The Role of Foreign Direct Investment, Agriculture, and Urbanization in Achieving Environmental Sustainability: Insight from an Emerging Economy

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ABSTRACT

This study strives to empirically examine the success or failure of different economic activities on environmental sustainability of Turkey over a given period of time. The abstract is organized based on different abstracts from three (3) distinct research by the author.

In chapter two of this study, the time-varying impact of foreign direct investment on environmental sustainability targets amidst global economic downturn was examined. To achieve this, a time-varying parameter approach was employed to investigate the impacts of increased foreign direct investment on environmental degradation amidst global economic downturn for the period 1970–2017. Results showed that the inflow of foreign direct investment (FDI), energy use, urbanization, and real income has led to environmental problems in Turkey. Thus recommended that the government enact policies that emphasize green FDI inflows, tighten environmental policies that deter the immigration of dirty production processes, ensure domestic investors to adhere strictly to the nation's environmental policies, and enact policies to foster mutual cooperation and understanding between the local and foreign stakeholders in a manner that drives the use of energy-saving technologies in production activities and the use of renewables in place of fossil fuels to control environmental hazards for both the immediate and future generations.

In addition, this third chapter aimed to examine the linkage among agriculture, energy use, economic performance and FDI with environmental sustainability. To this end, ecological footprint has been considered as a more comprehensive and reliable

indicator to measure the level of environmental degradation. This relationship has been investigated with different approaches such as the Residual Augmented Least Squares Augmented Dickey-Fuller (RALS-ADF), Residual Augmented Least Squares Engle and Granger (RALS-EG) and leveraged bootstrap causality test for the period from 1970 to 2017. The findings confirmed that all the variables investigated have cointegration relationship and have positive and statistically significant effect on environmental degradation in Turkey. Therefore, our findings provide insights for policymakers to consider investigated variables as a surest way to have environmental sustainability.

Finally, the fourth chapter aimed at examining the nexus among urbanization, energy use, foreign direct investment, economic growth and environmental sustainability in Turkey from 1970 to 2017. The analyses were carried out applying the Residual Augmented Least Squares analysis. The results revealed that urbanization and energy use deteriorate the environment, FDI inflow and GDP growth contributes to environmental sustainability in Turkey. The study suggests that to achieve sustainable urbanization, policymakers in Turkey should execute well-planned urbanization programs, create an energy conservation policy and encourage green industries to ensure a sustainable increase in environmental quality for Turkey.

Keywords: Foreign direct investment, Agriculture, Urbanization, Energy Consumption, and Environmental sustainability. Time-varying parameter. RALS cointegration. Turkey

ÖZ

Bu çalışma, belirli bir zaman diliminde farklı ekonomik faaliyetlerin Türkiye'nin çevresel sürdürülebilirliği üzerindeki başarısını veya başarısızlığını ampirik olarak incelemeyi amaçlamaktadır. Özet, yazar tarafından üç (3) farklı araştırmadan alınan farklı özetlere dayalı olarak düzenlenmiştir.

Bu çalışmanın ikinci bölümünde, küresel ekonomik gerilemenin ortasında doğrudan yabancı yatırımın çevresel sürdürülebilirlik hedefleri üzerindeki zamanla değişen etkisi incelenmiştir. Bunu başarmak için, 1970-2017 döneminde küresel ekonomik gerilemenin ortasında artan doğrudan yabancı yatırımın çevresel bozulma üzerindeki etkilerini araştırmak için zamanla değişen bir parametre yaklaşımı kullanıldı. Sonuçlar, doğrudan yabancı yatırım (DYY), enerji kullanımı, kentleşme ve reel gelir girişinin Türkiye'de çevre sorunlarına yol açtığını göstermiştir. Bu nedenle, hükümetin yeşil DYY girişlerini vurgulayan politikaları yürürlüğe koyması, kirli üretim süreçlerinin göçünü caydıran çevre politikalarını sıkılaştırması, yerli yatırımcıların ülkenin çevre politikalarına sıkı sıkıya bağlı kalmalarını sağlamaları ve yerli ve yabancı halk arasında karşılıklı işbirliğini ve anlayışı teşvik edecek politikaları üretim faaliyetlerinde enerji tasarruflu teknolojilerin kullanımını ve hem yakın hem de gelecek nesiller için çevresel tehlikeleri kontrol etmek için fosil yakıtlar yerine yenilenebilir kaynakların kullanımını yönlendirecek şekilde yürürlüğe koyması tavsiye edilmiştir.

Ek olarak, bu üçüncü bölüm tarım, enerji kullanımı, ekonomik performans ve doğrudan yabancı yatırımlar ile çevresel sürdürülebilirlik arasındaki bağlantıyı

incelemeyi amaçlamıştır. Bu amaçla ekolojik ayak izi, çevresel bozulma düzeyini ölçmek için daha kapsamlı ve güvenilir bir gösterge olarak kabul edilmiştir. Bu ilişki, 1970-2017 dönemi için Kalıntı Artırılmış En Küçük Kareler analiz yöntemleri (RALS-ADF, RALS-EG) ve Bootstrap ile düzeltilmiş nedensellik testi gibi farklı yaklaşımlarla araştırılmıştır. Bulgular, araştırılan tüm değişkenlerin eşbütünleşme ilişkisine sahip olduğunu ve Türkiye'deki çevresel bozulma üzerinde pozitif ve istatistiksel olarak anlamlı bir etkiye sahip olduğunu doğrulamıştır. Bu nedenle, bulgularımız politika yapıcılara, araştırılan değişkenleri çevresel sürdürülebilirliğe sahip olmanın en kesin yolu olarak görmeleri için fikir vermektedir.

Son olarak dördüncü bölümde, 1970'den 2017'ye kadar Türkiye'de kentleşme, enerji kullanımı, doğrudan yabancı yatırım, ekonomik büyüme ve çevresel sürdürülebilirlik arasındaki bağı incelemek amaçlamıştır. Analizler, Kalıntı Artırılmış En Küçük Kareler analizi uygulanarak gerçekleştirilmiştir. Sonuçlar, kentleşme ve enerji kullanımının çevreyi bozduğunu, DYY girişi ve GSYİH büyümesinin Türkiye'de çevresel sürdürülebilirliğe katkıda bulunduğunu ortaya koymaktadır. Çalışma, sürdürülebilir kentleşmeye ulaşmak için Türkiye'deki politika yapıcıların iyi planlanmış kentleşme programları yürütmesi, bir enerji tasarrufu politikası oluşturması ve Türkiye için çevre kalitesinde sürdürülebilir bir artış sağlamak için yeşil endüstrileri teşvik etmesi gerektiğini öne sürmektedir.

Anahtar Kelimeler: Doğrudan yabancı yatırım, Tarım, kentleşme, Enerji Tüketimi ve Çevresel sürdürülebilirlik, Zamanla değişen parametre, RALS eşbütünleşme, Türkiye

DEDICATION

To my beloved husband, Engr. Philip Abel

and

my adorable children, Audrey and El-Nathan

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LIST OF SYMBOLSAND ABBREVIATIONS

ADF	Augmented-Dickey Fuller
ARDL	Autoregressive Distributed Lag
CO_2	Carbon Emissions
EEA	European Environment Agency
EFP	Ecological Footprint
EG	Engle and Granger
EKC	Environmental Kuznet Curve
ENC	Energy consumption
EU	Europe
FD	Financial Development
FDI	Foreign Direct Investment
FMOLS	Fully Modified Ordinary Least Squares model
GDP	Gross Domestic Product
GHG	Green House Gases
GLB	Globalization
HJC	Hatemi-J information Criterion
IEA	International Energy Agency
IFC	International Finance Cooperation
MENA	Middle East and North Africa
NREN	Non-Renewable Energy
OECD	Organization of Economic Cooperation and Development
PARDL	Panel Autoregressive Distributed Lag
PMG	Pooled Mean Group

RALS	Residual Augmented Least Squares
REN	Renewable Energy
TO	Trade Openness
TVP	Time-Varying Approach
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
URB	Urbanization
USA	United State of America
VAR	Vector Autoregressive Model
VAR	Variance-Covariance Matrix
VECM	Vector Error Correction Model
WDI	World Development Indicators

Chapter 1

INTRODUCTION

Environmental sustainability has become a global phenomenon. It can be viewed as the drive to meet the present needs of an economy without compromising the potentiality of future generation. Environmental quality is an important factor in striving to utilize available resources efficiently to boost economic wellbeing, improve health and quality of life, reduce waste, increase the amount of clean air, and to guarantee a safe environment. The vital role of achieving environmental sustainability is by fighting against climate disasters to balance the available resources and their consumption to minimize or to avoid increase in greenhouse gas (GHG) emissions and other energy-related problems. Foreign investors have the enormous potential to influence a sustainable environment by utilizing modern technologies and promoting investment in key infrastructure. Most of the literature review supports the fact that foreign direct investment (FDI) reduces environmental degradation.

The uncertainty and unreliability emanating from not achieving environmental sustainability is one of the major sources of uncertainties in most economies. Environmental degradation and climate change have been considered as the greatest challenges to an economy, having seen its causes from both human-made and natural elements. The human-made factor includes urbanization and roads, fossil fuels, agriculture, and deforestation. These factors increase the volume of greenhouse gas discharge and global warming, especially carbon dioxide (CO2). Carbon dioxide is

influenced by humans which is the major contributor to environmental degradation. According to the European Commission (2021) stated that the effect of CO2 has increased to 48% in 2020 above its pre-industrial level, which is linked with a significant negative influence on the environment. Environmental pollution has negatively affected economic sustainability for a long-time, and attention has been giving across the world to reduce its effect on future economic sustainability.

Turkey's economic growth is expanding with the hope of becoming one of the tenth (10^{th}) largest economies globally, through the expansion of its industries, entrepreneurial and service sectors. To keep up with this, the energy sector is being supported by the government by encouraging the use of coal and renewable energy. The pollution in Turkey is increasing especially in the urban areas. In agreement with this, the European Environment Agency (EEA) stated that more than 97% of the urban population are exposed to hazardous level of emissions. The carbon dioxide emission in Turkey is rising which makes the country the 20^{th} largest emitter of GHG globally. The increase of emissions is mainly from the waste, agricultural production, and industrial activities. Turkey remains one of the highest emitters of pollutants. Turkey is located between key economies in Europe, Central Asia, Middle East, and Russia. Being a top industrial economy with rapid urbanization and population growth, Turkey has been faced with a variety of environmental challenges which consequently affect its growth and development. The challenges can manifest in various forms such as climate change, deforestation, and water related issues (European Environmental Agency, 2015). With the increasing energy demands (for consumption and production activities) mostly being met through nonrenewable energy sources (fossil fuels), carbon emissions are expected to continue to increase in Turkey, although the Turkish government and policymakers have put some policies in place to curtail the increase

in emissions. Major policies have been created to protect its environment from greenhouse gas emissions by encouraging the use of domestic coal and the development of renewable energy sector to lessen the use of imported oil and gas. Notwithstanding, no serious commitment has been made by the country to actively reduce the emissions. Though, Turkey is hoping to build coal production plan to 101.5 million tonnes, which no economy has been able to reach globally except for China who is planning to expand its coal capacity higher than that of Turkey. At the current rate, with an estimated population increase of 10 million by the United Nations (UN), the per capita metric tons of carbon emissions are likely to double from 5.9 metric tons per person to 10.5 metric tons per person by 2030, a figure that would exceed the current world average of 6.8 metric tons per person. Turkey's economic activities such as agriculture, industrial and service sectors, manufacturing, and transport equipment are all contributing to the environmental degradation through the excessive use of energy resources which in turn increases emissions. Most of the technologies used in agricultural or industrial activities utilize energy sources frequently and proceed to release carbon emissions which finally affect the quality of the environment negatively. Foreign direct investment contributes to the growth of economic performance by contributing to production and capital formation. Agricultural activities such as crop production and distribution, deforestation contribute greatly to greenhouse gases. Machine intensive farming, animal husbandry, water and tillage affects agriculture and environment. The use of fertilizers and other chemical substances in agricultural production contribute to emission of nitrogen oxide and all these bring about environmental emissions globally. The shift of population from rural to urban centers has increase the risk of environmental hazards through the loss of urban tree cover, food consumption, energy use, water and land. Apart from these

effects on the environment, urbanization can also affect the growth of an economy either positively or negatively. The positive side are industrialization, commercialization (trade) for export and import of goods and services, building of marketing institutions, technologies needed for trading are in the urban areas, political issues. Social benefits finding much better amenities in the urban centers, housing, education, employment, health care, standard of living and for recreation. On the negative side, urbanization can lead to increase in population which consequently limit resources availability, increases the number of slums, causes unemployment, and escalates crime rate. Urbanization also affects energy demand. As population surges, the rate of energy use also increases which alters climate change by releasing emission. Building and construction sector affect the environment through deforestation and building materials use. The occupants of the building contribute to climate change through the use of different energy sources which emit carbon dioxide emissions. Transportation sector is one of the contributors of carbon emissions in the urban areas through the use of oil and gas products. Turkey rely more on coal for energy use. Coal consumption contributes most of the pollution. Oil and gas are used mostly in the industries and manufacturing sectors use in machines, transportation purpose, building, farming, housing and so many other reasons.

The speed at which expanding economic growth occurs is essential to countries. Every country aimed at expanding economic growth which most likely leads to high energy demand, which is the major source of economic activities. Energy consumption is rising globally. Moreover, high urbanization increases both industrial and residential energy consumption as well as the use of natural resource which consequently leads to environmental degradation. Energy consumption is growing as the population increases and income rises across several nations of the world. Both renewable (wind,

biomass, geothermal, solar, and hydropower) and nonrenewable (coal, oil, and natural gas) energy impact the environment depending on the technology used. However, nonrenewable energy generally does more harm than renewable energy sources such as air and water pollution, public health damage, and global warming emissions (Hannah Ritchie 2020). Additionally, the increased demand for energy by the rapidly growing population in the country over the years necessitated the use of traditional sources such as fossil fuel and coal which are high GHG emitters. According to Bekun et al. (2019), energy production/consumption leads to the improvement in productivity and economic growth of any economy. Consequently, these increases result in environmental destruction by releasing harmful emissions. According to the world resources institute (2020), the energy sector is the major emitter of GHG with 73% of emissions. However, Turkey's energy supply is more of imports which are unfavorable to the environment given to the rise in emission. Several works of literature on the energy-environment nexus have highlighted the adverse consequences of energy use on the environment.

The rise in population and economic growth of Turkey has strongly increased energy consumption. Turkey aims to increase electricity production to 50% by 2023 from renewable energy to meet up the high energy demand. Policies are set to increase renewable energy production to reduce the high dependence on fossil fuel (oil and gas) imports to Turkey and enhance energy efficiency such as, diversifying the source of oil and gas supply, increase the domestic production of oil and gas, hard coal and lignite reserves, hydro, as well as improving renewable energy (wind and solar) supply in an efficient manner to meet the demand growth (IEA, March 2021). Akadiri et al (2020) stated that for every increase in energy consumption, environmental degradation escalates with the growing population in Turkey. Most studies argue that

energy consumption contributes to environmental degradation. According to them, energy consumption stimulates economic growth by providing efficient energy supply to industrial and residential sectors. The effects of environmental degradation on the economic growth and environment of most countries has not left the world the same, polluting and releasing of carbon emissions into the economies. These have left the nations to decide on means to curtail or reduce the effect of degradation through their policies on economic activities such as foreign investors, manufacturing, agriculture, industrialization. Several studies have proven that Turkey tend to contribute more to carbon emissions in their quest to expand the economy. Presently, there are policies set to control emissions by cutting the use of fossil fuel and shifting to the use of renewable energy sources. This is the main purpose where the idea of environmental sustainability in our various studies which is expressed with Foreign Direct Investment (FDI) and energy consumption and this is properly examined in the subsequent chapters. We measured the time-varying implication of FDI inflows for environmental sustainability targets with energy consumption and urbanization because most of these economic activities give rise to emissions in Turkey. In their quest to expand the economy by improving on their economic activities comes with the impact affecting its environmental quality. Lately, Turkey have been named among the faster growing nations hence, taking the lead in the global ranking of carbon emission release. This revealed that their economic expansion is not balancing with the environmental quality. On the empirical side, to the best of our knowledge, few of the studies have researched on FDI with energy and economic growth on environmental quality (Joshua, Bekun and Sarkodie 2020, Shahbaz et al. 2019), noon has directly examined the time-varying impact of FDI on carbon dioxide emissions in Turkey. By achieving this, the study has closed the gap and give way for future studies with the same interest.

We examined the various studies in this thesis with these variables: Energy consumption, FDI, Economic growth; Agriculture; Urbanization; Carbon dioxide and Ecological footprints as a proxy to environmental sustainability. The selected variables are for proper assessment of the forces that affect environmental sustainability. The country of interest in Turkey, which is one of the economies from the Western Asia region.

The first thread of our work examines the time-varying effects of foreign direct investment on environmental sustainability targets amidst global economic downturn. The main purpose is for the exposition of how FDI impacts the environment and economic activities. Thus, seeks to examine the impact of FDI on the Turkish environment while controlling for the effect of a changing economic climate. The study employed a time-varying parameter approach that adequately deals with potential parameter instabilities and nonlinearities, and effectively captures impact variations over time is posited in a method of testing FDI, energy use, economic growth, urbanization, and carbon emission. We found that carbon emission which is the dependent variable is affected positively by the selected variables. This is specifically indicating that the inflow of FDI, energy use, real income, and urbanization are contributing to the environmental pollution in Turkey. A vast amount of studies attempts to answer this simple question; how does foreign direct investment impact environmental conditions? Examples include (To et al. 2019, Saboori et al. 2012; Omri et al. 2014; Seker et al. 2015; Sarkodie and Strezov 2019). Some of their outcomes show that the inflow of FDI affects environmental pollution negatively (Saboori et al. 2012; Omri et al. 2014; Seker et al. 2015; Sarkodie and Strezov 2019), which are contrary to our results.

The second thread of the study is concentrated on the role of agriculture and energy consumption on environmental sustainability. The study utilizes the Residual Augmented Least Squares (RALS) procedure to analyze the stationarity level of each variable and their cointegration relationship. Examine the linkage among agriculture, energy use, economic performance, and FDI with environmental sustainability. To this end, environmental sustainability is proxy with ecological footprint which has been considered as a more comprehensive and reliable indicator to measure the level of environmental degradation. Research confirmed that all the variables investigated have cointegration relationship and have positive and statistically significant effects on environmental degradation. Agriculture and energy use increase environmental degradation in Turkey. The results also confirmed the inverted U-shaped EKC hypothesis for the relationship between economic performance and environmental sustainability.

The third and last thread of the study which is the fourth chapter focused on the implication of urbanization and energy consumption on the environmental sustainability of Turkey. The study also utilizes the Residual Augmented Least Squares (RALS) procedure and the Fully-Modified OLS model to analyze the impact of urbanization on the environment. We found that ecological footprint which is the dependent variable is affected positively by urbanization and energy use by deteriorating the environment and decreases the environmental quality where FDI inflow and GDP growth contribute to environmental sustainability in Turkey.

Several studies have utilized different techniques to explore the significance and effectiveness of environmental sustainability of different economies. The results of the vast amount of study carried out are different depending on the economy. There are

studies that find that economic growth affects environmental sustainability positively (Tiwari, Shahbaz and Hye 2013, Saint Akadiri, Alola 2020 Atasoy 2017, Aye and Edoja 2017) amongst others, whereas others suggested negative effects of economic growth on the environment.

The rest of the chapters is structured in this sequence: chapter 2-3-4 will be the presentation of the works we made on this study, and chapter 5 will be the conclusion and policy implication of the study.

Chapter 2

FOREIGN DIRECT INVESTMENT AMIDST GLOBAL ECONOMIC DOWNTURN: IS THERE A TIME-VARYING IMPLICATION FOR ENVIRONMENTAL SUSTAINABILITY TARGETS?

2.1 Introduction

As world economies move towards uncertainty, we observe that international investments are gradually declining. The uncertainty and unpredictability emanating from the trade wars between global superpowers like the USA-China trade war/tension and the structural challenges within the EU nations have adversely affected the world economy at large (Olasehinde-Williams 2020). Emerging economies, especially those reliant on exports, are some of the most affected by the economic downturn resulting from this heightened global uncertainty (Olanipekun et al. 2019).

Surprisingly, according to the United Nations Conference on Trade and Development (UNCTAD 2019), Turkey has been able to attract more foreign investment in periods when global foreign direct investment (FDI) inflows experienced recession. In 2019, when global FDI flows declined by about 13%, the FDI accessed by the Turkish economy rose by 13% to 13 billion USD (UNCTAD, 2019). This reduction in global FDI is the third in a row of preceding years, and it is the lowest level of global FDI inflows recorded since the global economic and financial crisis of 2008.Going by the

report, this situation highlights the shortfall of growth in global investment in this decennium.

The share of global FDI inflows to developing Asian countries increased from 33% in 2017 to about 39% (512 billion USD) in 2018. This noticeable increase in inflows was mainly recorded in China, Singapore, Indonesia, and Hong Kong and other ASEAN countries, along with Turkey and India. This clearly establishes Asia as the world's largest FDI recipient region. It is paramount to mention that four countries accounted for about 90% of the FDI inflows into Western Asia, with Turkey being the largest among the countries. It is striking that there is substantial increase in FDI flows into Turkey in spite of the uncertainty surrounding the Turkish lira and the imperceptible economic growth recorded.

Turkey remains one of the highest emitters of pollutants (Akadiri et al. 2019). Situated between Asia and Europe, it is recorded as the world's 20th largest emitter of greenhouse gases (GHGs). The nation's need for energy has been increasing expeditiously, and this is not projected to change any time soon. With the increasing energy demands (for consumption and production activities) mostly being met through nonrenewable energy sources (fossil fuels), carbon emissions are expected to continue to increase in Turkey, although the Turkish government and policymakers have put some policies in place to curtail the increase in emissions. Notwithstanding, no serious commitment has been made by the country to actively reduce the emissions. At the current rate, with an estimated population increase of 10 million by the United Nations (UN), the per capita metric tons of carbon emissions are likely to double from 5.9 metric tons per person to 10.5 metric tons per person by 2030, a figure that would exceed the current world average of 6.8 metric tons per person.

Having established facts about rising FDI inflows into the Turkish economy, it is also important to investigate the attendant impact of the increased FDI inflows on the environmental quality of the nation. Existing studies have established the positive impact of FDI on economic growth and development (see Katircioglu 2009; Taşpınar 2011; Guris 2012; Aga 2014; Yilmaz and Can 2016). However, the environmental impact on both the present and future generations is of priority to policymakers and environmentalists. This study thus seeks to investigate the impact of FDI on the Turkish environment while controlling for the effect of a changing economic climate.

To achieve the stated objective, this study employs a time-varying parameter approach, which adequately deals with potential parameter instabilities and nonlinearities, and effectively captures impact variations over time. Commonly employed conventional time-invariant linear regression models are based on restrictive functional form assumptions; they are thus generally susceptible to misspecifications that are capable of causing bias and inconsistency in parameter estimates when the functional form is unknown (Dogan et al. 2018). Moreover, factors such as energy policy changes, business cycles, and macroeconomic fluctuations can introduce nonlinearities and parameter instabilities into the relationship between FDI and environmental performance. Hence, a time-varying framework that adequately deals with all these challenges is adopted in this study.

Thus, this study specifically examines whether FDI inflows have a time-varying impact on carbon emissions amidst a changing economic climate and also determines the implication of the findings for Turkey's environmental sustainability targets, using a relatively updated time series data from 1970–2017.

This study contributes to existing literature both empirically and theoretically. On the empirical front, it is the first to directly examine the time-varying impact of foreign direct investment on carbon dioxide emissions in Turkey, while controlling for changes in the economic climate. On the theoretical front, the study further contributes to literature by showing that FDI-induced pollution did not become a major issue in Turkey until capital account liberalization was fully introduced in Turkey in 1989. Starting from 1980, fundamental economic policy changes, which eventually culminated into full capital liberalization in 1989, were introduced to address the macroeconomic imbalances experienced by Turkey in the 1970s. The resultant inflow of FDI has led to environmental problems in Turkey. This study thus contributes to literature and the body of knowledge both empirically and methodologically.

The remaining parts of the study are sectioned as follows; the "Literature review" section 2 reviews relevant literature, the "Data and methodology" section 3 presents the data and methodology employed, the "Results and discussion" section 4 provides and discusses the findings, while the "Conclusions and policy implication" section 5 concludes the study.

2.2 Literature review

Based on a review of existing studies related to this topic, this section is sub-divided into four—foreign direct investment (FDI) and carbon dioxide (CO_2) emission, economic growth and carbon dioxide (CO_2), energy consumption and carbon dioxide (CO_2), and urbanization and carbon emission.

2.2.1 Foreign direct investment and CO_2 emissions

Several studies have examined the connection between FDI and CO_2 emissions. Shahbaz et al. (2019) found that FDI has a positive effect on the environment. To et

al. (2019) utilized panel cointegration fully modified ordinary least squares (FMOLS) in examining the impact of FDI on environmental degradation in selected Asian countries over the period 1980–2016. They found that the impact of FDI on CO_2 emissions follows an inverted U-shaped pattern. That is, it leads to an increase in emissions until a turning point is reached, beyond which it reduces the emissions (EKC curve). According to Joshua et al. (2020), FDI positively impacts the environment mainly by introducing cleaner technologies and better management. They suggested that the inflow of FDI should be encouraged in order to improve the economy and reduce pollution. Other studies found a negative effect of FDI on environmental quality (Saboori, Sulaiman and Mohd 2012; Omri et al. 2014; Seker et al. 2015; Sarkodie and Strezov 2019). Hoffmann et al. (2005) analyzed the relationship between FDI and environmental pollution in 112 countries classified into three groups—low-income countries, middle-income countries, and high-income countries. Their findings showed that countries with low incomes attract more FDI, and the increased inflow of FDI raises the level of CO_2 emissions. Zomorrodi and Zhou (2017) employed the relationship between FDI and environmental quality in China for the period 2003–2014 using both time series regression and panel data regression. The result indicated that FDI has a significant but weak positive effect on environmental pollution. Haug and Ucal (2019) estimated the asymmetric impact on FDI on the environment. The conclusion reached on the basis of their findings is that FDI has no significant effect on CO_2 emissions in Turkey. Malik et al. (2020) found that FDI has a long-run positive impact on CO_2 emissions. Udemba et al. (2020) found that as FDI increases, CO_2 also increases in China.

2.2.2 Energy consumption and CO_2 emissions

Energy consumption is an important aspect of economic growth in any economy (Bekun et al. 2019a). The increase in energy use improves productivity. However, the use of energy also leads to greater carbon emissions (Mohiuddin et al. 2016; Bekun et al. 2019b; Adedoyin et al. 2020; Khan et al. 2020; Tong et al. 2020). Halicioglu (2009) examined the relationship among energy consumption, foreign trade, income, and CO_2 emissions in Turkey from 1960 to 2005 using time series data. Their results proved that energy consumption causes environmental degradation. Shahbaz et al. (2013a) also used the ARDL test and VECM technique to investigate the linkages among energy consumption, trade openness, economic growth, CO_2 emissions, and financial development in Indonesia. The empirical analysis confirmed that energy consumption increases CO_2 emissions. Using cointegration analysis, Bozkurt and Akan (2014) found a positive impact on environmental pollution by energy consumption. Gökmenoğlu and Taspinar (2016) discovered a negative relationship between energy consumption and environmental quality. Cetin et al. (2018) examined the impact of trade openness, energy consumption, financial development, and economic growth on CO_2 emissions from 1960 to 2013 in Turkey. Their findings revealed a long-run relationship among the variables, and unidirectional causality from energy consumption to CO_2 emission, indicating a positive relationship between energy consumption and environmental degradation. Akadiri et al. (2019) observed that environmental quality is adversely affected by energy production/consumption. Bekun et al. (2019a) claimed that energy consumption harms environmental quality, and therefore suggested replacing nonrenewable energy to renewable energy. Balsalobre-Lorente et al. (2018) examined the relationship among renewable energy consumption, trade openness, economic growth, natural resources, and CO_2 emissions in 5 EU

countries from 1985 to 2016. The study outcome showed that renewable energy consumption lowers CO_2 emissions, while trade openness and economic growth increase CO_2. Sinha and Shahbaz (2018) found that renewable energy has a significant negative impact on CO_2 emissions.

2.2.3 Economic growth and CO_2 emissions

Most of the studies on the relationship between economic growth and environmental performance have been carried out within the nonlinear environmental Kuznets curve framework. The EKC hypothesis states that economic growth positively increases pollution until a turning point is reached, beyond which economic growth starts to lower environmental pollution (Grossman and Krueger 1991; Stern and Common 2001; Tiwari et al. 2013; Khan et al. 2019). Tiwari et al. (2013) found that a long-run relationship exists between economic growth and environmental performance. They also found that the effect of economic growth on CO_2 emissions is nonlinear (inverted U-shaped), thus confirming the EKC hypothesis. Shahbaz et al. (2018) also validated the EKC analysis in their study and found a bidirectional connection between economic growth and environmental pollution. Saint Akadiri et al. (2020) reported that economic growth has a positive and significant effect on carbon emission both in the long and short run. Not all authors however support the EKC hypothesis, which reflects that environmental pollution cannot be solved simply by constant economic growth. Some of the studies have mixed conditions on how economic growth affects the environment (Narayan and Narayan 2010; Pal and Mitra 2017). Apergis (2016) used a panel and time series method to investigate the validity of EKC for 15 countries, and found that the relationship between output and CO_2 emissions postulates an inverted U-shape based on the level of development of a country. Atasoy (2017) examined the effects of economic growth on environmental quality from 1960 to 2010.

The study findings only validated the EKC hypothesis for 30 out of 50 states in the USA. Furthermore, Aye and Edoja (2017) examined the influence of economic growth on the environment, and found negative and positive effects of economic growth on environmental pollution both in the short and long run respectively. The study did not support the EKC hypothesis, but confirmed the existence of a U-shaped relationship. Some studies however failed to validate the EKC hypothesis (Shafik and Bandyopadhyay 1992; Roberts and Grimes 1997). HoltzEakin and Selden (1992) examined the relationship between per capita income and carbon dioxide emissions using panel data, and found that economic development does not alter CO_2 emissions. Etokakpan et al. (2020) confirmed the growth-induced energy consumption hypothesis in Turkey through a modified Wald test causality approach.

2.2.4 Urbanization and CO_2 emissions

Urbanization affects the economy positively and negatively. The positive effect of urbanization includes the improvement of infrastructure and technology, employment opportunities, high rates of transportation and communication, quality medical facilities, high standard of living, and quality education, which can in turn pollute the environment, affecting health and economic activities. McGee and York (2018) found that an increase in urbanization increases pollution. Mahmood et al. (2020) likewise observed that a rise in urbanization increases emissions due to the utilization of natural resources.

2.3 Data and methodology

2.3.1 Data

To examine the relationship between FDI and CO_2 emissions, annual time series data covering the period 1970–2017 is used. In addition to FDI (net inflows) and CO_2 emissions (metric tons), urbanization (urban population percent of the total

population), energy consumption (kilogram of oil equivalent per capita), and real GDP per capita (constant 2010 US$) are also included as control variables. Data on all the variables are sourced from the World Bank database. Table 2.1 presents a summary statistic of the variables used in the study.

Table 2.1: Summary Statistics

	Carbon emissions	Foreign direct investment	Energy use	GDP	Urbanization
Mean	178132.2	4390,000,000	1057.169	483000000000	34806637
Median	157992.7	753000,000	990.8995	406000000000	35021887
Maximum	395111.9	22000000,000	1806.653	1210000000000	60537696
Minimum	42639.88	10000000	522.1993	147000000000	13334606
Std. dev.	99593.65	6760000000	341.7258	287000000000	14282612
Skewness	0.492	1.372	0.426	0.904	0.091
Kurtosis	2.121	3.391	2.165	2.851	1.797
Jarque-Bera	3.479	15.365***	2.844	6.580	2.961

Note: ***$P < 0.01$

2.3.2 Methodology

This study employs a time-varying parameter (TVP) approach, which treats parameter estimations as functions of time. The rationale behind this choice is to address the shortcomings associated with constant coefficient estimations. Constant coefficient estimations are prone to mis-specification errors when no prior knowledge about the nature of the functional form exists. They therefore often produce biased and inconsistent results (Karimu and Brännlund 2013). Furthermore, factors such as policy, structural, and technological changes are likely to introduce nonlinearities into the relationship between FDI and carbon emissions. The TVP approach is well able to deal with parameter instabilities; regime shifts, structural breaks, and nonlinearities, as

well as effectively captures variations in the impacts of FDI on carbon emissions across time, with each time period having its own set of coefficients. Furthermore, the approach does not require stationary data series, as the state estimations are conditional upon their last realizations.

For this paper, the TVP model in a state-space is given thus:

$$\mathrm{Co2_t} = \mathrm{a_j} + \mathrm{X_t}\beta_\mathrm{t} + \mathrm{u_t} \quad (1)$$

$$\beta_t = \Phi\beta_{t-1} + v_t \quad (2)$$

$$\begin{pmatrix} u_t \\ v_t \end{pmatrix} = N\begin{pmatrix} \sigma^2 & 0 \\ 0 & R \end{pmatrix} \quad (3)$$

Equation (1) is the observation equation. $\mathrm{Co2_t}$ represents carbon emissions, X_t stands for the vector of regressors (FDI_t, $ENPC_t$, GDP_t, URB_t), β_t refers to the state vector, and u_t is the error term with zero mean and constant variance. The observation equation allows for time independence in the parameters. Equation (2) is the transition equation. Φ represents the k × k matrix, while v_t refers to the mutually independently distributed error term that is also independent of ut and distributed with zero mean and R variance. Equation (2) reveals the parameter movements. $a\beta_t$, as shown in Eq. (2), follows an AR(P) model and is therefore an unobservable random variable. This is useful in ensuring that parameter changes are free to occur at different points. The Kalman filter (Kalman 1960; Kalman and Bucy 1961) is employed in estimating the TVPs. The Kalman filter is selected because of the simplicity of its algorithm.

2.3.3 Results and discussion

As a preliminary test, Brock et al. 1996 test for nonlinear dependencies is first conducted to determine the appropriateness of the TVP approach. The result of the Brock et al. (BDS, 1996) nonlinearity test is reported in Table 2.2. The test outcome shows that the null hypothesis of iid residuals is rejected at 1% significance level

across various dimensions in all the variables (CO_2, FDI, ENPC, GDP, and URB). This confirms the presence of nonlinearities in the underlying data series and supports the choice of a TVP approach that is robust to such a problem. TVP estimations are next carried out to determine the impact of FDI on CO_2 emissions in Turkey across time. The time-varying coefficients are reported in Table 2.3, and the graphical plots of the significant coefficients are presented in Fig. 2.1.

Table 2.2: BDS nonlinearity test results

BDS statistics	Embedding dimensions				
Variables	*m* =2	*m* =3	*m* =4	*m* =5	*m* =6
Carbon emissions	0.175***	0.286***	0.361***	0.411***	0.446***
Foreign direct investment	0.136***	0.204***	0.255***	0.278***	0.276***
Energy use	0.175***	0.283***	0.358***	0.412***	0.449***
GDP	0.169***	0.275***	0.337***	0.370***	0.377***
Urbanization	0.198***	0.330***	0.424***	0.490***	0.540***

Notes:
(1) ***$P < 0.01$
(2) M represents dimension. Reported statistics are obtained from the application of the Brock et al.'s (BDS, 1996) test on the residuals of a VAR model for the selected variables

Table 2.3: Time-varying coefficient model

Year	Estimate	Standard error	T-stat
1971	-0.038	0.028	-1.342
1972	-0.031	0.015	-2.130
1973	-0.024	0.014	-1.741
1974	-0.023	0.014	-1.633
1975	-0.019	0.014	-1.351
1976	-0.014	0.016	-0.901
1977	-0.008	0.015	-0.507
1978	-0.011	0.015	-0.717
1979	-0.011	0.014	-0.803
1980	-0.012	0.015	-0.793
1981	-0.008	0.014	-0.587
1982	-0.004	0.014	-0.254

1983	-0.001	0.014	-0.097
1984	0.002	0.014	0.124
1985	0.008	0.014	0.546
1986	0.012	0.014	0.902
1987	0.018	0.014	1.314
1988	0.016	0.013	1.207
1989	0.020	0.013	1.589
1990	0.022	0.013	1.772
1991	0.023	0.012	1.857
1992	0.024	0.011	2.129
1993	0.027	0.013	2.109
1994	0.026	0.013	2.054
1995	0.030	0.012	2.413
1996	0.035	0.013	2.766
1997	0.037	0.012	2.975
1998	0.037	0.012	3.015
1999	0.037	0.012	2.941
2000	0.041	0.012	3.306
2001	0.034	0.012	2.897
2002	0.038	0.012	3.113
2003	0.040	0.012	3.350
2004	0.041	0.012	3.472
2005	0.041	0.011	3.675
2006	0.044	0.011	4.054
2007	0.047	0.011	4.386
2008	0.047	0.011	4.375
2009	0.048	0.011	4.330
2010	0.051	0.011	4.542
2011	0.053	0.011	4.856
2012	0.054	0.011	4.932
2013	0.054	0.011	4.909
2014	0.056	0.011	5.147
2015	0.056	0.011	5.197
2016	0.060	0.011	5.439
2017	0.063	0.011	5.667
Mean	0.043	0.012	3.771

Note: (1) *P<0.05 (2) Mean is the average of the significant coefficients

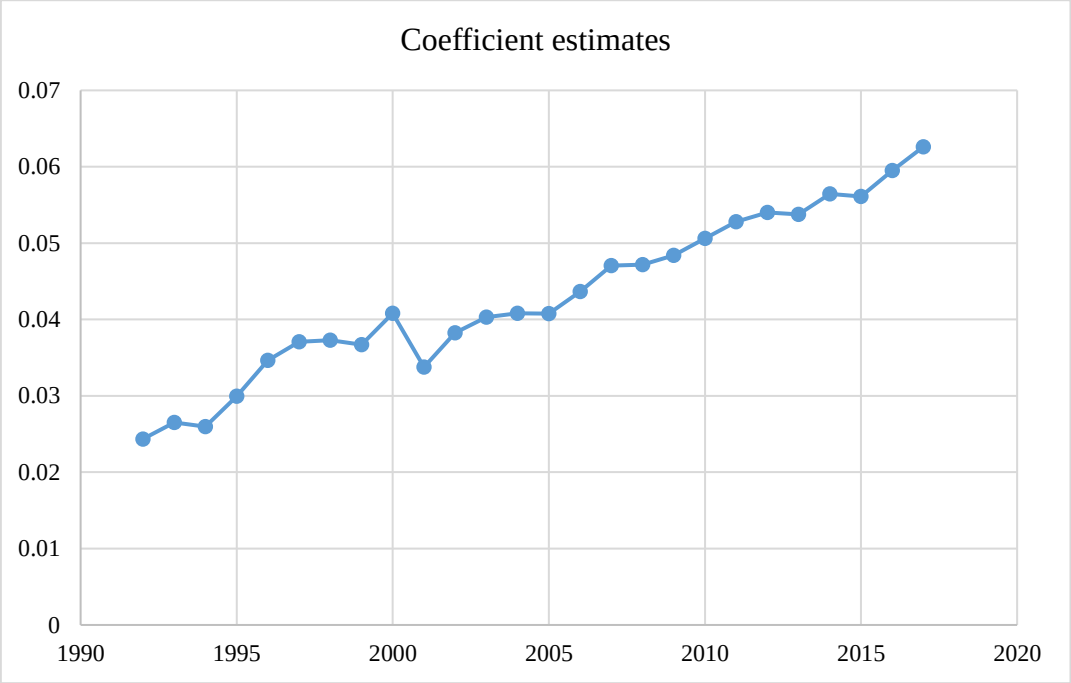

Figure 2.1: The evolution of coefficient estimates of the impact of FDI on CO_2 emissions in Turkey

The following can be deduced from the results; first, the time-varying coefficients fluctuate with time. Changes are noticeable in the coefficients and the changes are mainly in the form of an upward trend. This is an indication that the impact of FDI on CO2 emissions in Turkey has been on the rise over time. Second, the coefficients only became significant in 1992. This finding suggests that FDI-induced pollution did not become a major issue in Turkey until capital account liberalization was fully introduced in Turkey in 1989. Starting from 1980, fundamental economic policy changes, which eventually culminated into full capital liberalization in 1989, were introduced to address the macroeconomic imbalances experienced by Turkey in the 1970s. As shown by the results from this study, the resultant inflow of FDI has led to environmental problems in Turkey.

Third, slight fluctuations closely following the business cycle patterns of Turkey are also visible in the results. For instance, a slight fall in the size of the coefficient

occurred in 1994, a period characterized by a major currency crisis in Turkey. As a result of this crisis, a 6% decline occurred in output, a three-digit-level inflation was experienced; the currency lost over half of its value and the country lost half of its reserves. This finding shows that as a result of the slowing down of the economy, the adverse effect of FDI on the environment waned temporarily. A similar decline in coefficient size can also be seen in 2001. This may likewise be attributed to the severe 2000/01 banking crisis and the consequent political crisis of 2001 in the country. Overall, the results show that the environmental pollution caused by FDI slightly reduces during periods of economic downturn. Overall, the impact of FDI on CO_2 emissions in Turkey is predominantly positive. This positive relationship is in accordance with previous findings by authors such as Seker et al. (2015); Öztürk and Öz (2016); and Koçak and Şarkgüneşi (2018).

As expected, the effects of the control variables-energy use, GDP, and urbanization-are in accordance with economic theory and empirics. As shown in Table 2.4 and Figs. 2, 3, and 4 of the Appendix, the impacts of all three variables are positive and significant over the entire period sampled. The positive impact of energy use on carbon emissions is in alignment with the conclusions reached by Wang et al. (2011), Shahbaz et al. (2012), Shahbaz et al. (2013b), and Tang and Tan (2015). The positive relationship between GDP on carbon emissions likewise confirms the findings of Etokakpan et al. (2020). The findings also support the conclusions reached by McGranahan (2010), Sadorsky (2014), and Coskuner, Paskeh (2020) on the relationship between urbanization and carbon emissions

Table 2.4: Time-varying coefficient model

Year	Energy use	GDP	Urbanization
1971	1.003*	0.973*	0.648*
1972	1.003*	0.974*	0.648*
1973	1.003*	0.976*	0.648*
1974	1.003*	0.975*	0.648*
1975	1.003*	0.975*	0.648*
1976	1.003*	0.976*	0.648*
1977	1.004*	0.977*	0.648*
1978	1.003*	0.976*	0.648*
1979	1.003*	0.976*	0.648*
1980	1.003*	0.976*	0.648*
1981	1.003*	0.977*	0.648*
1982	1.003*	0.978*	0.648*
1983	1.003*	0.978*	0.648*
1984	1.003*	0.978*	0.648*
1985	1.003*	0.979*	0.648*
1986	1.003*	0.980*	0.648*
1987	1.003*	0.980*	0.648*
1988	1.003*	0.980*	0.648*
1989	1.003*	0.981*	0.648*
1990	1.003*	0.981*	0.648*
1991	1.003*	0.981*	0.648*
1992	1.003*	0.980*	0.648*
1993	1.003*	0.980*	0.648*
1994	1.003*	0.980*	0.648*
1995	1.003*	0.981*	0.648*
1996	1.003*	0.981*	0.648*
1997	1.003*	0.981*	0.648*
1998	1.003*	0.981*	0.648*
1999	1.003*	0.981*	0.648*
2000	1.003*	0.982*	0.648*
2001	1.003*	0.981*	0.648*
2002	1.003*	0.980*	0.648*
2003	1.003*	0.980*	0.648*
2004	1.003*	0.979*	0.648*
2005	1.003*	0.978*	0.648*
2006	1.003*	0.979*	0.648*
2007	1.003*	0.980*	0.648*
2008	1.003*	0.980*	0.648*
2009	1.003*	0.980*	0.648*
2010	1.003*	0.980*	0.648*

2011	1.003*	0.979*	0.648*
2012	1.003*	0.978	0.648*
2013	1.003*	0.976*	0.648*
2014	1.003*	0.976*	0.648*
2015	1.002*	0.975*	0.648*
2016	1.002*	0.976*	0.648*
2017	1.002*	0.976*	0.648*
Mean	1.003*	0.978*	0.648*

Notes: (1) *$P < 0.05$ (2) Mean is the average of the significant coefficients

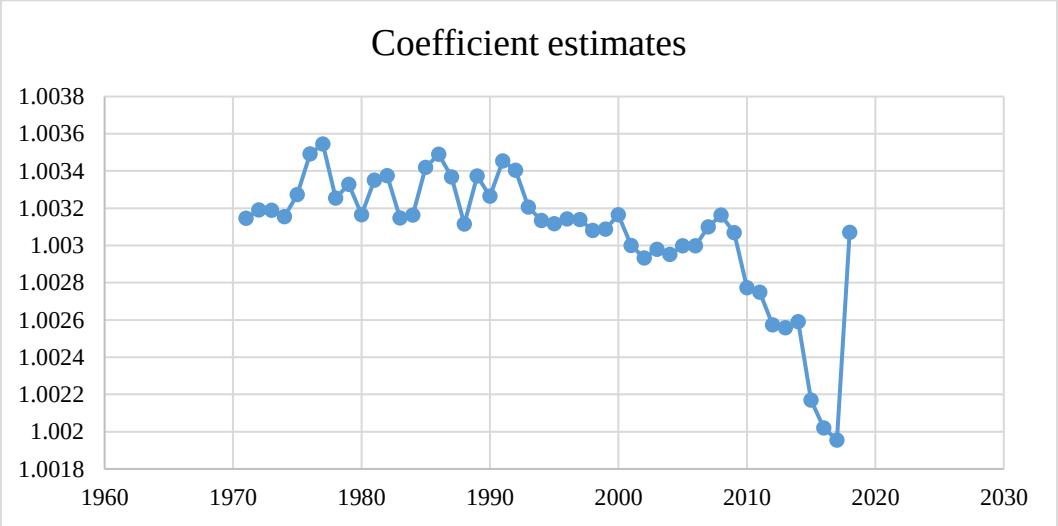

Figure 2.2: The evolution of coefficient estimates of the impact of energy use on CO_2 emissions in Turkey

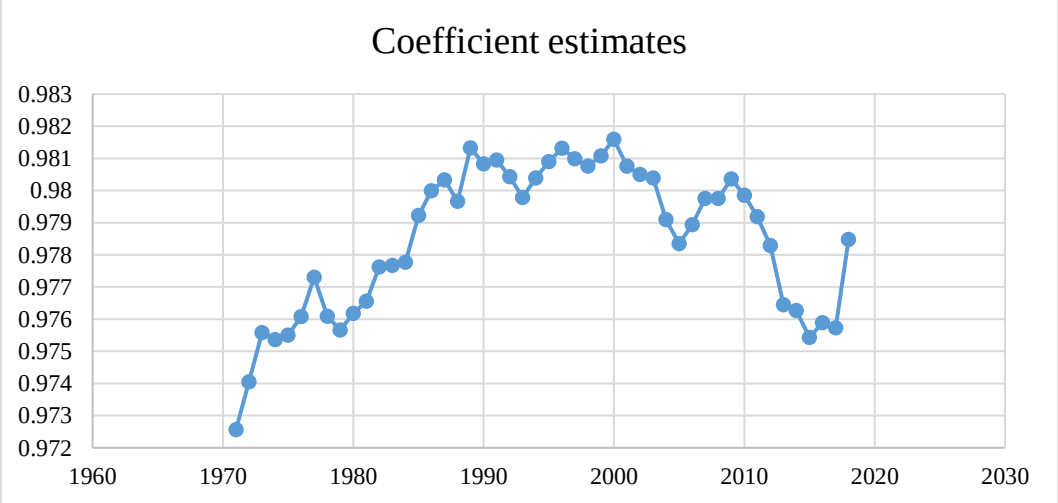

Figure2.3: The evolution of coefficient estimates of the impact of urbanization on CO_2 emissions in Turkey

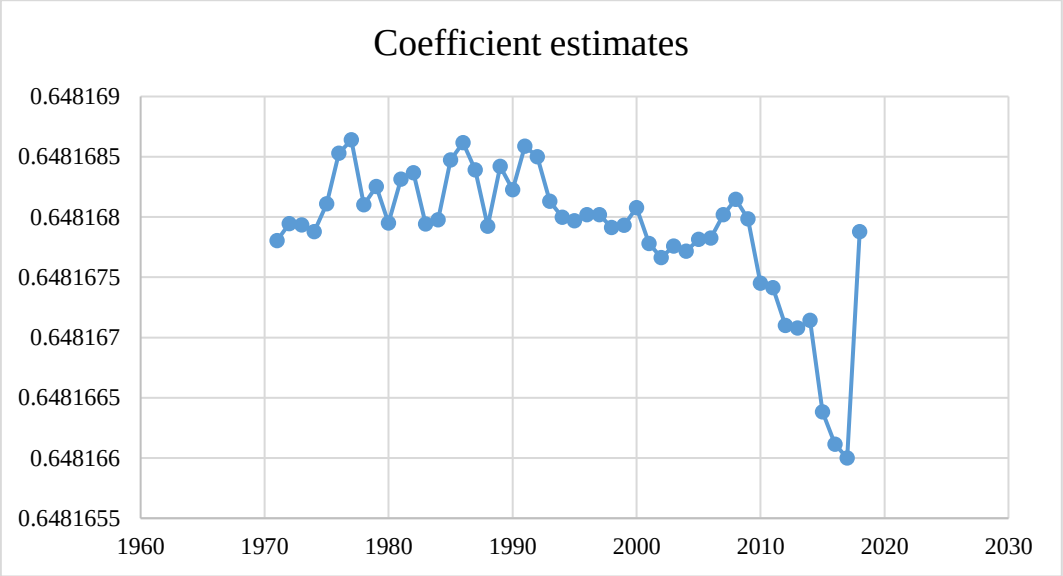

Figure 2.4: The evolution of coefficient estimates of the impact of urbanization on CO_2 emissions in Turkey

While the coefficients of energy use and urbanization remained stable over the said period, the coefficients of GDP recorded relatively large movements, and these variations closely reflected the economic patterns of the country.

2.3.4 Conclusion and policy implication

The aim of this study was to verify the time-varying nexus between foreign direct investment and carbon dioxide emissions, and also examine the significance of modeling the asymmetric relationship among the variables observed. Annual time series data for the period 1970–2017 was used. The selected variables were foreign direct investment, urbanization, energy consumption, real GDP per capita, and CO2 emissions. This A TVP approach, which treats parameter estimations as functions of time, was employed in order to address the shortcomings associated with constant coefficient estimations. Furthermore, the TVP approach captures parameter instabilities, regime shifts, structural breaks, and nonlinearities, and effectively controls variations in the impacts of FDI on carbon emissions across time, and with each time period having its own set of coefficients.

The following deductions can be made from the results; (1) the time-varying coefficients fluctuate with time in an upward trend, indicating that the impact of FDI on CO2 emissions in Turkey has been on the rise over time. (2) The coefficients only became significant in 1992, suggesting that FDI-induced pollution did not become a major issue in Turkey until capital account liberalization was fully introduced in Turkey in 1989. Starting from 1980, fundamental economic policy changes, which eventually culminated into full capital liberalization in 1989, were introduced to address the macroeconomic imbalances experienced by Turkey in the 1970s. As shown by the results from this study, the resultant inflow of FDI has led to environmental problems in Turkey. (3) Slight fluctuations closely following the business cycle patterns of Turkey are also visible in the results. For instance, a slight fall in the size of the coefficient occurred in 1994, a period characterized by a major currency crisis in Turkey. As a result of this crisis, a 6% decline occurred in output, a three-digit-level inflation was experienced; the currency lost over half of its value, and the country lost half of its reserves. The study finding shows that as a result of the slowing down of the economy, the adverse effect of FDI on the environment waned temporarily.

Having empirically established the time-varying negative impact of foreign direct investment inflows on environmental sustainability in Turkey, this study leads to the conclusion that the inflows of FDI into an economy adversely affect the environmental quality of the host country. From a policy viewpoint, it is therefore suggested that the government should do the following: (i) enact policies that emphasize green FDI inflows, (ii) enforce tighter environmental policies that deter the immigration of dirty production processes, (iii) engage in mixed and country-specific environmental policies in combating pollution, (iv) ensure domestic investors adhere strictly to the nation's environmental policies, and (v) enact policies to foster mutual cooperation

and understanding between the local and foreign stakeholders in a manner that drives the use of energy-saving technologies in production activities and the use of renewables in place of fossil fuels to control environmental hazards for both the immediate and future generations.

Chapter 3

ASSESSING THE ROLE OF AGRICULTURE AND ENERGY USE ON ENVIRONMENTAL SUSTAINABILITY: EVIDENCE FROM RALS COINTEGRATION TECHNIQUE

3.1 Introduction

Environmental and ecological degradation is a significant problem globally. This is one of the major areas of concerns in Turkey due to its ambitious economic expansion program which aim to place it as one of the ten largest economies globally by the year 2023. According to the European Environmental Agency (EEA), Turkey is the twentieth largest emitter of greenhouse gases (GHGs) mainly from its industrial, agricultural, and waste sectors. In other to its targets, the country uses environmentally friendly and traditional technologies in its agricultural sub-sectors. These activities harm environmental quality through machinery use, unethical waste disposal, climate change issues, (rainfall and temperature), deforestation, and soil degradation. Turkey is witnessing environmental degradation influenced by human activities from past to present due to its agricultural practices. Presently, the country is experiencing a myriad of environmental problems due to its massive agricultural production which often releases harmful substances such as methane (CH_4), nitrous dioxide (N_2O), and carbon dioxide (CO_2) through the practice of fertilization and the use of pesticides to increase

output. Additionally, tillage and desertification affect land, soil, air, and water quality (Čirjak, 2020).

Agriculture is an important sector for both developing and emerging economies. It has the propensity to engender higher-income generation, provide food and raw material to non-agricultural sectors, export, and reduce unemployment/poverty especially for labor abundant countries, such as Turkey. Turkey is among the leading economies of the Middle-East and Mediterranean region in terms of population and productive land. It is also one of the 20 largest economies globally and 7th largest producer and exporter of agricultural products. Turkey's agricultural sector plays a primary role in its economy by contributing majorly to income, export, employment rate, and rural growth (FAO, 2021). The agricultural sector covers 23% of the country's economy with 1000 square meters of farm size. The government validates that the National Agricultural Project intends to improve agricultural productivity in the county thereby making it one of the five major producers by 2023.

Additionally, the increased demand for energy by the rapidly growing population in the country over the years necessitated the use of traditional sources such as fossil fuel and coal which are high GHG emitters. According to Bekun et al. (2019), energy production/consumption leads to the improvement in productivity and economic growth of any economy. Consequently, these increases result in environmental destruction by releasing harmful emissions. According to the world resources institute (2020), the energy sector is the major emitter of GHG with 73% of emissions. However, Turkey's energy supply is more of imports which are unfavorable to the environment given to the rise in emission. Several works of literature on the energy-environment nexus have highlighted the adverse consequences of energy use on the

environment. For example, Oguz et al. (2020) and Sharif et al. (2020), asserted in their work that increase in energy use raises ecological footprint in Turkey. Furthermore, Tong et al (2020), Adedoyin et al (2020), and Cetin et al. (2018), Khan et al (2020), also indicated the inverse relationship of energy use on the environment in their studies. However, some of the studies revealed the positive effect of energy consumption as per emission reduction on the environment. (Sinha and Shabaz (2018); Balsalobre-Lorente et al. (2018); Etokakpan et al (2020).

Turkey is one of the fastest-growing economies in the world open to economic development (Akadiri et al.; 2019). Foreign Direct investment (FDI) takes part in the improvement in the growth rate and living standard of the country's economy, giving that in February 2021 FDI increased by 975USD mn. This shows that FDI which is one of the major sources of economic growth in Turkey (Katircioglu, 2009; Aga, 2014), could affect the environment positively or negatively. The positive impact of FDI inflows on the environmental quality has considered FDI as an additional indicator to environmental quality. Before now, existing literature which carefully examined the significant nexus between FDI and environmental quality concluded with different directions. For instance, Joshua et al. (2020) and Shahbaz et al. (2019), stated in their paper that FDI inflows influence the environment positively. On the contrary, some of the researchers found that FDI influences the environment negatively by increasing carbon dioxide emission (Seker et al 2015, Malik et al 2020, Sarkodie and Strezor 2019, and Udemba et al 2020, while others found out that FDI has no statistically significant impact on the environment (Haug and Ucal, 2019). However, to the best knowledge of the authors, there are no significant number of studies carried out to examine the relationship among FDI and ecological footprint to capture the overall effect of FDI on the environment.

A number of environmental literatures have observed the Environmental Kuznets Curve (EKC) hypothesis, which was first observed by Grossman and Krueger (1991) for the linkage between economic growth and environmental degradation. Thus, the EKC reflect that environmental quality reduces due to the increase in economic growth. This indicates that environmental damages increase first and later reduces with improvement in economic growth. The first phase impact of the curve shows that environmental quality deteriorates gradually with increase in growth from resources that trigger environmental degradation. As economic growth continues to rise, environmental damages surges in the same manner, showing an inverted U-shaped relation. Udemba (2020) revealed the positive linkage between economic performance and ecological footprint. A group of authors have implemented and affirmed the EKC hypothesis for different economies. Katricioglu and Katricioglu (2018) for Turkey, Tiwari et al (2013) for India, Shahbaz et al (2012) for Pakistan, Balcilar et al. (2010) for G-7 countries. However, others such as Richmond and Kaufmann (2006), and Agras and Chapman (1999) did not find any affirmation of the EKC hypothesis.

In the literature, some scholars applied CO_2 as proxy to environmental degradation to analyze the EKC hypothesis. Pata (2018) investigated the EKC hypothesis for Turkey indicating an inverted U-shaped relationship between economic performance and CO_2 emission. In addition, the EKC hypothesis was confirmed by Bulut (2021), Sharif (2020), Agboola and Bekun (2019), Dogan (2018), Shahbaz et al (2018), Pata (2018), Aslan et al (2018), and Ozcan (2018) Katircioglu (2017), Katircioglu and Taspinar (2017), Seker et al (2015), using CO_2 emission as a factor of environmental degradation. On the contrary, some studies cannot support the cogency of EKC hypothesis (see Alola and Donve (2021), Akbostanci et al (2009). However, others such as Ozcan (2018) and Malik (2021) did not confirm the EKC hypothesis for

Turkey. Recently, some studies by Bulut (2021), Selim and Rivas (2020), Godil (2020), and Fakher (2019) applied the Ecological Footprint (EF) as proxy to environmental degradation to scrutinize the EKC hypothesis. The studies affirmed the validity of the U-shaped relationship between the ecological footprint and economic performance in Turkey. In the contrary, Köksal et al (2020) and Ozcan et al. (2018) indicates that EKC hypothesis is not valid in Turkey. However, our study utilizes ecological footprint as proxy to environmental problem.

This study aims to examine Turkish's engagement in minimizing environmental degradation to promote environmental quality by examining the influence of agriculture, energy use and FDI on environmental degradation. To the best of our knowledge, there are scanty number of studies examining the effect of agricultural productivity on environmental degradation and none of the researches have examined the effect of agriculture, energy use, and FDI on ecological footprint using the new econometric technique, RALS analysis for Turkey. Ecological footprint has been used as a proxy to environmental sustainability compared to other researchers who mostly used CO_2 emission. Therefore, in this study, the Residual Augmented Least Squares (RALS) procedure which was developed by Im and Schmidt (2008) was utilized to analyze the stationarity level of each variable and their cointegration relationship. This model was used since it particularly allows us to obtain the information from nonnormal errors in estimations. Moreover, by using nonnormally distributed errors, both the RALS unit root test and RALS-EG cointegration test give more powerful results compared to traditional models. This can be assumed as one of our contributions to the existing literature. Moreover, the EKC hypothesis was examined by means of ecological footprint as a measure of environmental damage. Several recommendations can be provided for Turkey from the results of this research work.

This section is followed by literature reviews (2) while section (3) gives information about data and methodology and followed by empirical results (4). Section (5) concludes the study and gives policy recommendations.

3.2 Literature review

Past studies have emphasized the effect of agriculture, energy, FDI, and economic growth on the environment of different nations. Excessive agricultural production and energy consumption have, however, necessitated the release of excessive greenhouse gas emissions. Table 1 shows notable trend of agriculture, energy, and FDI on environmental degradation of different economies especially that of Turkey. Turkey recently has become more vulnerable to environmental changes leading to a rise in emission. Although, policies are already adopted to control the problems of the environment and climate change to achieve environmental sustainability. Most of the econometric models shown in Table 1 have strived to extend the analysis of the growth-energy-environmental degradation relationship with applicable variables. Nevertheless, there is still no consensus in the literature about the effect of the variables. Many studies have examined the EKC hypothesis in Turkey with conflicting results. Some of the studies validate the EKC hypothesis while others do not support the validity of the EKC hypothesis. Hence, the present study conveys the EKC hypothesis and examines the nexus among the variables using the RALS model. Several reviews on the role of agriculture, energy consumption and environmental quality. Recently, many studies investigated the nexus among agriculture, total energy with environmental degradation. For example, Dogan (2016) examined the relationship between agricultural performance and environmental pollution for Turkey and indicated a significant negative effect on environmental pollution. An increase in agricultural production improves the quality level of the environment and confirmed

the EKC hypothesis. In Turkey, Bas et al. (2021) inspected the environmental effect of agriculture, export, and energy utilization using data from 1991-2019, applying the Fully Modified Ordinary Least Squares and Autoregressive Distributed Lag models (FMOLS and ARDL measure). The outcome of the study revealed that agriculture value-added and export alleviate environmental problems, increase in energy utilization influence carbon emission. The environmental Kuznets Curve (EKC) hypothesis is validated for agriculture value-added and carbon emission linkage. In another study, Udemba (2020) explore the link among agriculture, FDI and EF for India from 1975 to 2016, using the linear and nonlinear ARDL. They concluded that the agricultural sector influences the environment negatively with a positive significant connection. Similarly, Ullah et al (2018) applied the annual data from 1972 to 2014 to inspect the causal linkage between agricultural practice and environmental degradation in Pakistan and revealed that agricultural ecosystem has a positive effect on environmental pollution thereby showing that any rise in agricultural practices results in a similar rise in CO_2 emission. In addition, Chandio et al. (2020) examined the cereal production response to CO_2 emissions from 1968 to 2014 in Turkey, using the ARDL model. The results reveal that CO_2 emissions harm agricultural production affecting cereal yield negatively in Turkey. These papers mostly used CO_2 emissions as an indicator for environmental degradation, however, there are scanty number of studies investigating this relationship by using ecological footprint.

Table 3.5: Summary of past literature on agriculture, energy consumption, foreign direct investment, and the environmental quality.

Authors	**Dates**	**Country/ Region**	**Variables**	**Method**	**Results**
Akbostanci et al (2009)	1968-2003	Turkey	CO_2, GDP	Time series model	The results do not confirm the EKC hypothesis

Halicioglu (2009)	1960-2005	Turkey	GDP, CO_2, EC, foreign trade	Bound test	Economic growth increases carbon emission
Ozturk and Acaravci (2010)	1968-2005	Turkey	CO_2, GDP, EC, employment	ARDL model and Granger causality	EC increases CO_2 emission
Jebli and Youssef (2015)	1980-2009	Tunisia	EC, GDP, CO_2	ARDL model and VECM	Failed to support the validity of EKC curve
Seker et al (2015)	1974-2010	Turkey	GDP, CO_2, EC, FDI	Bounds test approach and Hatemi-J test	FDI increase CO_2 emission Support the validity of EKC hypothesis
Jebli and Youssef (2017)	1980-2011	North Africa	AGR, CO_2, EU	Panel cointegration technique and Granger causality test	AGRP reduces CO_2 emission, while REC influences CO_2 emission
Katircioglu and Taspinar (2017)	1960-2010	Turkey	CO_2, EC, RGDP, FD	Unit root and cointegration	Confirmed the EKC hypothesis
Liu et al (2017)	1970-2013	ASEAN economies	AGR, NRE, RE, CO_2	VECM	AGR and EC reduces environmental degradation. NRE increase CO_2 The study do not support the U-shaped EKC
Cetin et al (2018)	1969-2017	Turkey	EC, CO_2, GDP, FD	ARDL	EC and GDP increase CO_2
Dogan (2018)	1971-2010	Turkey	CO_2, RGDP, EC, AGR	Bound test and ARDL	AGR increase CO_2.Confirm the present of an inverse U- shape EKC curve
Gokmenoglu and Taspinar (2018)	1971-2014	Pakistan	EU, AGR, GDP, CO_2.	FMOLS	EU and AGR both increase CO_2 Verified the agric-induced EKC hypothesis
Ozcan et al (2018)	1961-2013	Turkey	EF, GDP	Bootstrap time-varying causality approach	Result did not confirm EKC hypothesis
Shahbaz et al (2018)	1955-2016	France	EC, FDI, GDP, CO_2	Bootstrap Bound test	Validated the EKC hypothesis FDI influences CO_2 emission

Bekun et al. (2019)	1960-2016	BRICS	RGDP, EC, gross capital formation, and CO_2	Maki cointegration test	EC causes increase in CO_2 emission
Agboola and Bekun (2019)	1981-2014	Nigeria	CO_2, EC, RGDP, FDI, AGR, TO	ARDL and Granger causality	FDI mitigate pollution Support the EKC hypothesis. AGR has a positive effect on CO_2 emission
Fakher (2019)	1996-2016	Developing countries	GDP, EF, EC, FDI	Bayesian model averaging and Weighted averaging Least square	FDI increase EF Concur with the EKC hypothesis
Olanipekun et al (2019)	1996-2015	African countries	AGR, GDP, EF, Population	Pooled mean group (PMG)	AGR aggregate environmental degradation
Pata (2019)	1969-2017	Turkey	TO, RGDP, CO_2	ARDL	Validates the EKC hypothesis
Udemba (2019)	1995Q1-2016Q4	China	FDI, CO_2, GDP, EC, and Tourism arrivals	ARDL and Granger causality	FDI contribute to CO_2 emissions
Etokakpan et al (2020)	1970-2014	Turkey	EC, RGDP, EFP, globalization	Modified Wald test	Inverse relationship between EC and EFP
Selim and Rivas (2020)	1971-2014	Uruguay	GDP, FDI, EFP, and EC	ARDL and VECM	Energy use increase EFP Verified EKC hypothesis
Usman et al (2020)	1985-2014	USA	RGDP, EF, EC, FD	ARDL approach	EC and RGDP apply negative pressure on EF
Bachri and Normelani (2020)	1960-2018	Indonesia	FDI, GDP, CO_2	ARDL and Granger causality	FDI have a sign impact on CO_2 emissions and economic growth
Sabir et al (2020)	1984-2019	South Asia	EF, EC, GDP, FDI, Political institution	PARDL and Granger causality test	FDI and energy consumption have a positive and statistically significant impact on environmental degradation
Bulut (2021)	1970-2016	Turkey	GDP, EF, EC, FDI	ARDL technique	FDI reduces EF Confirmed the EKC hypothesis
Malik (2021)	1970-2014	Turkey	GDP, EC, CO_2, TO, Labour force	GMM technique	EC increases CO_2 Non-existence of EKC

Philip et al (2021)	1970-2017	Turkey	FDI, GDP, CO_2, URB	Time-varying parameter approach	FDI contribute to environmental degradation

Note: CO_2 is carbon dioxide emission, GDP is gross domestic product, EKC is environmental Kuznets curve, EC is energy consumption, VECM is vector error correction model, FDI is foreign direct investment, AGR is agricultural production, REC is renewable energy consumption, FD is financial development, NREC is nonrenewable energy consumption, ARDL is autoregressive distributed lag, EF is ecological footprint, TO is trade openness.

3.3 Data and Methodology

3.3.1 Data

This study examines the long-run effect of agriculture sector on environmental sustainability incorporating with energy use, foreign direct investment, and economic performance in Turkey. Data covered for this study is on annual basis from 1970 to 2017. Accordingly, the descriptions of investigated variables with their assertion of measurements and sources are given in Table 3.6. The data, except ecological footprint (EFP), obtained from World Bank World Development Indicators. Global Footprint Network official website was used to obtain Ecological footprint data.

Table 3.6: Variables' descriptions

Variables	**Measurements**	**Sources**
Ecological Footprint (EFP)	Global Hectares per capita (ghp)	Global Footprint Network official website
Agriculture, Value added (Agri)	% of GDP	World Bank
Energy Use (EU)	Kg of oil equivalent per capita	World Bank
Foreign Direct investment, net inflow (FDI)	% of GDP	World Bank
Gross Domestic Product per capita (Y)	Constant at 2010 prices	World Bank
Square of Gross Domestic Product per capita (Y^2)	Constant at 2010 prices	World Bank

3.3.2 Methodology

To investigate specified relationship among investigated variables, the model was constructed for the study given below.

$$\ln EFP_t = \alpha_0 + \beta_1 \ln AGRI_t + \beta_2 \ln EU_t + \beta_3 \ln FDI_t + \beta_4 \ln Y_t + \beta_5 \ln Y_t^2 + \varepsilon_t \quad (4)$$

Where ε_t represents error term in the model at t=1970, 1971, ...2017; $\beta_1, \beta_2 \ldots . \beta_5$ are the coefficients of the explanatory variables and show the magnitude of the nexus among explanatory variables and environmental sustainability. α_0 is used for the intercept. All the variables are in their logarithmic forms to stabilize the variance of a series.

Turkey prioritizes the economic growth to environmental sustainability for previous decades. Besides being an energy-import-dependent country and using traditional energy sources in its production process, its fragile financial market is sensitive to fluctuations in foreign capital flows. Therefore, in this study, the coefficients of all investigated variables are expected to have statistically significant and positive effect on ecological footprint.

To measure the significance and magnitude of these series on environmental sustainability, first, the integration order of the series is tested for stationarity using Augmented Dickey Fuller (ADF) test and a newly established Residual Augmented Least Squares ADF (RALS-ADF) test. Then, the existence of the long-run steady-state relationship among variables was examined by means of classical Engle and Granger (EG) and RALS-EG cointegration tests. With this, the direction, and the magnitude of long-term effects of explanatory variables and their significance on environmental sustainability were anticipated by means of fully modified ordinary least squares

(FMOLS) method. Finally, to test causal relationship of the investigated variables were examined by conducting newly established bootstrap leveraged Hacker and Hatemi-J (2012) causality test.

3.3.2.1 Cointegration test

To test the presence of the long-run steady-state relationship amongst investigated variables two-steps Engle and Granger (EG) (1987) methodology was employed which was developed due to t-statistics and residuals. At the first step, the unit root tests were employed to investigate the level of integration for each variable. To do this, ordinary least squares regression equation was estimated.

$$y_t = \phi z_t + \nu_t \tag{5}$$

$$\Delta \hat{\nu}_t = \phi_0 + \phi_1 \Delta \hat{\nu}_{t-1} + \sum_{i=1}^{k} \phi_{i+1} \Delta \hat{\nu}_{t-1} + u_t \tag{6}$$

In Equation 6, if the error term is not normally distributed, the higher moments of residuals cover information on the nature of non-normal residuals. Therefore, since the Im and Schmidt (2008)'s RALS process can be employed to cover high moment information found in non-normal errors in linear model frameworks and which can also give more powerful results with nonnormally distributed error terms. To this end, the EG procedure suggested by Lee et al. (2015) amplified RALS procedure and suggested the new term for new cointegration test by using 2nd and 3rd moments of the residuals. These residuals are obtained from classical cointegration tests. This term which extends Equation 3 can be given below

$$\hat{\omega}_t = g\left(\hat{u}_t\right) - \hat{D}_t - u_t \hat{K}_t\,,\ t = 1, 2, \ldots T$$

Here, $\hat{u}_t$ is the residuals obtained from Equation (6) and

$g\left(\hat{u}_t\right) = \left[\hat{u}_t^2, \hat{u}_t^3\right]$, $\hat{D} = \frac{1}{T}\sum_{i=1}^{T} g(\hat{u}_t)$ and $\hat{K} = \frac{1}{T}\sum_{i=1}^{T} g'(\hat{u}_t)$.

Subsequently Meng et al. (2017), the expression for RALS procedure is defined as follows.

$$\hat{\omega}_t = \left[\hat{u}_t^2 - \eta_2, \hat{u}_t^3 - \eta_3 - 3\eta_2 \hat{u}_t \right]', \tag{7}$$

Where $\eta_j = T^{-1}\sum_{i=1}^{T} \hat{u}_t^j$. Accordingly, by adding Equation (7) into Equation (6), the RALS cointegration regression can be obtained and given below.

$$\Delta\hat{v}_t = \phi_1 \hat{v}_{t-1} + \sum_{i=1}^{k} \phi_{i+1} \hat{v}_{t-1} + \hat{\omega}_t \lambda + \upsilon_t \tag{8}$$

Where the null hypothesis of no cointegration relationship among investigated series (ϕ_1=0) can be tested by using standard t-statistics. The asymptotic distribution of the test statistic can be represented as $t^* \rightarrow \rho \cdot t + \sqrt{(1-\rho^2)} \cdot H$. Here, t indicates for EG test statistics and t^*represents RALS-EG tests statistics. H shows the standard normal random variable and ρ is the correlation coefficient among obtained residuals from Equation (8) and Equation (6).

3.3.2.2 Leveraged bootstrapped causality analysis

Toda and Yamamoto (1995) progressed Granger test (1969) to analyze the direction and magnitude of the causal relationship among variables which can be different order of integration. Meanwhile, Hacker and Hatemi-J (2006) suggested the new properties to Toda and Yamamoto (1995) and investigated the size properties of MWALD test which allows to obtain stronger results with small-sampled size analysis. To this end, they also suggested the bootstrap disposition to decrease the size of distortions. According to Monte Carlo simulation, it was suggested that compared to asymptotic distribution, MWALD test has lesser size of distortions with prior selection of the lag lengths.

To this end, Hacker and Hatemi-J (2012) newly established causality test was used in this study to investigate the way and magnitude of the causal relationship among investigated variables within the framework of leveraged bootstrap technique. Hacker and Hatemi-J (2012) claimed that this test gives reliable and strong results compared to other traditional causality tests especially for small-sampled analysis. To the best knowledge of the authors, none of the studies yet used this technique to analyze the causal relationship among investigated variables for Turkey. This can be emphasized as one of the main contributions to the existing literature.

This model uses vector autoregressive model VAR(p) given below to obtain the results.

$$x_t = a + B_1 x_{t-1} + \ldots + B_p x_{t-p} + \nu_t \quad (9)$$

Where the dimensional vectors (n×1) are represented with a, v_t and x_t. Also, the n×n dimensional parameter matrix is represented as B_1 (where i ≥ 1) in equation 9.

Moreover, to get the stronger and reliable results, Hacker and Hatemi-J (2012) emphasized an alternative formulation for lag length selection (equation 10). This formula is the combination of Hannan-Quinn and Schwarz information criteria and named as Hatemi-J information criterion (HJC).

$$HJC = ln(\, det\, \hat{\vartheta}_j) + j\left(\frac{n^2\, ln\, S + 2n^2\, ln(\, ln\, S)}{2S}\right), j = 0,1,2, \ldots\ldots p \quad (10)$$

In this equation, the factor of the anticipated maximum possibility variance-covariance matrix of error-term in the VAR(j) model was represented by $det\, \hat{\vartheta}_j$. The natural logarithm form was symbolized as Ln and number of variables were represented by n and S was used for sample size (Hatemi-J and Uddin, 2014).

3.4.1 Empirical results

The aim of this study is to scrutinize the long-run nexus of agriculture sector on environmental sustainability incorporating with energy usage, economic performance and foreign direct investment. Together with this, the direction and the magnitude of causal relations among selected variables were aimed to be analyzed. To this end, our estimation procedure is of three-fold. First, the integration order of investigated variables are checked by using newly suggested model, RALS-ADF and confirmed with traditional ADF test. Then, the cointegration relationship was analyzed. Finally, newly established leverage bootstrap causality test (Hacker S and Hatemi-J A, 2012) was performed to inspect the causal link among the variables.

To examine the integration order of the variables, Augmented Dickey-Fuller and RALS-ADF unit root tests were performed (see Table 3.7). The outcome of these tests fails to reject the null hypothesis for all variables at their level form. Thus, it was concluded that the shocks have permanent effects for all investigated variables. However, all series are found stationary at their first differenced form. This means they are all integrated order one, which is the prominent condition for the cointegration analysis of the series.

Table 3.7: Stationarity tests

Variable	**ADF**	**RALS ADF**	$\boldsymbol{\rho^2}$
lnEFP	-0.75 (1)	-1.57 (1)	0.89
Δ lnEFP	-8.97 (0)*	-8.76(0)*	0.94
lnY	0.87	1.16	0.64
Δ lnY	-6.53 (0)*	-9.72 (0)*	0.64
lnY^2	0.86	1.67	0.65
Δ lnY^2	-6.48 (0)*	-9.19 (0)*	0.67

lnAGRI	-0.64 (0)	-0.38 (0)	0.94
Δ lnAGRI	-6.44(0)*	-7.100(0)	0.92
lnFDI	-1.13 (1)	-1.65 (1)	0.79
Δ lnFDI	-9.74(0)*	-11.25(0)*	0.82
lnEU	-1.64 (0)	-1.50 (0)	0.80
Δ lnEU	6.54(0)*	-7.05(0)*	0.81

Note:
(1) * stands for 1% significance level.
(2) The values into the parenthesis presents the best lag length obtained by applying recursive t-stat.
(3) The critical value of ADF test at 1%, is -3.58.
(4) The critical value of RALS-ADF at 1% is -4.45.

Table 3.8 presents the cointegration test results. Since the RALS-EG test statistic (-5.738) is lesser than the critical value (-4.80) at one percent significance level, null hypothesis of no cointegration relationship among investigated variables is rejected. The result of this test was confirmed with traditional EG cointegration test and concluded the existence of long-run steady-state relationship among investigated variables.

Table 3.8: Cointegration test results

Methods	**K**	**Test Statistics**	ρ^2
EG	0	-5.358*	-
RALS-EG	0	-5.738*	0.916

Note:
(1) (*) stands for %1 significance level and the optimum lag length determined using recursive t-statistics presented with k.
(2) The critical value for EG test at 1%significance level is -5.02.
(4) The critical value for RALS- EG test at 1% significance level is -4.80.

After confirmation of the cointegration relationship, the long-run effects and the magnitudes of the variables were estimated with the fully modified ordinary least squared method. This method suggested by Phillips and Hansen (1990) that produces reliable estimates for small sample size analysis under the incidence of serial

correlation and endogeneity problems. Table 3.9 demonstrates the estimation output for this test.

In line with our expectations, all explanatory variables have statistically significant and positive effect on ecological footprint in Turkey. This means that, although having different significance level, a 1% rise in the share of agriculture in GDP, energy use, share of FDI in GDP and economic performance will deteriorate environmental sustainability with different magnitudes in Turkey. In particular, a 1% increase in energy use will lead to deteriorate the sustainability of the environment by 1.043%, on average. This demonstrates that Turkey still could not reduce the import dependence of traditional energy sources and still behind the desired level of renewable energy use. Moreover, the coefficient of agriculture sector indicates that a 1 percent rise in the share of agriculture will lead to a 0.056% increase in ecological footprint in Turkey. Thus, the environmental sustainability level of Turkey will be deteriorated by 0.056%. Together with this, financial development also has positive but relatively small significant effect on environmental degradation level in Turkey. This means that, a 1% rise in FDI inflow causes 0.016% increase in ecological footprint. Finally, the inverted U-shaped relationship was confirmed with economic performance and environmental sustainability in Turkey. This means that, a 1% increase in economic performance of Turkey will lead to increase the deterioration level of environment by 5.408% up to threshold level, then for every 1% rise in the economic performance will be the remedy for environmental sustainability and contribute to the sustainability by 0.269%, on average.

Table 3.9: Results of FMOLS

Variables	Dependent Variables: InEFP			
	Coef	**Std Error**	**t-Stat**	**P-value**
InAGRI	0.056***	0.030	1.848	0.072
InEU	1.043**	0.989	-0.949	0.034
InFDI	0.016*	0.051	-2.703	0.010
InY	5.408*	1.459	3.706	0.001
InY^2	-0.269*	0.074	-3.621	0.001
C	-25.099*	6.255	-4.012	0.000
	R^2	0.945	Adjusted R^2	0.938

Note: The %1, %5 and %10* significance levels are represented by *, ** and ***, respectively. Table 3.9 presents the results of bootstrap leverage causality test results.

The null hypothesis of no causal relationship among variables can be rejected if the calculated MWALD statistic is greater than bootstrap critical values. The results of this test reveal the bidirectional causal relationship of environmental sustainability with agriculture sector as well as FDI and economic performance. Moreover, the one-way causal linkage running from environmental sustainability to energy use in Turkey. However, other unidirectional causal relationships have investigated that running from FDI to economic performance and agriculture sector, from agriculture sector to energy use and from economic performance to energy consumption. Finally, the feedback causal relationship has investigated among FDI and energy use. These results emphasize that an increase in FDI will lead increase in finance in the country. This leads to not only an increase in economic performance as well as production and profitability, which cause a greater demand for energy and higher environmental degradation by consuming more sources and emitting greenhouse gasses to the environment.

Table 3.10: Causal relationship results

Variables	Var (p)	M-WALD	Critical values (Bootstrap)		
			1%	5%	10%
InEFP → InAGRI	1	10.702*	8.81	5.079	3.598
InAGRI → InEFP	1	16.393*	7.714	4.383	3.021
InEFP→ InFDI	1	6.730**	8.43	4.498	3.134
InFDI→ InEFP	1	8.096**	9.015	5.112	3.696
InEFP → InEU	1	22.209*	16.884	12.003	9.624
InEU→ InEFP	1	0.566	7.347	4.000	2.808
InEFP → InY	1	20.557*	12.100	6.803	4.494
InY→ InEFP	1	4.917**	7.416	4.043	2.796
InAGRI→ InFDI	1	0.843	7.508	3.949	2.761
InFDI→ InAGRI	1	13.372*	12.081	7.089	5.188
InAGRI→ InEU	1	7.514**	10.259	6.300	4.59
InEU→ InAGRI	1	3.237	8.823	5.172	3.53
InAGRI→ InY	1	5.749	12.145	7.821	5.929
InY→ InAGRI	1	0.314	10.024	6.091	4.362
InFDI→ InEU	1	10.042**	10.574	6.111	4.415
InEU → InFDI	1	6.620**	7.677	4.153	2.957
InFDI→ InY	1	9.675**	10.775	6.503	4.833
InY→ InFDI	1	2.022	7.307	4.175	2.886
InEU → InY	1	3.561	12.945	8.661	6.632
InY→ InEU	1	4.065***	9.337	5.620	3.798

Note:
(1) %1, %5 and %10significance levels are indicated with *, ** and ***, respectively.
(2) HJC information criteria were used for the optimal lag length determination.
(3) critical values were acquired by 10.000 replications (bootstrap).

3.5 Conclusion and policy recommendation

Turkey, as an emerging economy, is amongst the world's 20 largest economies. It aimed to place in top 10 largest economy globally by year 2023. To this end, it set 11th development plan, which covers years from 2019 to 2023. One of the main objectives in this plan is to develop an efficient agricultural sector in terms of

economically, environmentally, and socially sustainable. However, Turkey is still behind the targeted level of doing environmentally friendly production since it prioritized the economic growth to the environment and using traditional way of production. Thus, agricultural productivity in Turkey continuously harms the environmental quality through machinery use, unethical waste disposal, climate change issues, deforestation, and soil degradation. As a Paris Agreement and Kyoto Protocol signatory, there are no specific regulation or restriction on Turkish agricultural production. However, it aimed to reduce emission level by 21% via integrating renewable energy sources to the production, reducing the use of traditional energy sources, controlling the use of fertilizers and supporting modern practices.

Previous studies have tried to investigate the way and the scale of the effect of agricultural production on the environmental degradation. The researchers have been mostly focused on single pollutant such as carbon dioxide emission, Sulphur dioxide etc. while investigating this relation. However, using single pollutant for measuring environmental degradation can be weak in giving detailed and clear information. Thus, in this study, ecological footprint has been considered as more comprehensive and reliable indicator which accumulates many emission sources to measure the level of environmental degradation. Therefore, in this study, we aimed to examine Turkish's engagement in minimizing environmental degradation to promote environmental quality by examining the influence of agriculture, energy use and FDI on environmental degradation. To this end, the RALS method was utilized to analyze the stationarity level of each variable and their cointegration relationship which allow us to obtain the stronger results under the non-normality assumption.

The results depict the authors claims and hypothesis and indicated that all investigated variables have cointegration relationship. Moreover, the explanatory variables used in this study have positive and statistically significant effect on environmental degradation level. In other words, a rise in the agricultural production, energy use, foreign direct investment and economic growth in Turkey cause deterioration in the environment. Besides, the inverted U-shaped EKC hypothesis was confirmed in this study which shows that a rise in economic performance leads to increase the level of environmental degradation up to certain threshold level, then, a rise in economic performance will contribute to environmental sustainability. On the other hand, the results of leveraged bootstrap causality test showed that there are bidirectional causal relationships of environmental sustainability with agriculture sector as well as FDI and economic performance. Also, the feedback causal relationship has investigated among FDI and energy use. Moreover, the unidirectional causal relationship running from environmental degradation to energy use and from FDI to economic performance and agriculture sector. The other unidirectional causal relationship running from agriculture sector to energy use and from economic performance to energy use.

The empirical outcomes of the analysis help us to suggest the following recommendations to the policy makers and environmentalist. Since FDI will lead increase in finance, it leads to not only an increase in economic performance as well as increase production and profitability, which cause a greater demand for energy and raise environmental degradation by consuming more sources and emitting greenhouse gasses to the environment. Therefore, firstly, the policymakers should regulate and attract the FDI for better environmental conditions. Also, the government/policymakers should regulate and sustain its economic performance with new progressed direct and indirect taxation technique to promote low carbon emitted

and environmentally friendly way of production. Since there are still high import dependency on traditional energy sources (fuel and coal) and lofty proportion of fossil fuel sources in the energy mix, it should revisit its energy policy and change its energy mix by integrating more renewable/cleaner energy sources into energy supply mix. This may lead to decrease in energy dependency and thus lead to increase in economic and environmental sustainability. On the other hand, policymakers should strengthen agricultural management. Turkey, in its agricultural production, should develop long term sustainability policies in its agricultural production and include the use of new environmentally friendly technologies in production, increase the share of clean energy sources in its energy mix and promote agricultural waste recycling.

Chapter 4

ASSESSING THE INFLUENCE OF URBANIZATION AND ENERGY ON CARBON EMISSION OF TURKEY: EVIDENCE USING THE NEW RALS ANALYSIS

4.1 Introduction

In recent times, the quest for better life has increased global urban population tremendously, indicating that 55% of the world population now reside in urban centers. This trend which is expected to surge continually in the coming years has the propensity to contribute to sustainable growth by boosting global GDP through productivity. This can however, lead to a myriad of challenges, such as increase in unemployment, energy consumption, climate change, health crisis, economic crisis, and social crisis (World Bank, April 2020).

Urbanization is the process whereby urban areas grow faster in the percentage of the population that migrated from rural areas to the cities for social benefits. This phenomenon has made Turkey to experience a very rapid increase over the past six decades leading to improvement in Turkish urban settlements (International Finance Cooperation, IFC 2021). In accordance with World Bank Document, Turkey's urban population increased from 30 to 55.3 million within the year 1989 to 2014 with a 0.9 percent increase annually. Also, according to the United Nations, the current population of Turkey as of May 2021 is 85 million people, while the urban region is

75.7% of the population. The increase in the number of persons living in urban centers has improved the economic growth through high industrialization, high technology, education, productivity, etc. Among the fastest growing urban regions are, Istanbul, Ankara, Izmir, Antalya, and Adana (Cadavid and Zhukova). Notwithstanding its benefit on the economy, increase in urban population confer some negative triggers such as increase unemployment, decreased health and wellbeing as well as heightened environmental pollution.

Environmental pollution is one of the major sources of concern in most countries. The rapid growth of urban population in Turkey has brought about environmental challenges such as environmental degradation, deforestation, and climate change. Currently, increased industrialization and the use of combustible materials to power vehicles as well as other movable equipment raise carbon dioxide (CO_2), emitter. Turkey's economic growth has been strongly affected by environmental pressures likely due to economic development and population growth. However, according to OECD Turkey is the largest and fastest growing economy among the OECD economies, powered by increase in population and economic growth (OECG Environmental Performance Reviews 2019).

Energy consumption is rising globally. Moreover, high urbanization increases both industrial and residential energy consumption as well as the use of natural resource which consequently leads to environmental degradation. Energy consumption is growing as the population increases and income rises across several nations of the world. Both renewable (wind, biomass, geothermal, solar, and hydropower) and nonrenewable (coal, oil, and natural gas) energy impact the environment depending on the technology used. However, nonrenewable energy generally does more harm than

renewable energy sources such as air and water pollution, public health damage, and global warming emissions (Hannah Ritchie 2020).

The rise in population and economic growth of Turkey has strongly increased energy consumption. Turkey aims to increase electricity production to 50% by 2023 from renewable energy to meet up the high energy demand. Policies are set to increase renewable energy production to reduce the high dependence on fossil fuel (oil and gas) imports to Turkey and enhance energy efficiency such as, diversifying the source of oil and gas supply, increase the domestic production of oil and gas, hard coal and lignite reserves, hydro, as well as improving renewable energy (wind and solar) supply in an efficient manner to meet the demand growth (IEA, March 2021). Akadiri et al (2020) stated that for every increase in energy consumption, environmental degradation escalates with the growing population in Turkey. Most studies argue that energy consumption contributes to environmental degradation. According to them, energy consumption stimulates economic growth by providing efficient energy supply to industrial and residential sectors. However, continual energy consumption can result in high environmental destructions (Bekun et al 2019, Sarkodie and Adams 2018, Emir and Bekun 2018).

Nonetheless, carbon neutrality is ensured to achieve environmental sustainability for the present and future growth of Turkey, which is of major significance to policymakers. This prompts the aim of this study which is to analyze the possible ways of reducing environmental degradation in Turkey, by investigating the nexus of urbanization, energy consumption, foreign direct investment (FDI), and economic growth. To our knowledge, this is the first study to look into the relationship between urbanization and energy usage, FDI, and ecological footprints in Turkey by applying

the RALS test introduced by Im and Schmidt (2008) to check the cointegration among the variables. This model is used in order to get the proper and stronger results under nonnormally distributed variables. None of the studies yet investigate the effect of urbanization on ecological footprint by using RALS-EG for cointegration analysis and RALS-ADF for testing integration order of the nonnormally distributed variables. In this study, FMOLS model was also employed to check the long-run effect and their significance on environmental sustainability.

The remaining part of the work are portion as follows: Literature review, Data and methodology, results and, lastly, Conclusions and policy implication.

4.2 Literature review

Previous studies have emphasized the effect of urbanization, energy, and FDI on the environment of different economies. The excessive growth in urbanization and energy consumption have increase emissions globally. Table 1 reveals the notable trend of urbanization, energy utilization, and FDI on the environment of different countries. The association between urbanization and environmental degradation is a controversial subject with many different findings. Some scholars argue that urbanization influences environmental quality negatively while others suggest that urbanization affect the environment positively by increasing the quality of the environment. Pata Uk (2018) argue that urbanization, along with financial development and energy consumption drives environmental degradation in Turkey. Ahmed et al (2020) report that urbanization positively impacts ecological degradation through energy use in industrial, residential, and transport sector. Urbanization contributes to the footprints by increasing waste generation and demand for infrastructure. Similarly, Al-Mulali and Ozturk (2015) indicate that urbanization,

along with energy consumption increase environmental damage in MENA countries. On the contrary, using time series data for Sri Lanka, from 1978 to 2014, the finding of the study by Gasimli, Gamage, and Shafiq (2019) revealed that the relationship between urbanization and environmental degradation is significantly negative, meaning urbanization does not lead to environmental damage. Tupy M. (2015) reports that urbanization has a positive impact on environmental quality by minimizing degradation due to efficient public facilities. Also, Fan et al (2006) confirmed in their results that urbanization does not lead to environmental damage depending on the levels of development.

The nexus between energy consumption and environmental sustainability has been studied by several researchers. According to Sharif et al (2020) energy utilization has a positive impact on the ecological footprints of Turkey, while high utilization of renewable energy reduces footprints in the long-run. Stated that, the volume of the impact of non-renewable energy on ecological footprints is higher than that of renewable energy. Employing the ARDL and Toda-Yamamoto models for Romania from 1990-2014, the findings of the study by Emir and Bekun (2018) stated that energy demand elevates carbon emissions. Renewable energy impacts economic growth and environmental sustainability positively. Additionally, Alola 2019, Akadiri (2019), and Balcilar et al (2019) stated that renewable energy is the pathway for environmental sustainability.

Foreign Direct Investment influences the economic growth of economies positively through the inflows of foreign capital. However, in return foreign investments affect the environment positively or negatively. FDI contributes to environmental damage through the inflows of technology referred to as the pollution haven hypothesis, while

on the contrary pollution halo hypothesis refers to when FDI inflows reduce environmental damages. Applying the heterogeneous panel causality method, Sabir et al (2020) confirm that FDI and energy consumption have a positive and statistically significant effect on environmental degradation in South Asia through the inflows of technology and the use of old production mechanisms. Abdouli et al (2018) confirm the FDI halo hypothesis. Stated that FDI and population density reduces carbon emissions. Udemba (2021) applied the nonlinear and asymmetric method to investigate the positive and negative impact of FDI on the environment, which shows that FDI has the potential to reduce environmental quality. Haug and Ucal (2019) stated that FDI has no significant long-run effects. An increase in FDI does not influence carbon emissions, rather carbon emission is influenced by urbanization and financial development.

Table 4.11: Recent literature review

Authors	**Year**	**Countries**	**Variables**	**Results**
Destek (2021)	1970-2017	Turkey	URB, GDP, HC, IND, CO_2	URB influences environmental degradation
Ahmed et al. (2020)	1970-2016	China	Ecological footprints, URB, human capital, and natural resources	URB and natural resources increase ecological footprints
Asongu et al (2020)	1980-2014	13 African countries	CO_2 emissions, URB, GDP, RENC and NRENC	URB impact the environment with least effects compared to other variables

Ulucak et al. (2020)	1992-2016	BRICS countries	EF, NRR, RGDP, REN, URB	Renewable energy and urbanization reduce ecological footprint
Nathaniel et al. (2020)	1990-2016	13 MENA countries	EF, GDP, URB, RENC and NRENC	URB influence environmental degradation
Bachri and Normelani (2020)	1960-2018	Indonesia	FDI, GDP, CO_2	FDI have a sign impact on CO_2 emissions and economic growth
Udemba (2019)	1995Q1-2016Q4	China	FDI, CO_2, GDP, energy use, and tourism arrivals	FDI contribute to CO_2 emissions
Sarkodie and Strezov (2019)	1982-2016	Developing countries	FDI, GDP, ENC, CO_2 emission	Positive effects of ENC on environmental degradation
Bekun et al. (2019)	1960-2016	BRICS countries	RGDP, energy use, gross capital formation, labour and CO_2 emission	energy consumption causes increase in CO_2 emission
Danish and Khan (2019)	1992-2016	BRICS	URB, REN, natural resources, and EF	URB and renewable energy decreases EF
Wang et al. (2018)	1980-2011	170 developed and developing countries	URB, GDP, and CO_2 emission	URB affects the environment based on country's income level
Gokmenoglu and Taspinar (2018)	1971-2014	Pakistan	CO_2, energy use, agriculture, and GDP	Energy use has inelastic and positive impacts on CO_2 emission
Sarkodie and Adams (2018)	1971-2017	South Africa	Urban population, CO_2, energy use, political institutional quality, REN and NREN, and GDP	Increase in NREN increases CO_2 emissions. Increase in REN reduces emissions.
Charfeddine (2017)	1970-2015	Qatar	GDP, URB, ENC, FD, and EF	URB increases EF

Lin S et al. (2017)	1991-2013	53 countries	URB, CO_2, and economic growth	URB has little influence on CO_2 emissions in low income countries
Busu and Busu (2017)	2007	Romania	URB, CO_2, GDP, renewable energy	URB has negative impact on CO_2 emissions with higher effects compared to other variables
Charfeddine and Mrabel (2017)	1975-2007	15 MENA countries	URB, EF, RGDP, energy use, fertility rate and political institutional	URB decreases EF by improving the environment
Ozatac et al. (2017)	1960-2013	Turkey	URB, ENC, GDP, CO_2, TO, FD	URB and ENC have a positive effect on environmental degradation
Nasreen et al (2017)	1980-2012	South Asian countries	EC, CO_2, GDP, population density, and financial stability	EC and GDP increase CO_2 emission
Wang et al (2016)	1985-2014	BRICS	URB and CO_2 emission	URB prompt the increase of CO_2 emission
Shahbaz et al. (2016)	1970Q1-2011Q4	Malaysia	GDP, CO_2, TO, ENC, and URB	Economic growth influences environmental degradation.
Gokmenoglu and Taspinar (2016)	1974-2010	Turkey	ENC, CO_2, GDP, and FDI	Economic growth causes increase ENC. ENC causes CO_2 emissions.
Al-Mulali and Ozturk (2015)	1996-2012	MENA countries	URB, EC, TO, industrial development and EF	URB and energy use drives ecological footprints
Destek and Ozsoy (2015)	1970-2010	Turkey	URB, ENC, GDP, GLB, CO_2	URB and ENC influences environmental pollution.
Xu and Lin (2015)	1980-2012	China	CO_2, GDP, URB	URB increases CO_2 emissions

Sharma (2011)	1985-2005	69 countries	GDP, ENC, TO, and CO_2 emission	ENC have a positive effect on CO_2 emission UEB have negative effects on CO_2 emission

Note: URB is urbanization, CO_2 is carbon emission, GDP is gross domestic product, EF is ecological footprint, FDI is foreign direct investment, TO is Trade openness, RENC is renewable energy consumption, NRENC is non-renewable energy consumption, FD is financial development, ENC is energy consumption, NRR is natural resource rent.

4.3 Data

The main goal of. The period covers from 1970 to 2017. Following the literature, the model constructed for this study is given below.

$$lnEFP_t = \alpha_0 + \beta_1 lnEU_t + \beta_2 lnFDI_t + \beta_3 lnURB_t + \beta_4 lnY_t + \beta_5 lnY^2_t + \varepsilon_t \quad (11)$$

The $lnEFP_t$ stands for ecological footprint per capita of a global hectare (gha) and used as an indicator for environmental quality. The historical data for it is obtained from the Global footprint network. Moreover, $lnEU_t$ stands for energy use (kg of oil equivalent per capita), $lnFDI_t$ indicates for foreign direct investment net inflow (% of GDP) and $lnURB_t$ is used for urbanization (percentage of total population). lnY_t and square of it (lnY^2_t) are utilized to examine long-run effect of economic performance of the Turkey on its environmental quality. At the same time, they are used to test the environmental Kuznets Curve hypothesis and to answer the discussion of prioritizing economic growth to environment. The data for these variables are acquired from World Bank WDI database. α_0 is the constant term and ε_t is the error term in the model. β_1, β_2, β_3, β_4 *and* β_5 are the elasticities of investigated variables.

Since Turkey is import-dependent country that prioritizes economic expansion over environmental quality, this analysis predicts that increased energy use and

urbanization would lead environmental deterioration. Thus, their coefficients are expected to be positive in the model. However, because the new investments cause capital inflow in Turkey, this will lead to cause developed and environmentally friendly structure in economy. Therefore, its coefficient is expected to be negative.

4.4 Methodology

To investigate these coefficients, firstly, Augmented-Dickey Fuller (ADF) and residual Augmented Least Squares ADF (RALS-ADF) have been applied to check the stationarity of investigated variables. After that, the presence of the long-run relationship among these variables was examined by employing classical cointegration analysis, i.e. Engle and Granger (EG), and newly developed RALS-EG (Lee et al. 2015). Besides, the long-run coefficients are obtained by applying the Fully Modified Ordinary Least Square model (FMOLS) and lastly, causality relationship among variables have been analysed by employing Engle and Granger causality test.

To test the cointegration among investigated variables in Turkey, the EG methodology was employed in two steps. Engle and Granger (1987) cointegration test developed based on t-statistics and residuals. Thus, in the first step. The level of integration order of the variables were determined. After that, it was concluded that the order of integration is one. Then, Ordinary least square regression was estimated.

$$y_t=\beta z_t+u_t \tag{12}$$

After estimating the $\hat{u}$ residuals, ADF was conducted.

$$\Delta\hat{u}_t = \alpha_0 + \alpha_1\hat{u}_{t-1} + \sum_{i=1}^{k}\alpha_{i+1}\Delta\hat{u}_{t-1} + e_t \tag{13}$$

Higher moments of the residuals include information on the nature of non-normal residuals if the errors in the equation are not normally distributed. The Im and Schmidt (2008) RALS technique can make use of additional high-moment information

discovered in nonnormal errors obtained from linear models. In this context, RALS procedure can give more robust and powerful results when error terms are not normally distributed. To this end, EG cointegration test and RALS procedure was augmented by Lee et al (2015) to conduct more powerful cointegration results. The 2nd and 3rd moments of the residuals of the classical cointegration analyses are used in this new model to create new term. To do so, the previous equation was extended with following term.

$$\widehat{w}_t = h(\hat{e}_t) - \widehat{D} - \hat{e}_t\widehat{K}_t \quad t = 1,2,3, \dots \dots \dots T \tag{14}$$

Here, $\hat{e}_t$ stands for the residuals gathered from equation 3 and $h(\hat{e}_t) = [\hat{e}_t^2, \hat{e}_t^3]$,

$\widehat{D} = \frac{1}{T}\sum_{i=1}^{T} h(\hat{e}_t), \widehat{K}_t = \frac{1}{T}\sum_{i=1}^{T} h'(\hat{e}_t)$.

With the light of Meng et al. (2017) study, $\widehat{w}_t$ is detected as follows:

$$\widehat{w}_t = \left[\hat{e}_t^2 - m_{2,}\hat{e}_t^3 - m_3 - 3m_2\hat{e}_t\right] \tag{15}$$

where, $m_j = T^{-1}\sum_{i=1}^{T} \hat{e}_t^{\,j}$.The RALS cointegration regression is acquired by adding equation 5 into equation 3.

$$\Delta\hat{u}_t = \alpha_1\hat{u}_{t-1} + \sum_{i=1}^{k} \alpha_{i+1}\Delta\hat{u}_{t-1} + \widehat{w}_t\vartheta + \omega_t \tag{16}$$

The null hypothesis of no cointegration ($\alpha_1 = 0$) is evaluated for this equation using normal t-statistics. For the asymptotic distribution of the test statistic, the following equation is developed.

$$t^* \to \varphi.t + \sqrt{1-\varphi^2}.Z \tag{17}$$

Here, t and t* stands for EG and RALS-EG test statistics, respectively. Moreover, standard normal random variable is indicated with Z, and long-run correlation between residuals ($\hat{e}_t$) and (ω_t) stands with φ.

4.5 Empirical Results

In previous studies, a vast number of researches have investigated the determinants of ecological footprint in Turkey. However, none of them has not yet been studied on these variables with these techniques. The ADF and RALS-ADF stationarity tests have been employed for investigated variables to test their integration order which is the core condition for most of the cointegration tests. Table 4.12 shows the output of these tests and proves that all investigated variables are stationary at their first differenced. In other words, all investigated variables are integrated order one. This also means that all the shocks have permanent effects on these series. Thus, the results enable the investigation of long run relationship and cointegration among investigated variables.

Table 4.12: Unit root tests results

Variable	**ADF**	**RALS ADF**	$\boldsymbol{\rho^2}$
InEFP	-0.7278 (0)	-0.3256 (0)	0.184
Δ InEFP	-12.940 (0)*	-7.970 (0)*	0.764
InY	0.218(0)	0.528(0)	0.640
Δ InY	-6.583(0)*	-9.898(0)*	0.633
InY^2	0.409(0)	0.951(0)	0.643
Δ InY^2	-6.563(0)*	-9.715(0)*	0.644
InFDI	-1.133(1)	-1.650(1)	0.792
Δ InFDI	-9.736(0)*	-11.247(0)*	0.816
InEU	-1.243(0)	-1.533(0)	0.809
Δ InEU	-6.460(0)*	-6.949(0)*	0.837
InURB	-1.954(2)	-0.500(2)	0.339
Δ InURB	-2.843(1)***	-2.722(1)***	0.322

Note:
(1) * and *** denotes 1%, and 10% significance level respectively.
(2) The values into the parenthesis presents the optimum lag length obtained by utilizing recursive t-stat.
(3) The critical values of ADF test at 1%, 5% and 10% are -3.58, -2.93 and -2.60, respectively.

The following table shows the cointegration test results obtained by employing EG and RALS-EG tests. In both cointegration tests (EG and RALS-EG), the estimated test statistics are less than the tests' critical value at 1%. Therefore, it can be concluded that the null hypothesis of no cointegration is rejected and the presence of long-run relationship among variables is confirmed.

Table 4.13: Results of cointegration test

Techniques	**K**	**Test Stat**	$\boldsymbol{\rho^2}$
RALS-EG	0	-24.184**	0.981
EG	0	-8.249*	-

Note:
(1) Significance level of %1, %5 and %10 are denoted with *, ** and *** respectively.
(2) Optimum lag length is denoted with k.
(3) %5 and %1 critical value for EG test are -4.32 and -5.02, for RALS-EG -4.54 and -5.16, respectively.

Further, Table 4.14 presents long-term relationship among investigated variables. In the outcome, the coefficients of independent variables parallel with the hypotheses expected for Turkey. The coefficient of energy use is positive and has highly statistically significant effect on ecological footprint. It confirms high deterioration on environment. Therefore, in this case, one percent increase in energy use in Turkey will lead to deteriorate the environment by 2.67%, on average. This also implies that Turkey has yet to achieve the desired level of green energy output. This may be because of high demand on low quality fuel consumption and high level of deforestation in Turkey. These findings are aligned with Cetin et al (2018) and Ozturk and Acaravci (2013) studies.

The coefficient of urbanization shows that the effect is statistically significant and positive on ecological footprint. One percent increase in urbanization in Turkey will hampers the environmental sustainability by 4.15%. These outcomes are consistent

with previous studies Koyuncu et al (2021). On the other hand, the coefficients of FDI inflow and economic performance of Turkey depicts the opposite results as energy use and urbanization. This means, the higher the capital inflow to Turkey will cause more development and lead to improve the environment in long run. One per cent increase in FDI inflow cause a decline in the deterioration level by 0.222%. Meanwhile, the coefficient of economic performance, in the outcome, presents the highly significant and negative effect on EFP whereas, its square is positive and significant. So here, it confirms the existence of the U-shaped environmental Kuznets curve hypothesis in Turkey. This indicates that at the beginning, an increase in economic performance leads to the decline in EFP, i.e. the condition of environment improves, after the threshold level, a further increase in economic performance will deteriorates the environment. One percent increase in economic performance will decrease EFP level by 8.04%, then after the threshold stage, one percent upsurge in economic performance leads to rise the EFP level by 1.45%. This finding is aligned with the previous results given by Katircioglu and Katircioglu (2018) and Godil et al. (2020).

Table 4.14: Long-term estimation results (FMOLS)

Variables	**Dependent Variable: InEFP**			
	Coefficient	**Standard Error**	**t-Statistic**	**Prob.**
LEU	2.672**	1.266	2.109	0.0410
LFDI	-0.222***	0.059	-3.743	0.0006
LURB	4.147**	1.657	2.502	0.0164
LY	-8.038*	17.892	-4.490	0.0001
LY^2	1.447*	0.3197	4.535	0.0000

Notation: ***, ** and * denotes the significance in %10, %5 and %1 respectively.

Furthermore, causality relationship among investigated variables tested by employing simple Granger causality test. Table 4.15 presents the results of Granger causality test. The outcomes reveal that energy use Granger causes ecological footprint while no

evidence of causality was investigated from ecological footprint to energy use. Moreover, there are unidirectional Granger causality running from FDI inflow, urbanization, and economic performance to ecological footprint. The feedback Granger causality found between FDI inflow and energy use as well as urbanization and energy use. The unidirectional Granger causality investigated from economic performance to energy use whilst, two-way Granger causality has investigated between urbanisation and FDI inflow. Furthermore, the unidirectional Granger causality running from economic performance to urbanization and FDI.

Table 4.15: Causality test results

Null Hypothesis:	**Obs**	**F-Statistic**	**Prob.**
LEU → LEFP	47	3.36510	0.0734
LEFP → LEU		0.54629	0.4638
LFDI → LEFP	47	3.68875	0.0613
LEFP → LFDI		0.67031	0.4174
LURB → LEFP	47	4.85697	0.0328
LEFP → LURB		0.22214	0.6397
LY → LEFP	47	3.51271	0.0675
LEFP → LY		0.01514	0.9026
LFDI → LEU	47	6.61993	0.0135
LEU → LFDI		10.0418	0.0028
LURB → LEU	47	3.35133	0.0739
LEU → LURB		6.46141	0.0146
LY → LEU	47	11.3007	0.0016
LEU → LY		2.03147	0.1611
LURB → LFDI	47	12.1528	0.0011
LFDI → LURB		3.04899	0.0878
LY → LFDI	47	10.8475	0.0020
LFDI → LY		1.37734	0.2469
LY → LURB	47	3.75575	0.0591
LURB → LY		0.16112	0.6901

4.6 Conclusion and policy implication

This study mainly focused on the nexus among urbanization and environmental sustainability with the help of energy use, foreign direct investment, and economic performance in Turkey. Time series data were used from 1970 to 2017. Turkey has one of the rapidly growing urban population, majorly due to its high industrialization, commercialization, social advantages and services. This prompts the increase in energy consumption which in return leads to a number of challenges for the environmental sustainability. We applied different approaches with the purpose of testing the current state of Turkish environment performance and its capacity to alleviate environmental deterioration. Notably, we observed the findings from RALS-EG analysis by (Lee et al. 2015) to check cointegration among the variables. The long run relationship consistency was checked by employing Engle and Granger (EG) analysis. The cointegration relationship among the variables were confirmed. Besides, the FMOLS model was applied to check the significant and long-run effect of the investigated variables on environmental sustainability.

Contradicting with expectations, the existence of the U-shaped EKC hypothesis was confirmed. This indicates that an increase in economic performance leads to the decline in ecological footprint by improving the quality of the environment then later, as economic performance continues to increase will deteriorates the environment. A 1% increase in economic performance reduce the level of ecological footprint by 8.04%, then later, 1% increase in economic performance lead to the rise in ecological footprint level by 1.45%. This confirms the EKC hypothesis of Godil et al (2020).

The results obtained show that urbanization hinders environmental sustainability. The coefficient of urbanization is statistically significant and positive on the ecological footprint. Indicating, an increase in urbanization will increase the environmental degradation in Turkey. Also, the coefficient of energy use is statistically significant and positive on ecological footprint. Indicating that increase in energy use will lead to the rise in environmental degradation. Contrarily, the coefficient of FDI and economic performance indicated that any increase in capital inflows and GDP in Turkey will improve development and environmental quality. The causality test results show that all the variables are seen transmitting to ecological footprint in a one-way causal relationship.

The study suggests that to achieve sustainable urbanization, policymakers in Turkey should execute well-planned urbanization programs, create an energy conservation policy and encourage green industries to ensure a sustainable increase in environmental quality for Turkey.

Chapter 5

CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Conclusion

The variables (FDI, agriculture, urbanization, energy use, and economic growth) used are important economic activities that contribute to the environmental sustainability of an economy. Under the three subjects, the variables are related with different approaches and outcomes. Moreover, the first and second subjects used the same variables and different approaches with the same results, indicating a positive effect of all the variables on the environmental degradation of Turkey. However, the third subject also uses the same variables excluding agriculture, shows that urbanization and energy use influences environmental damage, while FDI improves the quality of the environment. The diagram below shows the relationship between the variables used in all three (3) studies.

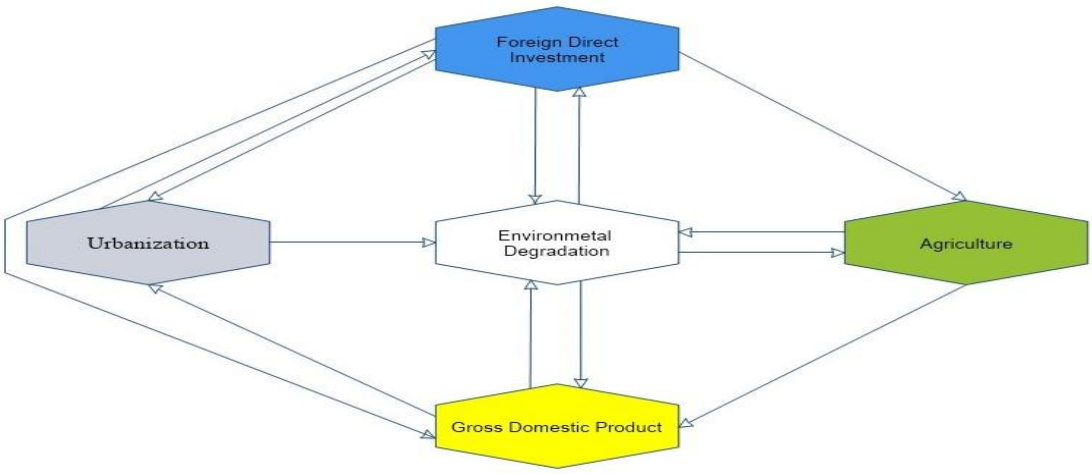

Figure 5.1: Diagram showing the relationship between the variables used in all the studies

An ample of literature from different studies have been published on the impacts of FDI-environment connection for different economies such as that of Turkey's economy. The literature recommends that FDI can have a positive or negative effect on environmental sustainability. Foreign investors have the enormous potential to influence a sustainable environment by utilizing modern technologies and promoting investment in key infrastructure. Most of the literature review supports the fact that FDI reduces environmental degradation. Generally, FDI is significant for the development of economies globally. Mainly provides funds for the expansion of international trade, consequently raises other concerns.

Turkey is one of the highest producers of agricultural produce. Its economic activities such as agriculture contribute to environmental degradation through the excessive use of energy resources, technologies, and chemical substances which in turn increase emissions.

The shift of the population from rural to urban centers has increased the risk of environmental hazards. Apart from these effects on the environment, urbanization can also affect the growth of an economy either positively or negatively. Urbanization enhances energy demand increasing both industrial and residential energy consumption as well as the use of natural resources which consequently leads to environmental degradation. Energy consumption is growing as the population increases across several nations of the world. Both renewable and nonrenewable energy impact the environment depending on the technology used.

This study is the examination of the link among FDI, agriculture, urbanization, and environmental sustainability, through the relation of the chosen variables (agriculture,

FDI, energy use, GDP, urbanization, carbon dioxide emission, and ecological footprint). The sequential process is employed in this thesis for the presentation of different studies related to the chosen topic centered on Turkey's economy. The studies arrived at different conclusions and different policy implications from each study. Generally, the summery of the conclusions of the different studies will be the conclusion of the thesis.

The aim of this thesis is three-party: Firstly, from chapter 2 which is made up of the first study, investigate the nexus among foreign direct investment, energy consumption, urbanization, and real GDP to determine the environmental sustainability. The environmental sustainability is proxy with carbon emission. The aim was to verify the time-varying nexus between foreign direct investment and carbon dioxide emissions, and also examine the significance of modeling the asymmetric relationship among the variables observed using the annual time series data for the period 1970–2017. The study employed the Time-varying Approach (TVP) which treats parameter estimations as functions of time. Furthermore, the TVP approach captures parameter instabilities, regime shifts, structural breaks, and nonlinearities, and effectively controls variations in the impacts of FDI on carbon emissions across time, and with each time period having its own set of coefficients. The presence of nonlinearities was confirmed in the underlying data series and support the choice of a TVP approach that is robust to such problem. Among the outcomes is the positive impact of FDI on CO2 emissions. The finding is in accordance with previous findings by authors such as Seker et al. (2015); Öztürk and Öz (2016); and Koçak and Şarkgüneşi (2018). The effects of the control variables-energy use, GDP, and urbanization-are positive and significant over the entire period sampled in accordance with the economic theory and empirics. The positive impact of energy use on carbon

emissions is in alignment with the conclusions reached by Wang et al. (2011), Shahbaz et al. (2012), Shahbaz et al. (2013b), and Tang and Tan (2015). The positive relationship between GDP on carbon emissions likewise confirms the findings of Etokakpan et al. (2020). The findings also support the conclusions reached by McGranahan (2010), Sadorsky (2014), and Coskuner, Paskeh et al. (2020) on the relationship among urbanization and carbon emissions. While the coefficients of energy use and urbanization remained stable over the said period, the coefficients of GDP recorded relatively large movements, and these variations closely reflected the economic patterns of the country.

Secondly from chapter 3, scrutinize the long-run nexus of the agriculture sector on environmental sustainability incorporating with energy usage, economic performance and foreign direct investment. The study aimed to examine Turkish's engagement in minimizing environmental degradation to promote environmental quality by examining the influence of agriculture, energy use and FDI on environmental degradation. To this end, the RALS method was utilized to analyze the stationarity level of each variable and their cointegration relationship which allow us to obtain stronger results under the non-normality assumption. The results indicated that all investigated variables have cointegration relationship. Furthermore, the explanatory variables included in this study have positive and statistically significant impact on the level of environmental degradation. In other words, a rise in agricultural production, energy use, foreign direct investment and economic growth in Turkey cause deterioration in the environment. The results of the bidirectional causal relationship revealed, the one-way causal linkage running from environmental sustainability to energy use in Turkey. FDI to economic performance and agriculture sector, from agriculture sector to energy use and from economic performance to energy

consumption. Finally, the feedback causal relationship has been investigated among FDI and energy use. These results emphasize that an increase in FDI will lead increase in finance in the country. This leads to not only an increase in economic performance as well as production and profitability, which causes a greater demand for energy and higher environmental degradation by consuming more sources and emitting greenhouse gasses to the environment. Finally, the inverted U-shaped relationship was confirmed with economic performance and environmental sustainability in Turkey. This means that an increase in the economic performance of Turkey will lead to an increase in the deterioration level of the environment up to threshold level, then every rise in the economic performance will be the remedy for environmental sustainability and contribute to sustainability.

Thirdly, from chapter 4, this study mainly focused on the nexus among urbanization and environmental sustainability with the help of energy use, FDI, and economic performance in Turkey. Time series data were used from 1970 to 2017 using the RALS-EG analysis by Lee et al. (2015) to check cointegration among the variables. The cointegration relationship among the variables were confirmed. Besides, the FMOLS model was applied to check the significant and long-run effect of the investigated variables on environmental sustainability. Urbanization and energy use are both statistically significant and positive on ecological footprint. Indicating that an increase in the variables will lead to the rise in environmental degradation. These findings are aligned with Koyuncu et al (2021), Cetin et al (2018) and Ozturk and Acaravci (2013) studies. Contrarily, FDI and economic performance indicated that any increase in capital inflows and GDP in Turkey will improve development and environmental quality. This is aligned with the previous results given by Katircioglu and Katircioglu (2018) and Godil et al. (2020). The causality test results show that all

the variables are seen transmitting to ecological footprint in a one-way causal relationship. The U-shaped EKC hypothesis was confirmed. This indicates that an increase in economic performance leads to the decline in ecological footprint by improving the quality of the environment then later, as economic performance continues to increase will deteriorates the environment.

Overall, the empirical results revealed the long-run effects in regards to all environmental degradation measures. The study found out positive effects of all the variables on environmental degradation, except for the third study, which has a negative impact of FDI and economic growth on environmental degradation in Turkey. Indicating that an increase in FDI, agriculture, economic growth, and urbanization increases environmental degradation in Turkey. However, the negative effect of FDI on environmental degradation, implies that the provision of cleaner technologies and better management techniques of Turkey help to enhance its environmental quality.

5.2 Policy Implications

The main policy and recommendation of this thesis can be procured based on the findings of the empirical report. Having empirically established the time-varying negative impact of foreign direct investment inflows on environmental sustainability in Turkey, this study leads to the conclusion that the inflows of FDI into an economy adversely affect the environmental quality of the host country. From a policy viewpoint, it is therefore suggested that the government should do the following; (i) enact policies that emphasize green FDI inflows, (ii) enforce tighter environmental policies that deter the immigration of dirty production processes, (iii) engage in mixed and country-specific environmental policies in combating pollution, (iv) ensure domestic investors adhere strictly to the nation's environmental policies, and (v) enact

policies to foster mutual cooperation and understanding between the local and foreign stakeholders in a manner that drives the use of energy-saving technologies in production activities and the use of renewables in place of fossil fuels to control environmental hazards for both the immediate and future generations.

In order for Turkey to benefit from a sustainable environment, the policymakers should regulate and attract the FDI for better environmental conditions. Also, the government/policymakers should regulate and sustain its economic performance with new progressed direct and indirect taxation techniques to promote low carbon emitted and environmentally friendly way of production. Since there is still high import dependency on traditional energy sources (fuel and coal) and lofty proportion of fossil fuel sources in the energy mix, it should revisit its energy policy and change its energy mix by integrating more renewable/cleaner energy sources into the energy supply mix. This may lead to a decrease in energy dependency and thus lead to an increase in economic and environmental sustainability. On the other hand, policymakers should strengthen agricultural management. Turkey, in its agricultural production, should develop long term sustainability policies in its agricultural production and include the use of new environmentally friendly technologies in production, improve the share of clean energy sources in its energy mix and promote agricultural waste recycling.

The study suggests that to achieve sustainable urbanization, policymakers in Turkey should execute well-planned urbanization programs, create an energy conservation policy and encourage green industries to ensure a sustainable increase in environmental quality for Turkey. In order to reduce environmental pollution government should encourage the use of renewable energy (solar energy) consumption vehicles for transportation and should be considered among the policies.

The government policy implication should also be framed and centered on how to mitigate urbanization, FDI, and energy utilization to sustain the present environmental condition of Turkey. The Turkish Government should provide incentives to foreign investors in order to create an avenue for attracting FDI. The significance of environmental sustainability is emphasized to elucidate the economic stability of an economy. With these recommendations in mind, appropriate and balanced governing policies should be in place to moderate the influence between the economic activities and environmental degradation of Turkey.

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