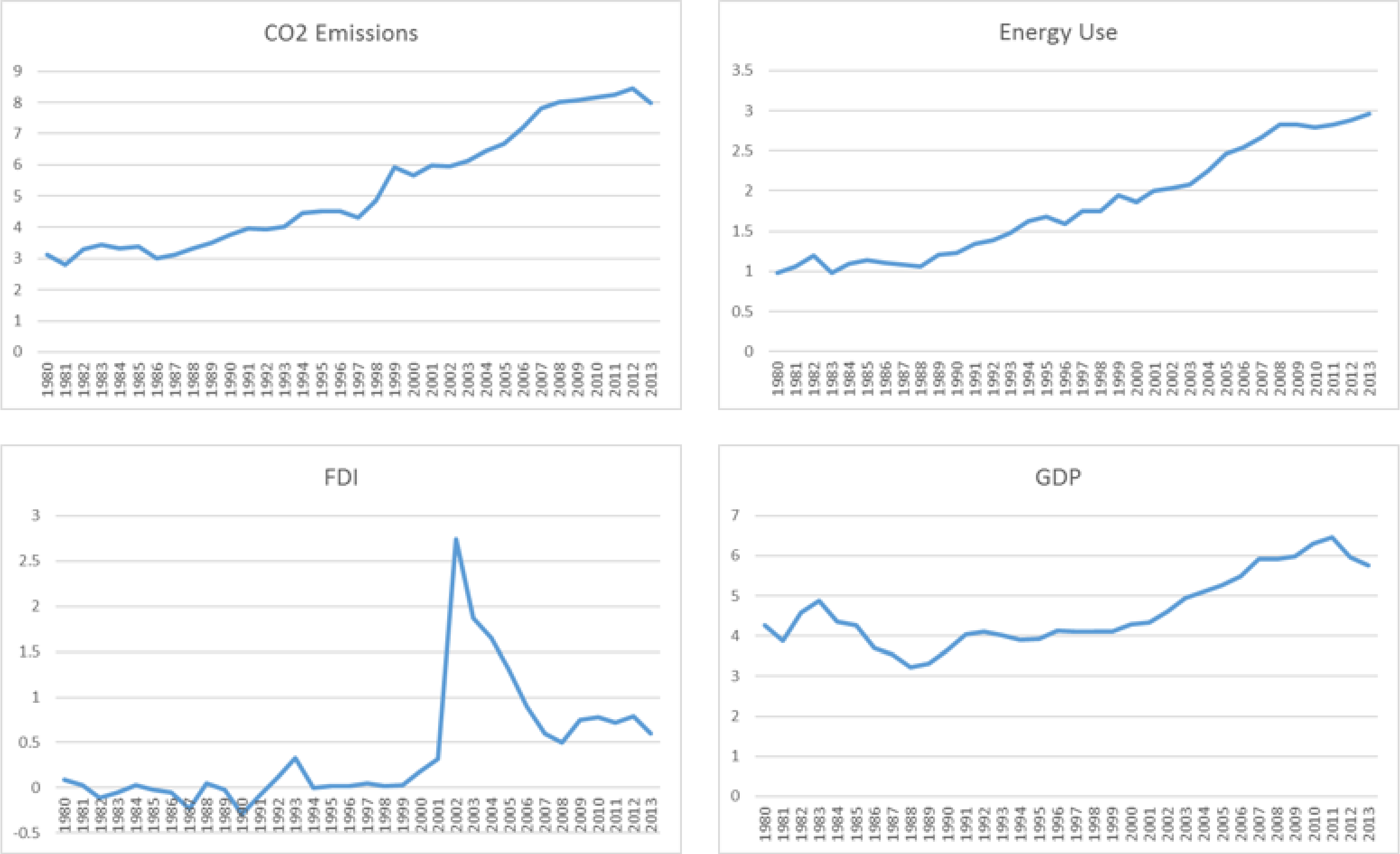
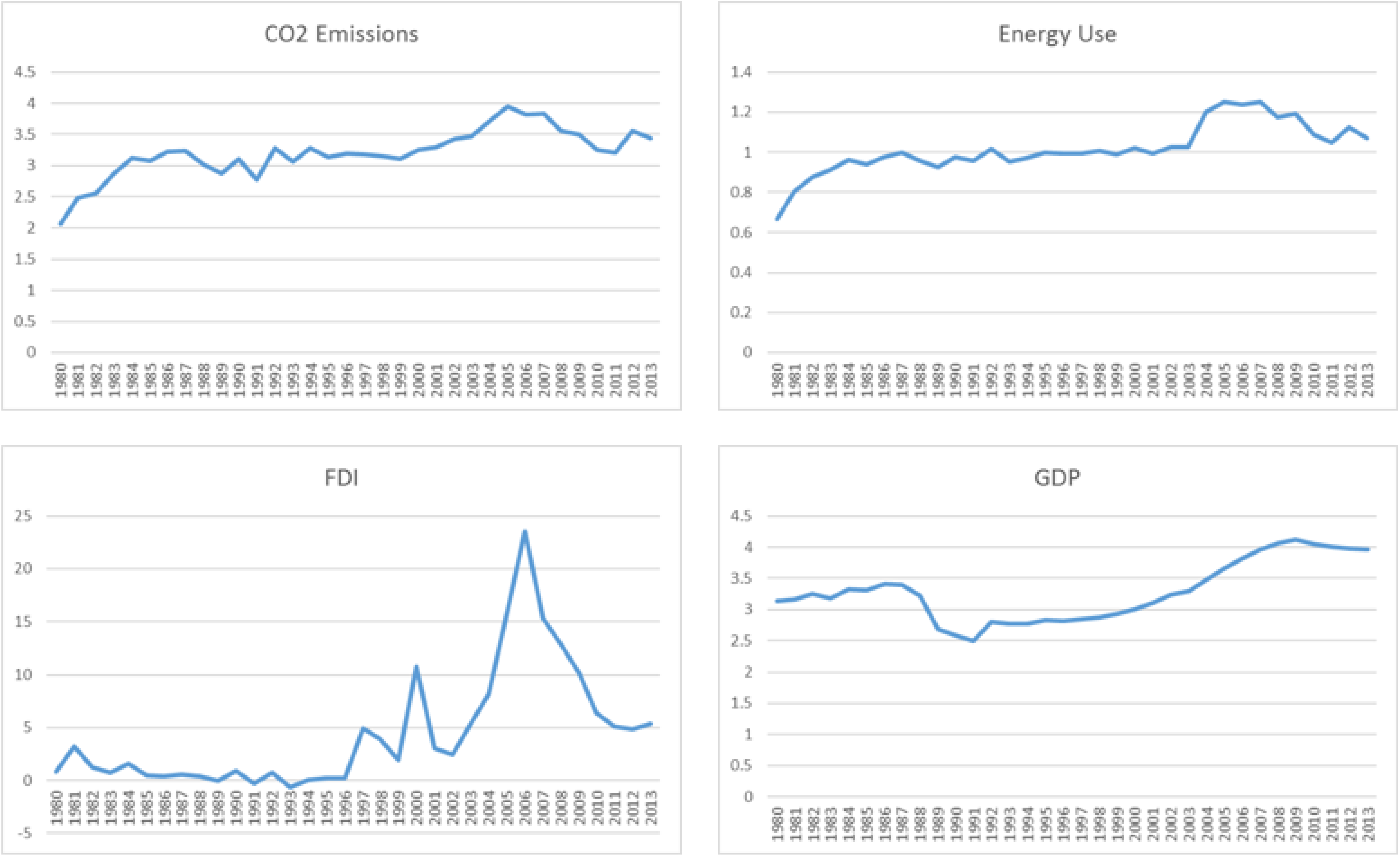


Figure 8: Time Series Data of Iran


CO2 Emissions

Energy Use

FDI

GDP

Figure 9: Time Series Data of Jordan

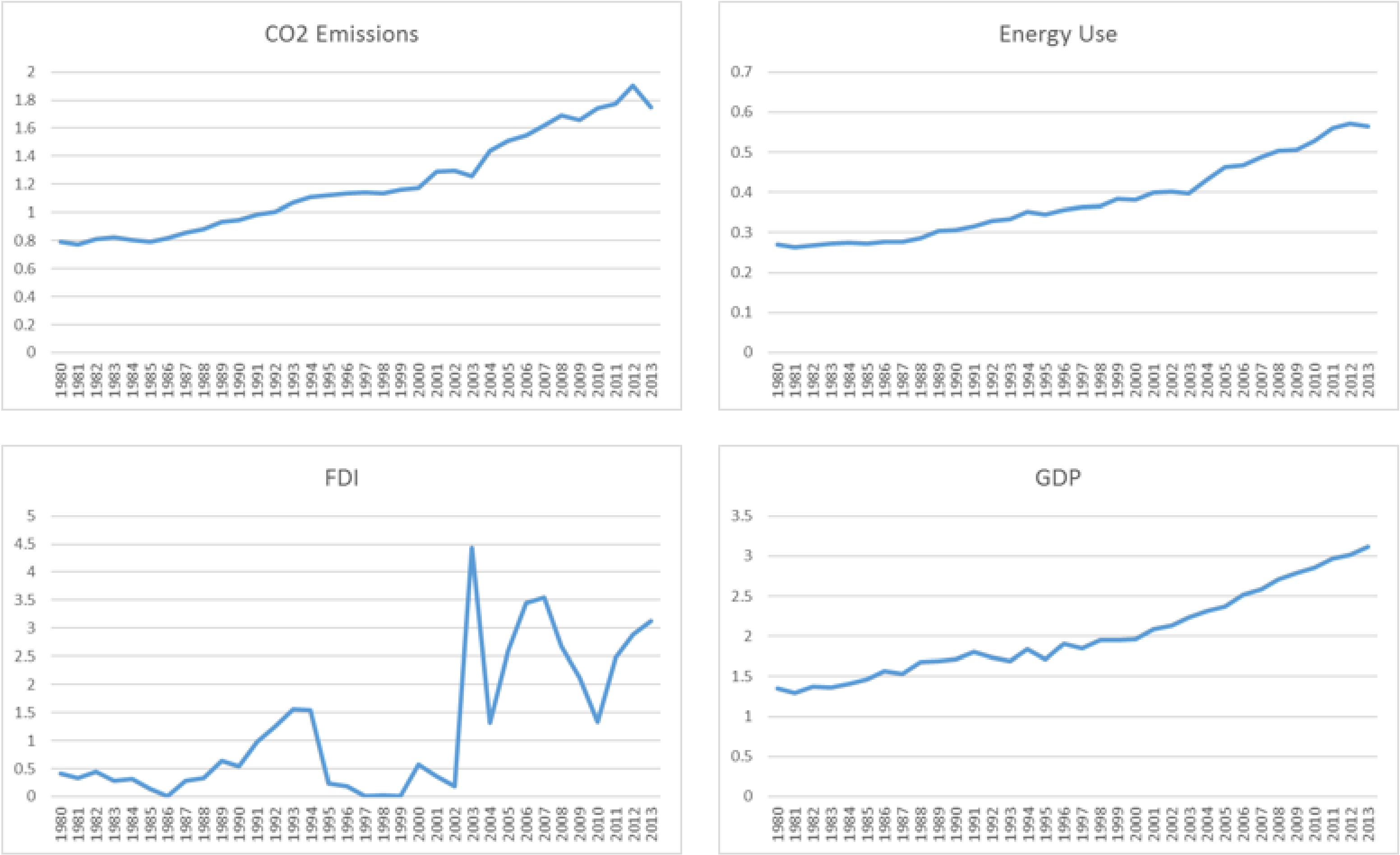


Figure 10: Time Series Data of Morocco

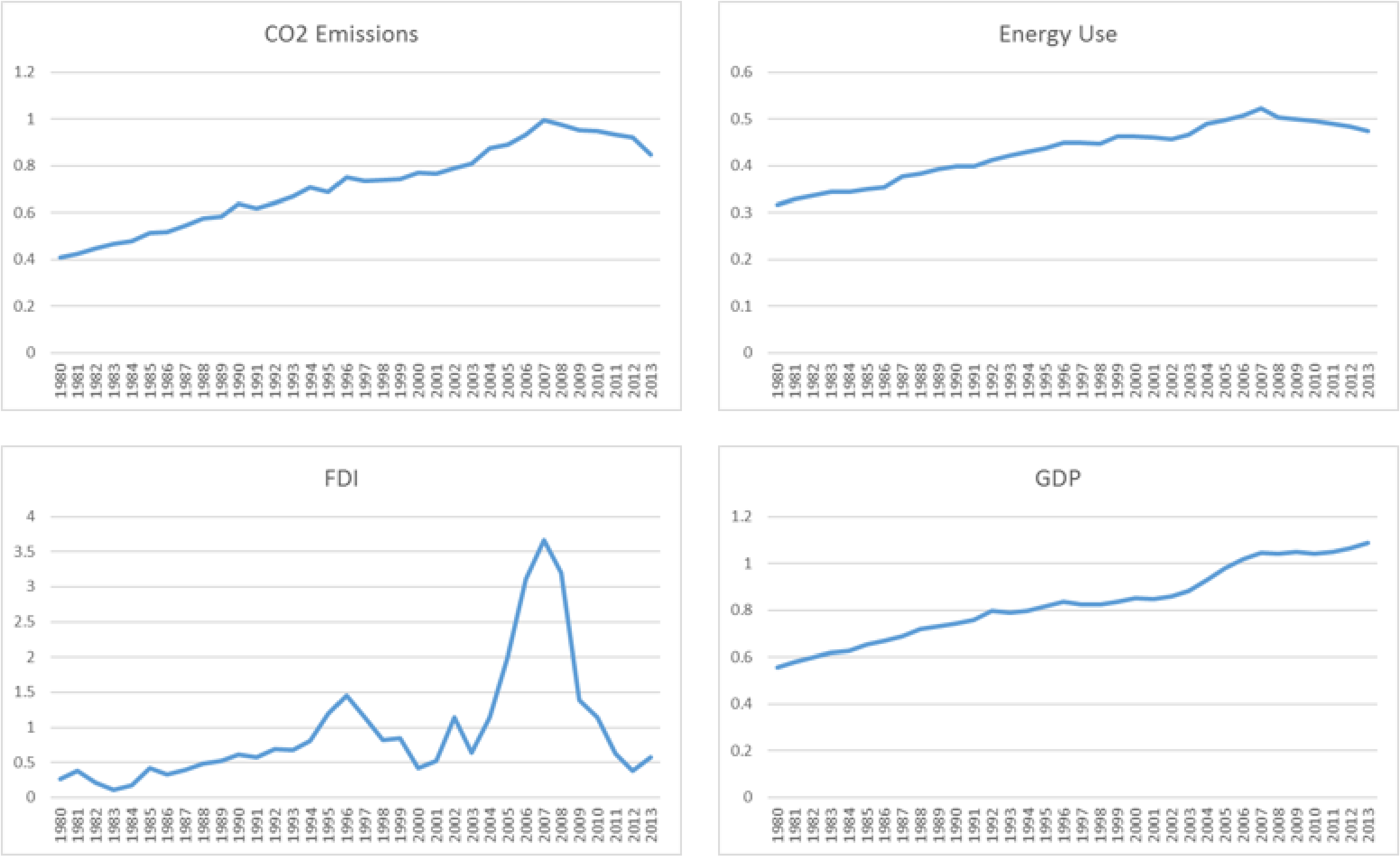


Figure 11: Time Series Data of Pakistan

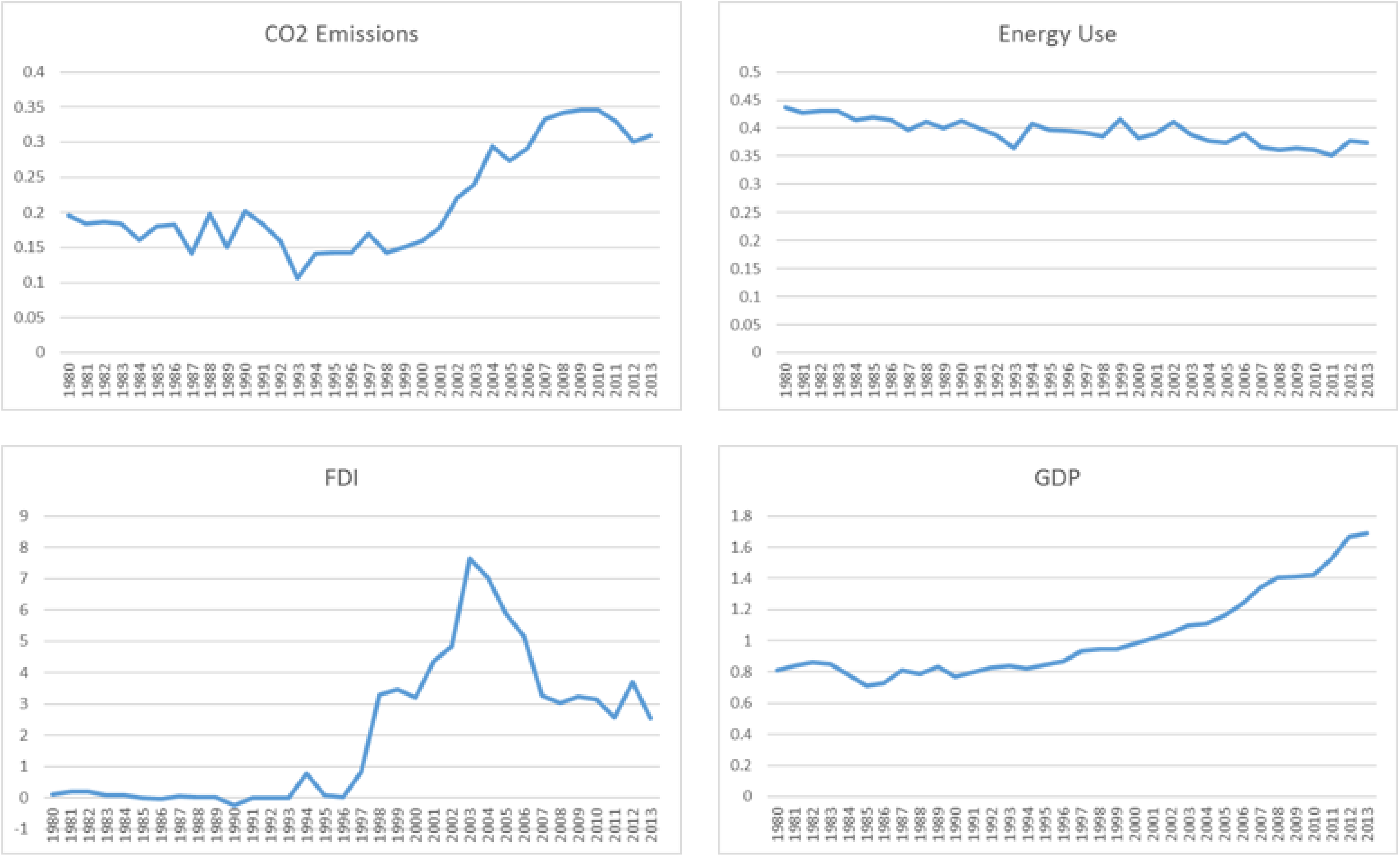


Figure 12: Time Series Data of Sudan

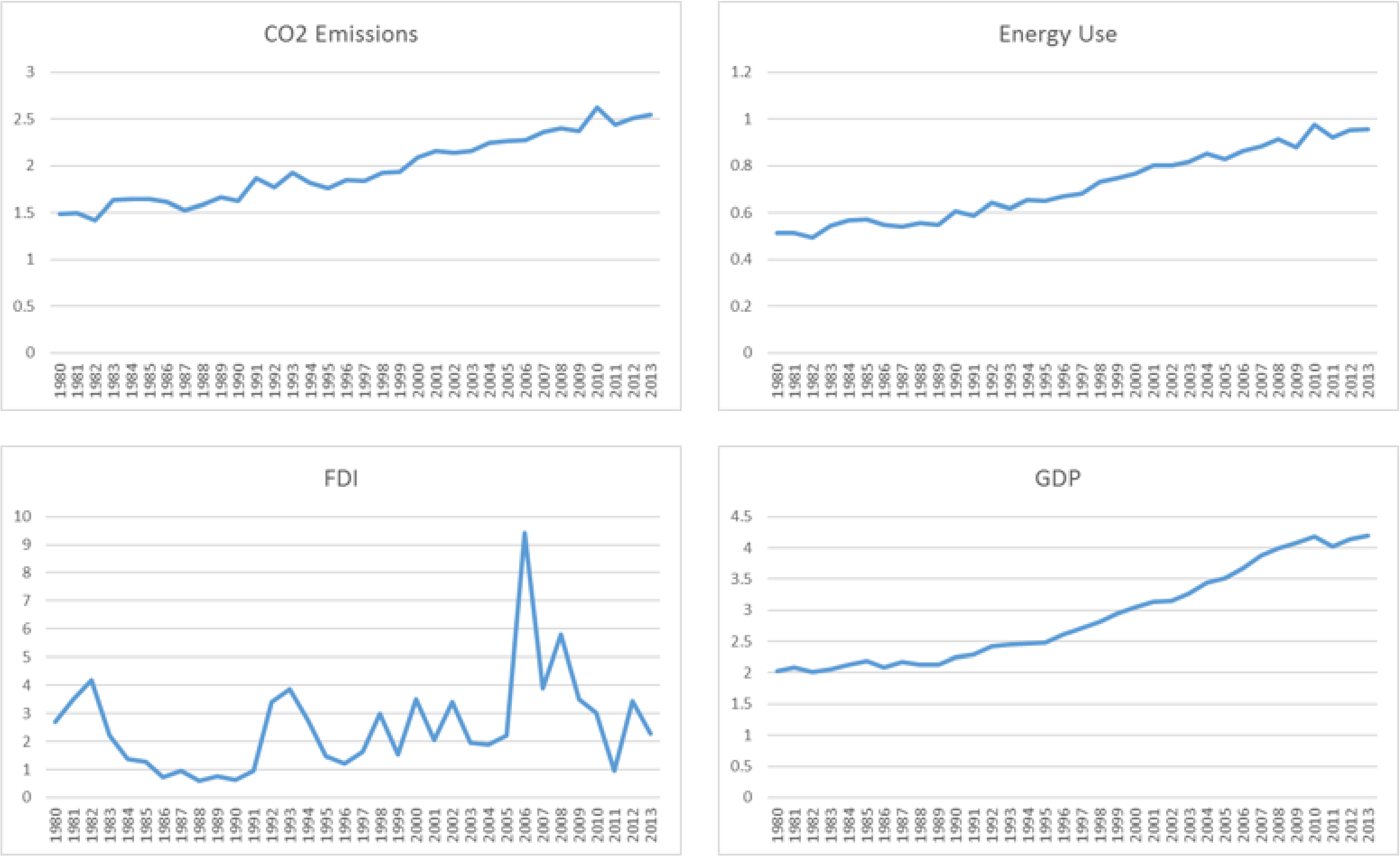


Figure 13: Time Series Data of Tunisia

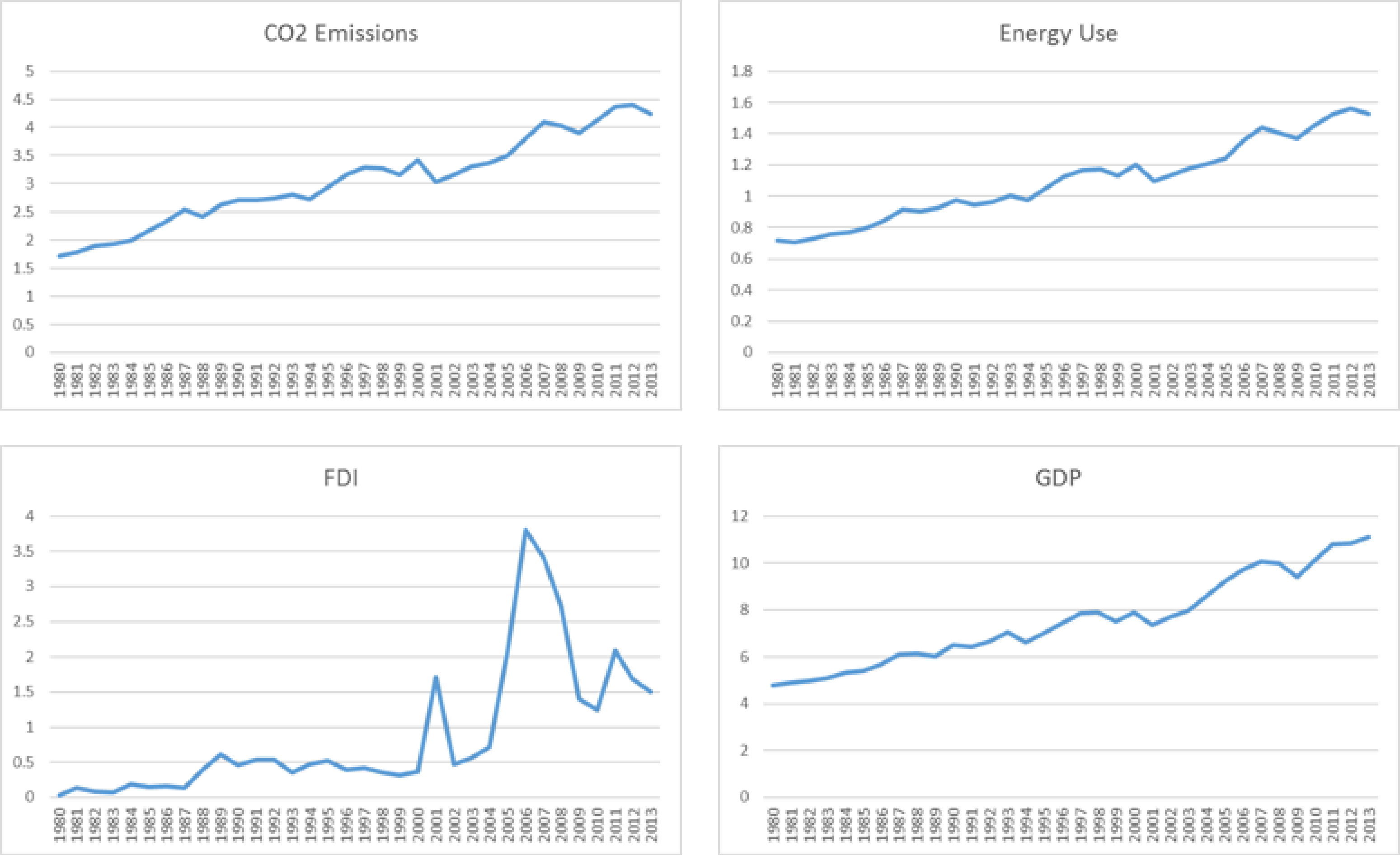


Figure 14: Time Series Data of Turkey

Appendix D. Tez Fotokopisi İzin Formu

TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Sosyal Bilimler Enstitüsü

YAZARIN

Soyadı: Görüş

Adı: Muhammed Şehid

Bölümü: İktisat (Tezli YL)

TEZİN ADI: IMPACTS OF ECONOMIC INDICATORS ON ENVIRONMENTAL DEGRADATION: EVIDENCE FROM MENA COUNTRIES

TEZİN TÜRÜ: Yüksek Lisans

1. Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir.
2. Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir.
3. Tezimden bir (1) yıl süreyle fotokopi alınamaz.

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: