THE ROLE OF SHADOW ECONOMIES IN ECOLOGICAL FOOTPRINT QUALITY: EMPIRICAL EVIDENCE FROM TURKEY

CİHAT KÖKSAL

BOĞAZİÇİ UNIVERSITY

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Cihat Köksal

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The thesis of Cihat Köksal

has been approved by:

Assist. Prof. Mehtap Işık
(Thesis Advisor)

Assist. Prof. Ülfet Zeynep Ata

Assist. Prof. Hasan Karaduman
(External Member)

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DECLARATION OF ORIGINALITY

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ABSTRACT

The Role of Shadow Economies in Ecological Footprint Quality:

Empirical Evidence from Turkey

With this study, the role of shadow economies in ecological footprint levels is intended to be investigated for the case of Turkey. Annual data that ranges from 1961 to 2014 has been selected with this respect. Results of this study confirm the long-term effects of shadow economic activities on the levels of ecological footprint in Turkey. It is found that the volume of shadow economies exerts positively significant and elastic effects on ecological footprint; that is, one percent change in shadow economic activities leads to one percent change in ecological footprint in the same directions. Therefore, this study reaches a significant conclusion that shadow economies in Turkey are long-term and vital drivers of environmental pollution in the case of Turkey. In order to acquire Turkey's historical background, demographic information and foreign trade on environmental degradation, an ecological footprint-income model with variables such as energy consumption, urbanization, financial development, real exchange rate, and trade openness have been augmented. The empirical conclusions reveal that the Environmental Kuznets Curve (EKC) hypothesis holds in the long-run. All variables except urbanization have also been found statistically significant on ecological footprints of Turkey.

ÖZET

Kayıt Dışı Ekonomilerin Ekolojik Ayak İzi Düzeyindeki Rolü: Türkiye'den Ampirik Kanıtlar

Bu çalışma ile kayıt dışı ekonomilerin ekolojik ayak izi düzeyindeki rolünün Türkiye örneğinde ortaya konması amaçlanmıştır. Bu bağlamda 1961 ile 2014 yılları arasında yıllık veriler seçilmiştir. Bu çalışmanın sonuçları, kayıt dışı ekonomik faaliyetlerin Türkiye'deki ekolojik ayak izi seviyeleri üzerindeki uzun vadeli etkilerini doğrulamaktadır. Kayıt dışı ekonomileri hacminin ekolojik ayak izi üzerinde pozitif ve elastik etki yaratmıştır; yani, kayıt dışı ekonomik faaliyetlerdeki yüzde bir değişiklik ekolojik ayak izinde aynı yönde yüzde bir değişime yol açmaktadır. Bu nedenle, bu çalışma, Türkiye'deki kayıt dışı ekonomilerin Türkiye örneğinde uzun vadede çevre kirliliğinin önemli itici güçleri olduğu sonucuna varmıştır. Türkiye'nin tarihsel gelişiminin, demografik bilgilerinin ve dış ticaretinin çevresel kirlenme üzerindeki etkilerini elde etmek için, enerji tüketimi, kentleşme oranı, finansal gelişme, reel döviz kuru ve dış ticaret açıklığı gibi değişkenleri olan ekolojik ayak izi gelir modeli tasarlanmıştır. Ampirik sonuçlar, Çevresel Kuznets Eğrisi (EKC) hipotezinin uzun vadede geçerli olduğunu göstermektedir. Kentleşme dışındaki bütün değişkenler, Türkiye'nin ekolojik ayak izleri üzerinde önemli derecede etkili bulunmuştur.

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ABBREVIATIONS

CC	Coal consumption
CO_2	Carbon dioxide
CP	Capital
EC	Energy consumption
EFP	Ecological footprint
EKC	Environmental Kuznets Curve
FD	Financial development
FDI	Foreign direct investment
FP	Fiscal policy
GDP	Gross domestic product
IS	Industry structure
LF	Labor force
OG	Output growth
PHH	Pollution haven hypothesis
RER	Real exchange rate
SPM	Suspended particulate matter
TO	Trade openness
UN	United Nations
URB	Urbanization

CHAPTER 1

INTRODUCTION

Researches regarding environmental matters have gained momentum in recent years. Various models have been proposed to investigate the relationship between environmental quality and economic growth. This nexus is mainly tested using the Environmental Kuznets Curve (EKC) Hypothesis suggesting the presence of an inverted U-shaped relationship between various variables of environmental pollution and economic activity. While environmental quality has been analyzed using different indicators such as carbon dioxide (CO_2), sulfur dioxide (SO_2) methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6), GDP was generally the only variable used to represent economic growth being the official economic indicator in analyzing economic growth-environment nexus (Biswas, Farzanegan, & Thum, 2012). Unofficial economic activities exist in both developed and developing countries; therefore, GDP alone does not reflect the economic growth in any country. Governments take actions to decrease the percentage of informal economic activities in their countries; however, it can be suggested that this concept has become a structural economic problem in many countries. Thus, any environmental quality-economic growth research would be incomplete if the size of their informal economy is ignored.

Scholars have used different terms to define unofficial economic activities: Irregular economy (Ferman & Ferman,1973), the subterranean economy (Gutmann,1977), the underground economy (Simon & Witte,1982; Houston, 1987), black economy (Dilnot & Morris,1981), shadow economy (Frey, Weck & Pommerehne,1982, Cassel & Cichy,1986) and informal economy (McCrohan & Smith,1986). All these terms refer to unregulated and unobserved sectors in the marketplace and therefore cannot be taxed. In this study, the term “shadow economy” proposed by Simon & Witte (1982) is used.

This thesis aims to contribute to the debate on environmental pollution by estimating an EKC for ecological footprints for Turkey bearing in mind both the official and informal economic activities. The motivation for selecting Turkey for this analysis is that Turkey has a growing economy with a large ratio of informality in its economy and relies on polluting industries for its development. On the other hand, Turkey signed the Kyoto Protocol in 2009 and the Paris Agreement in 2016 intending to reduce its greenhouse gas emission levels. As a result of these initiatives, Turkey decreased its greenhouse gas emissions by 87 million tons during the period between 2012 and 2016. A total amount of 1 billion 920 million tons of greenhouse gas emissions were targeted to be decreased in the 2012-2030 period. (Ozturk, 2017)

When analyzing the environmental degradation, one has to bear in mind that government regulations play a significant role in controlling and exercising ecological standards. As the pressure on the companies to produce environmentally friendly increases, they are more likely to shift their polluting industries to informal activities. As mentioned above, Turkey has an ambition of decreasing its pollution levels in the latest years, and therefore, regulatory bodies introduced stricter environmental standards.

Baksi and Bose (2010) suggested that the existence of a large shadow economy in developing countries makes it hard to implement environmental regulations. Hence, the shadow economy is a crucial part of the economy that has to be included in any environmental policy research in a given country, and therefore, it is essential that informal economic activities have to be taken into account before policymakers decide on environmental policies.

This thesis aims to investigate the relationship between shadow economic activities and environmental degradation in Turkey using ecological footprint which consists of not only greenhouse gases but also built-up land, cropland, fishing grounds, forest products, and grazing land. Therefore, the ecological footprint is a better indicator to represent environmental degradation than greenhouse gases which are used extensively in the previous studies in this field. Also, traditional EKC model is tested for Turkey using control variables such as energy consumption, financial development, real exchange rate, trade openness, and urbanization.

This thesis is designed as follows: Environmental Degradation section provides information regarding the history of environmental degradation, major ecological problems, and literature review behind environmental degradation. Shadow Economy chapter includes information about the importance, industries, and level of shadow economies around the world and Turkey. The chapter on empirical analysis consists of five subtitles. The theoretical setting section explains the theoretical approach used in this study, data and methodology section introduces the data and method used in this study, unit root tests and long-run equilibrium subtitles provide application part of the study. Finally, the conclusion section finalizes the thesis with the findings and policy recommendations.

CHAPTER 2

ENVIRONMENTAL DEGRADATION

2.1 History of environmental degradation

The concept of environmental pollution was first dealt with by the Massachusetts Public Health Committee in 1869, and an explanatory statement was published. In this statement, it is suggested that every person needs fresh air, water, and soil, and they should not be polluted. (Institute of Medicine (US) Committee for the Study of the Future of Public Health, 2016)

Chemicals and harmful wastes resulting from the economic activities of people, especially in the industrial sector, cause pollution both nationally and internationally. Uncontrolled release of toxic chemicals and hazardous wastes to nature during and after industrial production can lead to irreversible damage in the world.

Since the existence of humanity, human and environment have been in a mutual relationship, and human beings use the environment for their benefits. Until the 20th century, human activities did not reach the extent of destroying the environment. With the industrial revolution as a result of the technological advances in the west, the improvement of living conditions, the increase in production, and the development of the world economy become possible. Increase in product diversity and change in consumption patterns required more resources, which caused environmental pollution with unconscious use of natural resources.

Since the second half of the 20th century, interest in environmental issues has increased. This is due to the fact that nature's ability to renew itself cannot overcome ecological problems, making these problems more visible. Environmental issues do not emerge at a time, progressing cumulatively. The last period of the 20th century was the stage of progress. For the 21st century, the predictions are not heartwarming, and it seems that this process will accelerate further.

A report named “The Limits to Growth” written by MIT for the Club of Rome in 1972 investigated the five factors that limit the growth on earth: population increase, agricultural production, nonrenewable resource depletion, industrial output, and pollution generation. This work was exaggerated and pessimistic because it was based on the dilemma of changing something or disappearing; however, it has been on the agenda of the international public as it is the harbinger of the disaster awaiting humanity. They drew a pessimistic scenario suggesting that the rates of population growth, usage of resources, pollution increase, and material consumption would grow exponentially and then exceed the limits leading to a collapse in the next century. According to them, the destruction will realize as the world will exceed limits in nonrenewable resources, agricultural production, and excessive pollution (Ozcan & Ozturk, 2019).

Environmental topics have received increasing attention for the last forty years. During the years of 1960, the first interest gained was the industrial pollution created by the developed countries after the industrial revolution. The 1970s were the years when international trade was the subject being discussed at the center of environmental pollution. In the 1980s trans-boundary environmental problems took place in trade negotiations. In the 1990s, it was realized that the strictness of environmental regulations could have a significant role in the development level of countries and their sectors. Afterward, the interest in environmental regulations and their level increased noticeably. The environment became one of the hot topics discussed in many international platforms (Jayadevappa & Chhatre, 2000).

Sustainable development has a long history, but the very first meeting for international concerns for the environment and development needs was at the United Nations (UN) Conference on the Human Environment in 1972. At this conference, the principles for the protection and improvement of the natural resources were defined. During the meeting, problems were identified because of industrialization, such as habitat degradation, toxicity, and acid rain. It is also mentioned that the development strategies do not meet the expectations of the developing countries; however, these environmental problems were the dominant case at the meeting and attracted more attention. (Ulucak, Yücel, & Kocak, 2019)

In 1987, the UN formed the Commission on Environment and Development, which is also known as the Brundtland Commission. In this commission, a report called "Our Common Future" was prepared. According to this report, sustainable development is defined as "Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The depletion of environmental resources to further develop, neglecting the welfare and health of future generations were mentioned in this report. (World Commission on Environment and Development, 2009)

Rio Conference took place in 1992 with the aim of discussing global temperature increase, which would lead to climate change and then could mean disastrous implications for humanity. In order to cope with global warming and its adverse effects, all of the countries needed to combat decreasing international greenhouse gas emissions. (Back in time: What was Rio 1992?, 2019)

Greenhouse gas emissions are increasing global warming, and their harmful effects on the environment became a big problem for the world. Kyoto Protocol was signed by the United Nations Framework Convention on Climate Change, Kyoto, in

1997. This protocol requires the countries to reduce their emission levels for industrialized countries. The countries which signed the contract are needed to reduce their GHGs from 5% to 8% according to their level of emissions for the five-year commitment period. (Kyoto Protocol - Targets for the first commitment period, 2012) Kyoto Protocol has enacted three flexibility mechanisms to enable countries to fulfill their emission targets and encourage low-income countries to contribute to emission reduction attempts. These are joint implementation, clean development mechanism, and international emissions trading. Joint implementation let a state committed emission reduction under the Kyoto protocol might take part in an emission reduction project in any other country with a commitment under the protocol. Clean development mechanism allows developing countries to create plans to earn certified emission reduction credits. Then, they can trade these credits to meet their emission targets. International emissions trading will enable countries to sell their surplus emission reductions to those other countries which could not reach their emission goals. (Ulucak, Yücel & Kocak, 2019)

2.2 Major environmental problems

The most important resources for the survival of life is the soil, water, and air, which are closely connected. Agricultural resources, which are one of the sources of life, must be co-existed to grow. The destruction caused by the human hand in nature is shortly environmental pollution. Contamination is the presence of chemical, radioactive elements, and solid wastes, including the unwanted amount of heat energy, light, and sound.

Environmental pollution is the pollution and deterioration that occurs in air, water, and soil and affects the health of human beings and other living things negatively. In this context, we will examine environmental pollution, underwater pollution, deterioration of air quality, soil pollution, and noise pollution.

The term pollution of water resources means the presence of any organic, inorganic, radioactive or biological material in the water in such a way as to impair the use of water resources or reduce the quality of the damage. In the Glossary of Environmental Terms prepared by the EU Environmental Protection Organization, water pollution is defined as the addition of sewage water, industrial waste or other harmful substances to the water in a quantity that can deteriorate the water quality to a measurable rate.

Although most of the earth is covered with water, the amount of drinking water is limited. Today, with the increasing population, the need for water increases due to the destruction of the natural vegetation and the developing industry, thus the underground and surface resources are insufficient.

The atmosphere makes the life of living things favorable in the world. It is the basis of processes such as respiration, digestion, and photosynthesis that are necessary for the survival of living things. Air pollution is the pollutants released into the atmosphere from a particular source, disrupting its natural composition and transforming it into a structure that will harm living beings and nature. Soot, smoke, dust, gas, and steam form pollutants in the atmosphere.

The importance of the quality of the air we breathe to live is evident for our health — carbon particles carried by air, ozone, carbon monoxide, sulfur dioxide, and so on. Pollutants disrupt the usual mechanism by affecting people's airways; Dirty air leads to problems such as shortness of breath. The effects of air pollution in humans are, to some extent, seen in plants and animals. The best example of the impact of air pollution on plants is the damages caused by acid rains caused by the washing of H_2SO_4 (sulfuric acid) produced by the reactions of SO_2 gas discharged from coal plants in the atmosphere with rainwater.

Most of the environmental problems arise as a result of the misuse of nature. Soil pollution, which is one of the main components of nature, forms the basis of many environmental problems.

Especially with the rapid population growth towards the middle of the twentieth century, with the rapid increase in industry and technology in agriculture and other fields, soil pollution started to increase. Non-natural substances that contribute to the structure of the soil, which can be considered as the source of living life, cause soil pollution. Plants cannot grow in polluted soils; pollutants from soil to plants and animals can reach human beings through the food chain.

Another type of environmental pollution caused by industrialization, distorted urbanization, and population growth is noise pollution. Although other environmental pollution problems do not come up to the agenda, industrial plants, vehicles, aircraft, etc. noise is known to reach significant dimensions. Noise refers to the level of sound that is undesirable for human health and disrupts the psychological and physiological structure of the human being.

Although other environmental pollutants do not come up to the agenda, the effects of noise pollution are most visible on human health. Noise, which triggers many psychological and mental disorders, including stress, reduces the productivity of labor by creating a concentration disorder.

2.3 Literature behind environmental degradation

Simon Kuznets has found a relationship between per capita income and income inequality and formulated this nexus as an inverted-U shaped curve based on his empirical analysis, including countries Germany, USA, and England. In the early stages of the development, per capita income increases along with income inequality and starts declining after a certain level. This curve named after its creator, Kuznets. Many kinds of research have been conducted to prove this relationship. Some of them could approve this relation while some others could not.

Starting with the 1990s, Kuznets Curve has been used for a different nexus, environmental degradation, and per capita income. Many researchers studied to prove whether this curve also exists for this relationship. (Grossman & Krueger, 1991) is the first study to apply an empirical analysis of environmental pollution and per capita GDP. The study examines the extent and direction of the relationship between income growth and environmental pollution generated by the North American Free Trade Agreement (NAFTA). They state that economic growth will adversely affect the environment due to both the increase in energy use and the increase in by-products resulting from the expansion of the scale of production and transportation in the early stages of the free trade agreement. However, in the advanced stages of the deal, it was stated that the pressure on the economic environment would be reduced due to changes in the economic structure and changing production technology thanks to technology transfer. Their findings showed a similar pattern like the Kuznets Curve. As the economy grows, environmental pollution firstly increases and then after a turning point decreases, which is why this new phenomenon was called as Environmental Kuznets Curve coined by Panayotou (1993). In this study, he argued that among the factors that have contributed to the emergence of this relationship, the extent of economic activities had been expressed by supporting the results obtained that factors such as the sectoral and technological structure of the economy and the demand for environmental quality play an important role. In the panel data analysis, the threshold income level for forest destruction in developed and developing countries, which is considered as an environmental indicator, was found to be between $800 and the threshold income level for SO_2 emission causing air pollution was between $5,000.

Grossman and Krueger (1991) attribute three different effects to the increase in income, followed by firstly increasing and then declining course of environmental degradation. These effects are scale, composition, and technology. The scale effect is seen in the first stage of economic growth and affects the environment negatively. In the pre-industrialization period, economic activities are limited to agriculture, and therefore, there is no pollution due to industrial production. Increasing the number of natural resources used with the transition to an industrial society, increasing the number of pollutant emissions, using technologies that cause environmental pollution, producing more to increase the amount of output and not considering the ecological dimensions of development and growth, rapidly increase environmental pollution.

The composition effect is a positive effect of economic growth on the environment against the negative impact of scale effect. The composition effect refers to structural changes in economic activities. In the first stage of economic growth, the economic activities that have passed from agriculture to industry have experienced a transition from the industrial sector to service and information sectors in the next phase of economic growth. The services and information industries are less dependent on natural resources and generate less waste and pollution. In this sense, the composition effect of economic growth on the environment is favorable.

Technology effect is seen in the next stage of economic growth, and the impact on the environment is positive. As the welfare levels of countries increase, funds allocated for research and development increase. Technological progress emerges with a dirty and growing economy, and with growth, old technologies are replaced by new and cleaner technologies that improve environmental quality. The EKC hypothesis suggests that the scale effect hurts the environment in the first stage of economic growth, but lower emission levels will prevail with the positive effects of composition and technology on the environment.

A year later, the World Bank's World Development Report (World Development Report, 1992) increased the popularity of this new concept. The report states that economic growth at low-income levels hurts the environment, but growth at medium and high-income levels reduces environmental pollution. It is noted that the most crucial reason behind the change in this relationship over time is the economic policies such as changes in investments, energy prices, foreign trade policy, indebtedness ratio and political and civil disabilities. In the empirical part of the study, the relationship between ten different environmental degradation indicators, including air and water pollution from renewable sources and forest destruction, is examined. As a result of the findings, it is determined that the increase in income is the most critical factor affecting environmental degradation. The report concluded that there is a monotonous increase between water pollution and CO_2 emission and income, and an inverse U-shape relationship between Suspended particulate matter SPM and SO_2 and income. In the study, it was also calculated that the income level, which maximizes the SO_2 ratio, is around $5,000 for the USA where the research is conducted.

After these milestone papers, there has been a growing interest in EKC concept. Later on, many researchers studied on many different pollutants for testing the EKC hypothesis including deforestation, greenhouse gas emissions such as CO_2, SO_2, CH_4, N_2O, HFCs, PFCs and SF_6, toxic waste, motor vehicle lead emissions, built-up land, cropland, and fishing grounds. Some latest papers such as (He, Goh, Gan, Al-mulali, & Adebola, 2019; Mikayilov, Mukhtarov, Mammadov, & Azizov, 2019; Uddin, Alam, & Gow, 2019) used ecological footprint variable as a proxy to measure environmental degradation instead of greenhouse gas emissions only. Explanations regarding this curve shown in Figure 1, are summarized under five topics. (Dinda, 2004)

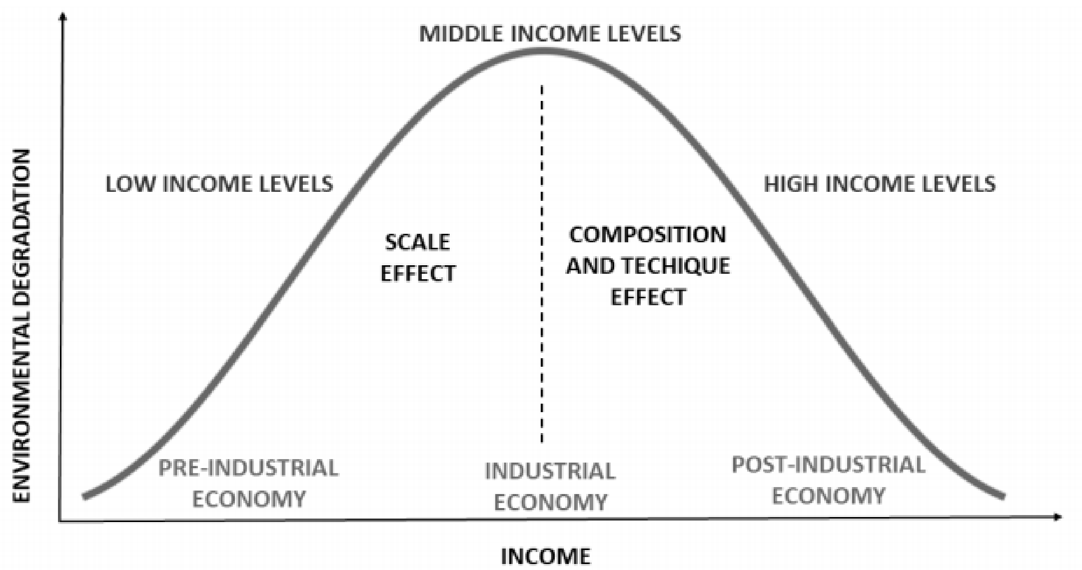

Figure 1. Environmental Kuznets Curve

Source: (Mitic, Kresoja, & Minovic, 2012)

1. Income elasticity of the demand for environmental quality: as income increases, people who achieve better living conditions are beginning to attach more importance to environmental quality. The need for a better environment can lead to structural transformations that can reduce environmental degradation in the economy.

2. Scale, technology, and composition effects: Economic growth affects environmental quality through different channels. Because of the scale effect, as the economy grows, more inputs are used in production, and as a result of increased production, more waste and pollution emissions are produced. On the other hand, as

a result of the composite effect, as the income increases, structural changes occur in the economy, and gradually cleaner economic activities are initiated. Cleaner environment can be possible with the shift from energy-intensive industry to services and information technology-based industries. Besides, countries with increased income can spend more on R & D, and technological growth leads to economic growth. As a result, old and dirty technologies are being replaced by new and clean technologies.

3. International trade: International trade can affect the quality of the environment through the effects of scale, technology, and composition as well as the pollution levels through comparative advantages. On the other hand, technological innovations can spread between countries through foreign direct investment and trade. In this way, clean technologies can be transferred from developed countries to developing countries. Therefore, trade liberalization can improve environmental quality in countries.

4. Market mechanism: In developing countries, the market mechanism can be strengthened in the process of economic development. As a result, the economy gradually shifts to the use of in-market energy sources that produce less pollution rather than non-market energy sources.

5. Regulations: Pollution increases in a country will continue as long as there are no environmental regulations. As countries progress along the path of development, they grow economically and develop social institutions that play a significant role in the implementation of environmental regulations. Thus, decreases in pollution levels can be observed after a particular stage of the development process.

Some scholars tested the EKC hypothesis using various econometric methods such as panel data, parametric and non-parametric analysis, co-integration analysis, causality analysis, and multivariate regression. Some others studied a specific country or a group of countries and regions covering different time series and added some control variables, including social and political, international trade, energy, and economic indicators.

The empirical studies show different results and not always as the inverted-U shaped suggested by EKC hypothesis. The possible forms can be in forms as monotonic increasing, monotonic decreasing, inverted-U shaped, U-shaped, N-shaped, and inverted-N shaped. (Abid, 2015)

Most of the existing literature has employed panel data of a selected group of countries or ARDL Model for the selected country on the CO_2 emissions – economic growth nexus, international trade - CO_2 emissions nexus and energy consumption – CO_2 emissions nexus. These studies focused on the basic EKC hypothesis and then included other control variables shown in Table 1. The studies mainly used CO_2 emissions as a dependent variable to measure the level of environmental degradation.

This study is an attempt to fill the gap by including shadow economic activities to the existing EKC framework with using the dependent variable ecological footprint which is believed as a better indicator to reflect environmental degradation in a developing country example, Turkey.

Table 1. Summary of Literature Review

Authors	Period	Country	Methodology	Variables	EKC
Ang (2007)	1960-2000	France	Johansen, ARDL, VECM	CO_2, EC, GDP, GDP^2, OG	Yes
Pao and Tsai (2010)	1971–2005	BRIC	OLS, VECM Granger	CO_2, EC, GDP, GDP^2	Yes
Shahbaz et al. (2012)	1971-2009	Pakistan	Granger	CO_2, EC, GDP, TO	Yes
Saboori et al. (2012)	1980-2009	Malaysia	ARDL	CO_2, GDP	Yes
Hamit-Haggar (2012)	1990-2007	Canada	OLS, VECM Granger	CO_2, EC, GDP, GDP^2	Yes
Du et al. (2012)	1995-2009	China	Fixed effect (FE) GMM	EC, GDP, GDP^2, IS, TO, URB	Yes
Shahbaz et al. (2013)	1980-2010	Romania	ARDL	CO_2, EC, GDP, GDP^2	Yes
Tiwari et al. (2013)	1966-2011	India	ARDL	CC, CO_2, GDP, TO	Yes
Shahbaz et al. (2014)	1971–2010	Tunisia	ARDL, VECM Granger	CO_2, EC, GDP, GDP^2, TO	Yes
Shahbaz et al. (2015)	1971-2008	Portugal	ARDL	CO2, EC, GDP, TO, URB	Yes
Al-Mulali et al. (2015)	1981-2011	Vietnam	Fixed effect (FE) GMM	CP, GDP, LF, TO	Yes
Dogan, Turkekul (2016)	1960-2010	USA	ARDL, Granger	CO_2, FD, GDP, GDP^2, TO, URB	No
Katircioglu, Katircioglu (2018)	1960-2013	Turkey	Panel data	CO_2, EC, FP, GDP, RER	Yes
Destek et al. (2018)	1980-2013	EU	Panel data	EC, EFP, GDP, GDP^2, TO	Yes

Notes: CC coal consumption, CO2 carbon dioxide emission, CP capital, EC energy consumption, EFP ecological footprint, FD financial development, FP fiscal policy, GDP gross domestic product, IS industry structure, LF labor force, OG output growth, RER real exchange rate, URB urbanization, TO trade openness

2.3.1 Economic growth nexus

Nexus between economic growth and environmental pollution is built by the EKC hypothesis suggesting the existence of an inverted U-shaped relationship. According to EKC, environmental degradation increases with economic growth and reaches a peak point and then starts to decline as the economic growth increases after the turning point have been reached. As explained in the previous section, environmental pollution can be examined in three parts: scale effect, composition effect, and technique effect. (Grossman & Krueger, 1991) Scale effect suggests that economic growth hurts the environment as ceteris paribus economic growth will lead to an increased level of pollution on the environment. The composition effect indicates that the structural shift from agricultural production to the more heavily industrialized type of output in the economy. As the economy improves, the transformation will be this time from heavy industry to light industrial kind of production and service industries. This process will let the environment end up having less pollution and degradation. Lastly, the technique effect will enable recent and cleaner technologies to be replaced with old and dirtier technologies, which will improve environmental quality.

The attention of scholars to the issue of environmental pollution and economic growth linkage has increased, especially in the last decade. Many pieces of research have been conducted using different variables in various countries and regions to find out how this relationship evolved. According to the EKC hypothesis, economic growth has a vital role in improving environmental quality as after an income level; the environment will be improved without having to impose new policies.

As a proxy for environmental degradation, greenhouse gas emissions and mainly CO_2 emissions are used widely in the literature. (Ang, 2007; Dogan & Turkekul, 2016; Hamit-Haggar, 2012; Salih Katircioglu & Katircioglu, 2018; Pao & Tsai, 2010; Saboori, Sulaiman, & Mohd, 2012; Shahbaz, Dube, Ozturk, & Jalil, 2015; Shahbaz, Khraief, Uddin, & Ozturk, 2014; Shahbaz, Lean, & Shabbir, 2012; Shahbaz, Mutascu, & Azim, 2013; Tiwari, Shahbaz, & Adnan Hye, 2013)

These studies tried to reveal whether the EKC hypothesis holds for the countries they studied. Except for the research on the USA conducted by Dogan and Turkekul (2016), all of the other studies confirmed the existence of the EKC hypothesis. Some latest papers such as He et al., (2019); Mikayilov et al., (2019);

Uddin et al., (2019) used ecological footprint variable as a proxy to measure environmental degradation instead of greenhouse gas emissions only.

2.3.2 Energy usage nexus

Continuous increase in energy consumption has created significant changes in the environment. These human-made effects began with the agricultural revolution and became more apparent with the industrial revolution. Technological developments, rapid population growth and increasing prosperity levels of individuals, which are the primary inputs of global economic and social development and which tend to increase with industrialization, have led to an increase in demand for energy. As a result of this, increasing energy demand has resulted in some environmental problems as it is supplied from fuels that will cause environmental pollution.

A primary EKC hypothesis suggests that energy consumption and therefore, pollution is the main driver of climate change (Heidari, Katircioglu, & Saeidpour, 2015). As the economy grows, the demand for energy usage increases, and this leads to a rise in greenhouse gas emissions. (Salih Katircioglu & Katircioglu, 2018)

There are many pieces of researches being conducted to find out the relationship between energy consumption and economic growth using panel data and time series analysis.

In many countries, especially in developing ones, rural-urban migration has caused various problems which have social and economic backgrounds. This phenomenon, also named as urbanization, in no small extent, brings economic development. As the population in big cities increase, there exists a new demand for more products and services. Fulfilling these needs in an environmentally friendly way is most of the time not possible for developing countries. Therefore, urbanization is added to the modern EKC models as it has an effect of polluting the environment. (Abid, 2015; Dogan & Turkekul, 2016; Du, Wei, & Cai, 2012; Shahbaz et al., 2015)

On the other hand Setareh Katircioglu and Katircioglu (2018) pointed out that fuel oil and other traditional energy sources are the main reason behind carbon dioxide emissions, which are strictly related to urban development.

2.3.3 International trade nexus

The relationship between environment and trade came to the fore in the General Agreement on Tariffs and Trade (GATT), which was first signed in 1947 to establish the foundations of the post-war trade system and entered into force in January 1948 on an international legal basis. In general, the rapid growth, post-war reconstruction, and recovery, which was observed as a feature of the 1950s after World War II, also caused inadequacies in approaching environmental issues and problems and this was observed in GATT. The ecological aspect is merely the GATT (1948) XX. article. According to GATT; Member States may adopt and implement measures necessary for the protection of human, animal or plant life and health or conservation of consumable natural resources without discrimination or implicitly restricting trade between countries (WTO, Trade and environment, 2019). Although insufficient, this article has been the focus of discussions on the environment-trade relationship on the GATT and WTO level.

However, along with the economic expansion and increasing international trade, environmental pollution also increased as a result of the fast-growing polluting industries. International trade has, therefore, become one of the widely used determinants to test the EKC framework. Scholars used some variables to test the effect of international trade on the EKC hypothesis including trade openness (Al-

Mulali, Weng-Wai, Sheau-Ting, & Mohammed, 2015; Destek, Ulucak, & Dogan, 2018; Dogan & Turkekul, 2016; Du et al., 2012; Ozatac, Gokmenoglu, & Taspinar, 2017; Shahbaz et al., 2012; Tiwari et al., 2013) and exports & imports (Al-Mulali, Saboori, & Ozturk, 2015; Salih Katircioglu, Katircioglu, & Altinay, 2017; Ren, Yuan, Ma, & Chen, 2014; Suri & Chapman, 1998) However, there are opposing views regarding the effect of international trade on environmental degradation. While (Al-Mulali, Weng-Wai, et al., 2015; Ozatac et al., 2017; Ren et al., 2014; Tiwari et al., 2013) found that international trade leads to deterioration of the environment, some others such as (Du et al., 2012; Ohlan, 2015) could not find any evidence to support this argument. Furthermore (Destek et al., 2018; Dogan & Turkekul, 2016; Shahbaz, Kumar Tiwari, & Nasir, 2013; Shahbaz et al., 2012) found in their research that international trade decreased environmental degradation.

Economic growth relies merely on polluting industries in developing countries because of the comparative advantage over the developed countries. On the other hand, developed countries focus more on service and light manufacturing industries. The difference between these two country blocks based on their development level allows them to vary on their economic structure, which creates the composition effect, and this phenomenon can be explained by Pollution Haven Hypothesis (PHH). Liberal trade theories suggest the countries produce those goods with comparative advantage. Due to the differences in the environmental standards between countries, the ones which apply stricter ecological standards cannot deliver products which require dirty production process. Thus, they shift these type of their industries to countries which do not have strict environmental regulations. The countries which become a center of attraction for dirty production industries are known as pollution haven. If pollution havens tighten up their pollution standards, the net exports and net incoming foreign direct investments (FDI) are going to fall in the related industries.

On the other hand, FDI inflows and environmental pollution might have a negative relationship when multinational companies transfer their cleaner technologies to the target countries. This effect is named as "Pollution Halo Hypothesis" (Balsalobre-Lorente, Gokmenoglu, Taspinar, & Cantos-Cantos, 2019). Cole et al. (2008) and Tamazian et al. (2009) suggest that attracting FDI could benefit countries improve their environmental standards by transferring cleaner technologies to their home countries.

This thesis focused on the case of Turkey as a fast-growing developing country; therefore, a closer look at its trade statistics is needed. In 1960, trade openness of Turkey, which is estimated as international trade as a percentage of its GDP, accounted for only 5.72%. After 57 years, this ratio had risen sharply to 54.12% in the year 2017, which is as a result of Turkey's continuous trade liberalization policies and globalization phenomenon in the world. (The World Bank Database, 2019) In 2017, Turkey exported 0.89% and imported 1.30% of the world merchandise trade. (World Trade Report, 2018)

Some latest researches focus on the effect of other economic activities on environmental degradation such as industry structure (Du et al., 2012), capital and labor force (Al-Mulali, Weng-Wai, et al., 2015) and financial development (Dogan & Turkekul, 2016).

CHAPTER 3

SHADOW ECONOMY

GDP stands for Gross Domestic Product, and it represents the total monetary value of all final goods and services produced within a country during a period which is generally one year. GDP is the most commonly used measure of formal economic activity. The first fundamental concept of GDP was invented at the end of the 18th century. American economist Simon Kuznets developed the modern notion in 1934 and adopted as the primary measure of a country's economy at the Bretton Woods conference in 1944. (What is GDP - Worldometers, 2019)

The distinction between the informal and formal economy in the economic structure in a given country began to attract the attention of economists only in the late 1970s. In the 1950s and 1960s, the informal sector, which became very prominent as a result of migration to cities, was the subject of examination by sociologists and anthropologists before it was the expression of the existence of a segment that was disconnected from the official institutions and organizations and especially the social security system. The first definition of unregistered labor in the “third world” context was introduced by K. Hart, but the primary academic approach was developed by the International Labor Organization (ILO) in 1972. The first study on the dimensions of informality in developed countries was made in 1958. In the following years, the US The Internal Revenue Service also made efforts to estimate the extent of informality and made recommendations to the Congress to register. However, the attention of both economists and the public opinion of the world regarding the issue was attracted towards the end of the 1970s. Scientific and political interest to the informal economy in Turkey began to form in the early 1990s to about fifteen-year delay.

Although many policies have been implemented to decrease the informal economic activities, the ratio in the economy is still high, especially in developing countries. There are many motivations behind this kind of events. The high tax burden, strict environmental standards, illegal production are some of the reasons behind it. Shadow economic activities as a percent of GDP of the regions are classified in Figure 2.

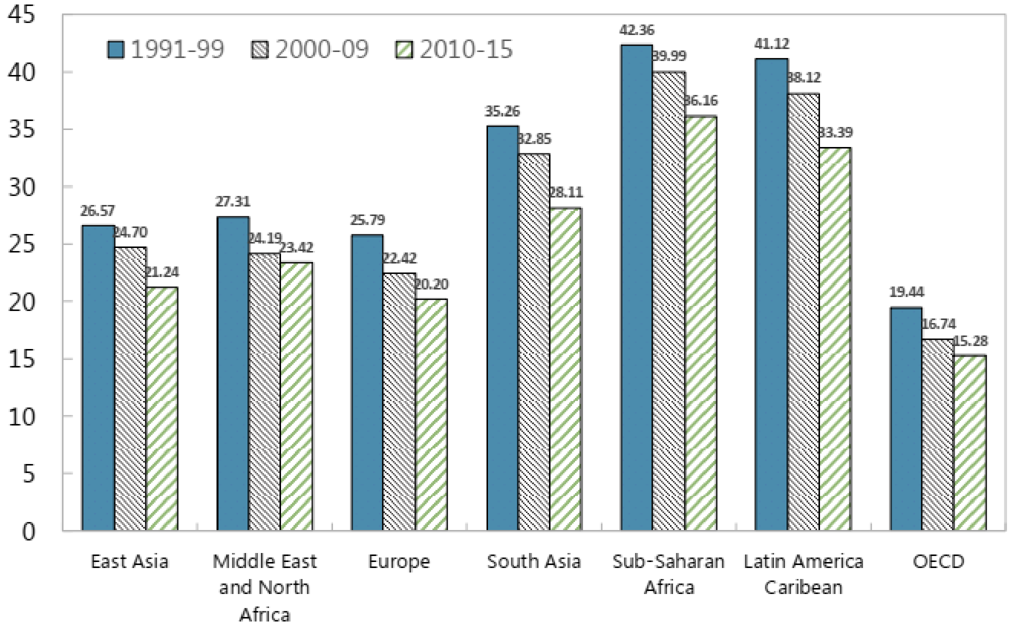

Figure 2. Shadow economy by region

Source: (Medina & Schneider, 2018) (average, percent of GDP)

Sub-Saharan Africa, Latin America, and South Asia have the largest share of shadow economies in their economies between 28 and 33 percent. More developed regions like East Asia, Middle East-North Africa, and Europe have shadow economic activities between 20 and 23 percent. It can be seen from the figure that all the regions are successful in their efforts to decrease the shadow economy in their economies from the 1990s to 2010s.

Environmental problems are also being affected by shadow economic activities, mainly in developing countries. However, there are not many studies being conducted on the relationship between the shadow economy and environment nexus. To name some, theoretical studies from Baksi and Bose (2010), Chaudhuri and Mukhopadhyay (2006) investigated the effectiveness of environmental regulations on shadow economies. Their results indicate that the more pressure being applied to firms to produce more environmentally friendly, lead them to shift their production more to informal sectors to save possible new costs. It is also suggested that without coping with the shadow economic activities, governments won't be able to apply new effective environmental policies (Biswas et al., 2012).

CHAPTER 4

EMPIRICAL ANALYSIS

4.1 Theoretical setting

The main idea behind this research is that both official and unofficial (shadow) economies are the determinants of environmental pollution. As a crucial part of environmental pollution, energy consumption is included in the model. Moreover, as proposed by many scholars in the empirical literature, trade openness, financial development, urbanization, and real exchange rate were considered as control variables in the model. Under the EKC framework, the model proposed is as follows:

$$EFP_{it} = \beta_0 + \beta_1 GDP_t + \beta_2 GDP^2{}_t + \beta_3 EC_t + \beta_4 FD_t + \beta_5 TRD_t + \beta_6 URB_t + u_t \quad (1)$$

where EFP denotes ecological footprints, GDP denotes official economy, GDP^2 denotes square of GDP, EC denotes energy consumption, FD denotes financial development, and TRD denotes trade volume, and URB denotes urbanization.

In an effort to measure the effect of both official and unofficial economies on the environmental quality, in the long run, the following model is proposed in logarithmic structure:

$$ln\,EFP_t = \beta_0 + \beta_1 lnGDP_t + \beta_2 lnGDP2_t + \beta_3 lnEC_t + \beta_4\, lnFD_t + \beta_5 ln\,TO_t + \beta_6 ln\,SE_t + \beta_7 lnURB_t + \beta_8 lnRER_t + u_t \quad (2)$$

where TO denotes trade openness, SE denotes shadow economy, and RER indicates the real exchange rate. Also β_1, β_2, β_3, β_4, $\beta_5, \beta_6, \beta_7$ and β_8 are the coefficients of the regressors and lastly u_t stands for the error term.

4.2 Data

With an attempt to investigate the effect of official and unofficial economies on the environmental degradation for Turkey, annual data ranging from 1961 to 2014 are used in this study. The descriptive statistics of the variables are in Table 2.

Table 2. Descriptive Statistics of Variables

	lnGDP	*lnEFP*	*lnEC*	*lnFD*	*lnRER*	*lnSE*	*lnTO*	*lnURB*
Mean	26.463	18.575	6.748	3.686	14.239	4.174	3.245	17.054
Median	26.521	18.624	6.818	3.588	14.125	4.192	3.477	17.177
Maximum	27.656	19.351	7.369	4.364	14.702	4.361	4.007	17.846
Minimum	25.203	17.614	5.954	3.194	13.879	3.785	2.120	16.016
Std. Dev.	0.678	0.514	0.402	0.290	0.261	0.122	0.630	0.565
Skewness	-0.085	-0.205	-0.275	0.611	0.370	-1.207	-0.456	-0.316
Kurtosis	1.972	1.903	2.045	2.716	1.639	4.587	1.653	1.757
Jarque-Bera	2.440	3.083	2.734	3.541	5.401	18.790	5.955	4.376
Sum	1429.0	1003.0	364.4	199.1	768.9	225.4	175.3	920.9
Observations	54	54	54	54	54	54	54	54

The variables used in this research are as follows: The ecological footprints (EFP); the official size of the economy (GDP; real GDP measured in 2010 constant USD), the shadow economy representing the unofficial size of the economy (SE), energy consumption (EC; kt of oil equivalent), trade openness (TO; international trade as of GDP), financial development index (FD), urbanization population as share of total population (URB) and real exchange rate (RER). GDP, EC, TO, and URB are taken from World Bank Development Indicators, FD is taken from IMF Financial Development Index Database, RER is taken from Turkish Statistical Institute (TÜİK), SE is taken from (Medina & Schneider, 2018) and EFP is taken from Global Footprint Network.

4.3 Methodology

Based on the theoretical model for the period 1961 and 2014 above, the formulation of the hypotheses are as follows:

H1: The shadow economy precedes significant changes in the levels of ecological footprints in Turkey.

H2: The EKC hypothesis holds for Turkey.

H3**:** EC, URB, FD, RER, and TO precede significant changes in the levels of ecological footprints in Turkey.

In order to test these hypotheses, firstly unit root tests will be conducted for all of the variables of interest. Johansen co-integration test is also employed if variable series were found as I(1). Starting from the traditional EKC hypothesis, other variables are included one by one into the model, and test results are reported in Table 5.

4.4 Unit root tests

According to Philips Perron Unit Root Tests and Augmented Dickey Fuller Tests reported in Table 3 and Table 4, respectively, all the variables are not stationary at the level and become stationary at their first difference. Upon fulfillment of this requirement, Johansen Co-integration tests can be conducted as all the variables become stationary when their first difference is taken.

Table 3. Phillips-Perron Unit Root Test

	Statistics (Level)			Statistics (First Difference)			
	PP_T	PP_I	PP_N	PP_T	PP_I	PP_N	Conclusion
lnEC	-2,790	-1.580	4.816	-7.028	-6.981	-5.277	I (1)
	(0.206)	(0.481)	(1.000)	(0.000)	(0.000)	(0.000)	
lnEFP	-2.638	-1.550	5.944	-19.755	-14.613	-8.629	I (1)
	(0.235)	(0.500)	(1.000)	(0.000)	(0.000)	(0.000)	
lnFD	-1.540	-0.313	3.079	-7.475	-7.359	-6.589	I (1)
	(0.802)	(0.976)	(0.999)	(0.000)	(0.000)	(0.000)	
lnGDP	-3.066	-0.656	8.499	-6.976	-7.028	-3.636	I (1)
	(0.124)	(0.848)	(1.000)	(0.000)	(0.000)	(0.000)	
$lnGDP^2$	-2.978	-0.392	8.397	-6.975	-7.044	-3.667	I (1)
	(0.147)	(0.902)	(1.000)	(0.000)	(0.000)	(0.000)	
lnRER	-1.576	-1.735	-0.075	-6.142	- 6.121	-6.179	I (1)
	(0.789)	(0.408)	(0.653)	(0.000)	(0.000)	(0.000)	
lnSE	-1.241	-0.914	-0.738	-8.709	-7.915	-7.869	I (1)
	(0.891)	(0.776)	(0.391)	(0.000)	(0.000)	(0.000)	
lnTO	-2.262	-1.006	1.060	-5.888	-5.954	-5.930	I (1)
	(0.446)	(0.744)	(0.922)	(0.000)	(0.000)	(0.000)	
lnURB	-1.224	-1.550	-8.916	-7.015	-6.440	-6.898	I (1)
	(0.898)	(0.500)	(1.000)	(0.000)	(0.000)	(0.000)	

Notes: Numbers in brackets are MacKinnon (1996) one-sided p-values. PP_T refers to Philips-Perron unit root test with the trend, PP_I refers to the test with intercept, and PP_N refers to the test without trend and intercept (none). The spectral estimation method is Bartlett kernel, and Newey-west bandwidth is selected as 3.

Table 4. Augmented Dickey Fuller Unit Root Test

	Statistics (Level)			Statistics (First Difference)			
	ADF_T	ADF_I	ADF_N	ADF_T	ADF_I	ADF_N	Conclusion
lnEC	-2.730	-1.502	4.737	-7.007	-6.976	-5.234	I (1)
	(0.229)	(0.524)	(1.000)	(0.000)	(0.000)	(0.000)	
lnEFP	-4.629	-1.436	4.642	-11.517	-11.442	-8.770	I (1)
	(0.002)	(0.557)	(1.000)	(0.000)	(0.000)	(0.000)	
lnFD	-1.547	-0.005	2.444	-7.251	-7.253	-6.589	I (1)
	(0.799)	(0.953)	(0.996)	(0.000)	(0.000)	(0.000)	
lnGDP	-3.066	-0.656	8.544	-6.977	-7.029	-2.293	I (1)
	(0.124)	(0.848)	(1.000)	(0.000)	(0.000)	(0.022)	
$lnGDP^2$	-2.978	-0.392	8.440	-6.976	-7.045	-2.282	I (1)
	(0.147)	(0.902)	(1.000)	(0.000)	(0.000)	(0.023)	
lnRER	-1.266	-1.437	-0.078	-6.102	-6.068	-6.129	I (1)
	(0.885)	(0.557)	(0.652)	(0.000)	(0.000)	(0.000)	
lnSE	-1.336	-0.914	-0.686	-8.090	-7.918	-7.885	I (1)
	(0.867)	(0.776)	(0.414)	(0.000)	(0.000)	(0.000)	
lnTO	-2.262	-0.941	1.128	-5.951	-6.013	-5.933	I (1)
	(0.446)	(0.767)	(0.931)	(0.000)	(0.000)	(0.000)	
lnURB	-0.772	-2.291	1.417	-7.257	-6.789	-6.913	I (1)
	(0.961)	(0.178)	(0.959)	(0.000)	(0.000)	(0.000)	

Notes: Numbers in brackets are MacKinnon (1996) one-sided p-values. ADF_T refers to Augmented Dickey Fuller unit root test with the trend, ADF_I refers to the test with intercept, and ADF_N refers to the test without trend and intercept (none). Schwarz info criterion is used to perform the tests.

4.5 Long-run equilibrium

Firstly, traditional EKC hypothesis has been tested with the first model. The dependent variable is lnEFP, and independent variables are GDP and GDP^2. Both the independent variables and the model itself are statistically significant (Model 1). With the addition of EC, the model and all the variables are still statistically significant (Model 2). The FD variable has been added in the model, and EC becomes statistically insignificant while the other variables are statistically significant. (Model 3) Then, the URB variable has been included in the model, and the FD variable becomes statistically insignificant while other variables are statistically significant (Model 4). Then, the RER variable has been included in the model, and all the variables except FD become statistically significant. (Model 5) Afterward, the variable TO has been added in the model, and all variables except EC become statistically significant (Model 6). Lastly, the SE variable has been added in the model, and all variables except URB variable become statistically significant.

All the models can be seen in Table 5 with their coefficients. It can be observed that the coefficients of GDP are very elastic, signs are positive (except models 4 and 5) and statistically significant in all of the models. The signs of squared GDP (GDP^2) are negative (except models 4 and 5) and statistically significant all over the models. This finding proves that the coefficients confirm the EKC hypothesis, which suggests that there is an inverted U-shaped relationship between environmental degradation and economic well-being for the case of Turkey. Energy consumption, financial development, trade openness, and real exchange rate were all found to be statistic significantly effective on environmental pollution. These findings are in accordance with the results of (Cetin, Ecevit, & Yucel, 2018b; Gökmenoğlu & Taspinar, 2016; Halicioglu, 2009; Salih Katircioglu & Katircioglu, 2018; Ozturk & Acaravci, 2013; Pata, 2018; Yavuz, 2014). However, this study does not confirm the results of (Cetin, Ecevit, & Yucel, 2018a; Setareh Katircioglu & Katircioglu, 2018), who suggested that urbanization leads to higher environmental pollution.

Figures 3, 4, 5, and 6 shows the EKC shapes including the basic EKC (model 1) and models 2, 3, and 7 which confirms the inverted-U form proving the traditional EKC framework. Although all plots drawn show similar patterns regarding the structure of EKC, estimation of EKC model drawn in figure 6 gave a better EKC plot where estimated EFP increases up to a level where it reaches a peak point and then starts to move horizontally and then declines as in the conventional EKC framework.

The peak point according to actual EKC plot was 2012 when GDP per capita was $11,720, and with the increase of GDP per capita to $12,542 and $12,127 in the years 2013 and 2014, the plot firstly decreased and then moved horizontally. However, Turkey could not sustain the increase of its GDP per capita and experienced a sharp decrease after 2014 to the levels under $11,000. This situation can be explained with the term middle income trap related to some structural economic problems. Thus, it is expected that the EKC plot won't give an inverted U shape until the peak point is climbed over. The findings are parallel with those studies of (S. T. Katircioglu, 2014; S. T. Katircioglu & Taşpinar, 2017) in the case of Turkey.

The figures 3,4,5 and 6 to represent models 1,2,3 and 7, respectively. Models 4,5 and 6 do not give us familiar shapes as FD becomes statistically insignificant when URB variable is added in the model. However, after SE variable is included in the model, all variables except URB becomes statistically significant.

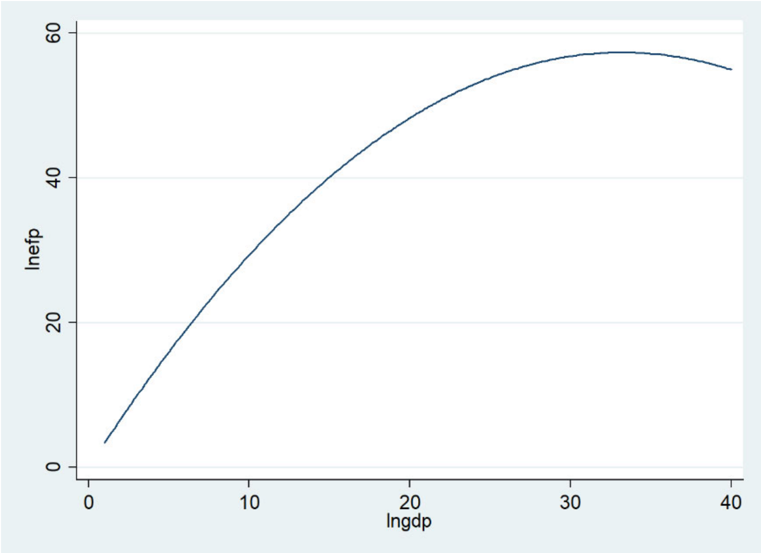

Figure 3. EKC model 1

The turning point, according to model 1, was found as 33.211. The highest value lnGDP took 27.65, so we can conclude that Turkey could not reach the turning point level in this model.

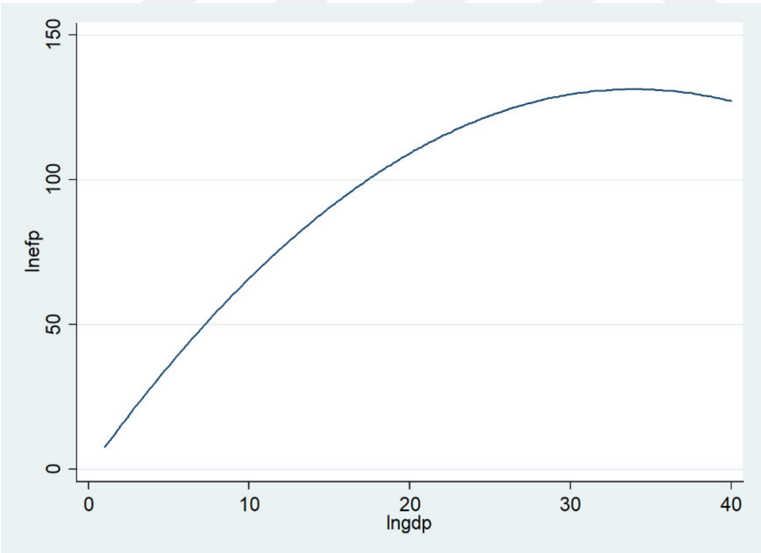

Figure 4. EKC model 2

The turning point, according to Model 2, was found as 33.947. The highest value lnGDP took 27.65, so we can conclude that Turkey could not reach the turning point level in this model as well.

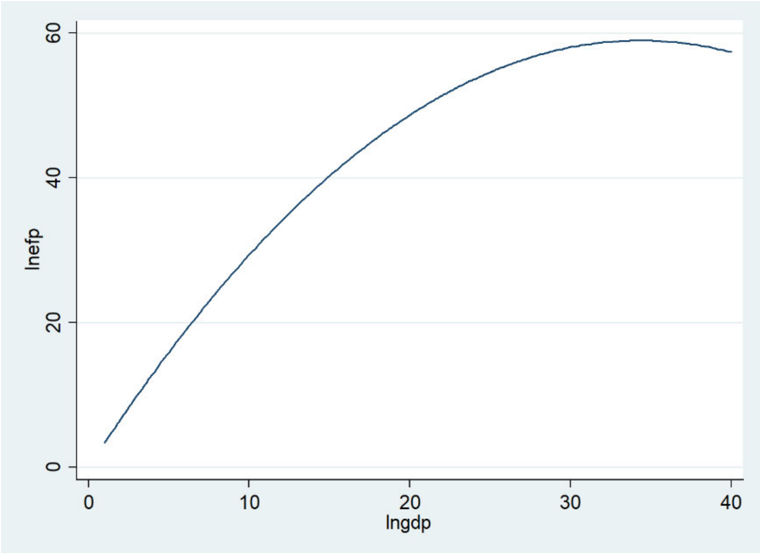

Figure 5. EKC model 3

The turning point, according to model 3, was found as 34.35. The highest value lnGDP took 27.65, so we can conclude that Turkey could not reach the turning point level in this model as well.

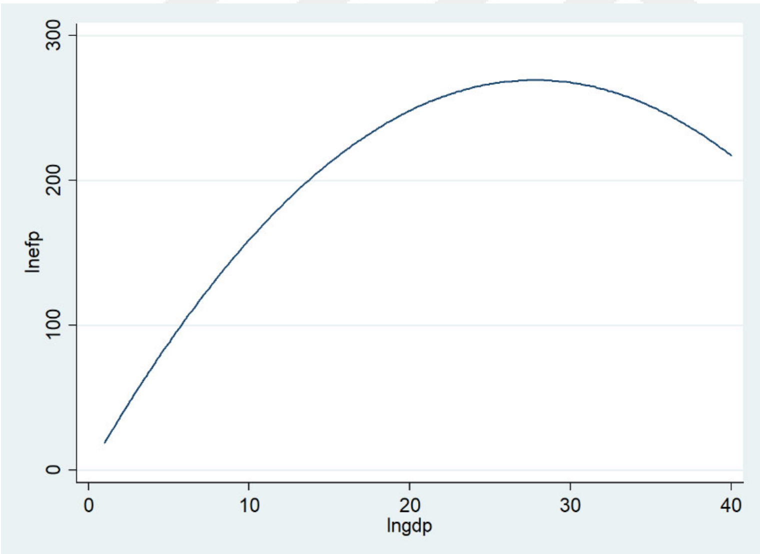

Figure 6. EKC model 7

The turning point, according to Model 7, was found as 27.07. The highest value lnGDP took 27.65, so we can conclude that Turkey reached the turning point level in this model. Model 7 included shadow economies in the model as an explanatory variable. This finding shows us how it is vital to include shadow economies in the model as the inverted-U curve closes to the X-axis meaning environmental pollution starts to decrease when GDP continues to increase.

Table 5. Long-run Equilibrium Test Results

Dep.var.: lnEFP	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Intercept	36.269	95.415	36.693	-83.886	-156.332	56.630	234.780
lnGDP	3.454***	7.740***	3.435***	-5.738***	-11.440***	4.858***	19.395***
$lnGDP^2$	-0.052***	-0.114***	-0.050***	0.103***	0.203***	-0.003***	-0.349***
lnEC		-1.527***	0.007	0.803***	0.907**	-0.245	-1.235***
lnFD			-0.067**	-0.015	0.062	0.164***	0.185***
lnURB				0.524***	1.045**	0.372**	0.186
lnRER					-4.056***	-0.18***	-0.118**
lnTO						0.158***	0.476***
lnSE							1.008***
Lag Order	2	5	3	1	1	2	2
Cointegration	yes	yes	yes	yes	yes	yes	yes
R-Square	0.424	0.589	0.744	0.402	0.412	0.738	0.665
BG LM test	0.5713	0.6561	0.1851	0.3912	0.5292	0.5687	0.3013
White test	0.0874	0.5034	0.2498	0.2025	0.1897	0.3172	0.2201
ECT_{t-1}	-0.955***	-0.804**	-0.583***	-0.507***	-0.282**	-0.431***	-0.716***

Notes: **, **, and *** denote the rejection of the null hypothesis at the 10, 5, and 1 percent levels respectively. BG LM test refers to Breusch Godfrey LM to test the autocorrelation of the models. The white test is conducted to test the heteroscedasticity of the models.*

According to Table 5, there is no autocorrelation and heteroscedasticity problem in all of the models. In the last model, the explanatory power R-square is relatively high, which is 66.5%. All of the ECT terms given in the regressions in Table 4 are negatively significant as expected. ECT term in the last model where all the variables are included in the model, is -0.716 which implies that lnEFP (ecological footprint) converges towards its long-term equilibrium path by 71.6% speed of adjustment through the channels of real income, energy consumption, trade openness, urbanization, financial development, real exchange rate, and shadow economy. The other ECTs in the remaining six models in Table 5, gave similar results. This finding shows that shadow economic activities in Turkey significantly contributes to the EKC model to reach its long-term equilibrium path.

CHAPTER 5

CONCLUSION

Majority of the studies in the field of environmental degradation and economic growth is based on official economy data. There are not many studies in the literature examining the relationship, taking into account the shadow economies as well as formal economies and environmental pollution.

This thesis aims to fill this gap by investigating the role of shadow economies in ecological footprint levels for the case of Turkey. To the best of the author's knowledge, the present study is the first of its kind in the relevant literature to investigate the interaction between the shadow economy and ecological footprints, using the theoretical EKC framework. The annual data that ranges from 1961 to 2014 has been selected with this respect.

Results of this thesis confirm the long-term effects of shadow economic activities on the levels of ecological footprint in Turkey. It is found that the volume of shadow economies exerts positively significant and elastic effects on ecological footprint; that is, one percent change in shadow economic activities leads to one percent change in ecological footprint in the same directions. Therefore, this study reaches a significant conclusion that shadow economies in Turkey are long-term and substantial drivers of environmental pollution in the case of Turkey. Other variables such as GDP, EC, FD, URB, TO, and RER are also added to the model as control variables. All the variables except urbanization have been found significant in the model.

Another important conclusion is that the EKC hypothesis is again confirmed in the case of Turkey; that is, the shape is an inverted-U as proposed in the conventional EKC framework. Figure 6 shows us how the EKC graph converges to an inverted-U shape after shadow economy variable is included in the model. According to this shape, it can be seen that Turkey reached the turning point income. After the economy reaches a higher level, it can be expected that environmental policies can be stricter, and non-polluting industries may develop. It will help Turkey to move to the stage on the EKC graph where environmental pollution decreases with the increase in GDP as in some developed countries.

Shadow economies, especially in developing countries, has an essential place in their economies. In the light of this study, as the effect of shadow economies on environmental degradation is enormous and statistically significant, the government should attempt to cope with these informal activities not only because of the tax loss but also their apparent adverse effects on the environment. Another policy recommendation would be to enact laws that will impose a polluter pay mechanism on the polluting industries and support environmental friendly sectors and technologies.

Further researches can be conducted using other macro-economic variables for Turkey and other developing countries emphasizing the role of shadow economies on environmental degradation.

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