KADIR HAS UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES

# ANALYSIS OF THE DETERMINANTS OF ECOLOGICAL FOOTPRINT IN TURKEY

GRADUTE THESIS

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February, 2015

Ali Alper Alemdar

M.A. Thesis

2015

# ANALYSIS OF THE DETERMINANTS OF ECOLOGICAL FOOTPRINT IN TURKEY

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Submitted to the Graduate School of Social Sciences
in partial fulfillment of the requirements for the degree of
Master of Arts
in
ECONOMICS

KADIR HAS UNIVERSITY
February, 2015

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"I, Ali Alper Alemdar, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis."

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# ABSTRACT

ANALYSIS OF THE DETERMINANTS OF ECOLOGICAL FOOTPRINT IN TURKEY

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Master of Arts in Economics

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February, 2015

This paper aims to investigate political economy factors which affect environmental degradation in Turkey. The investigation is based on environmental sociology theories and through assumptions of theories, I test validity of these theories for Turkey. The theories that I test are the environmental Kuznets curve, ecological modernization, treadmill of production and destruction, ecologically unequal exchange, and political economy of urbanization. I use time-series data for Turkey covering the period 1970-2010 and in order to see relationship between the effect of economic development, export density to developed countries, urbanization rate, military expenditure and the ecological footprint per capita of Turkey. I employ Johansen cointegration technique. There is a statistically significant and positive relation between economic development, urbanization with ecological footprint, and there is no evidence for ecologically unequal exchange theory, the environmental Kuznets curve and militarization.

Keywords: environmental sociology, ecological economics, ecological footprint

# ÖZET

ANALYSIS OF THE DETERMINANTS OF ECOLOGICAL FOOTPRINT IN TURKEY

Ali Alper Alemdar

Ekonomi, Yüksek Lisans

Danışman: Doç. Dr. K. Ali Akkemik

Şubat, 2015

Bu çalışma Türkiye'deki çevresel bozulmanın arkasında yatan ekonomi politik faktörleri keşfetmeyi amaçlamaktadır. Bu araştırma çevre sosyolojisi teorilerine dayanmaktadır ve teorilerin varsayımları aracılığıyla, bu teorilerin Türkiye için geçerliliğini test etmektedir. Test ettiğim teoriler, çevresel Kuznets eğrisi, ekolojik modernleşme teorisi, üretim değirmeni, yıkımın değirmeni teorileri, ekolojik eşit olmayan değişim teorisi ve kentleşmenin ekonomi politiğidir. Metodolojik olarak, Türkiye için 1970 ve 2010 yılları arasını kapsayan zaman serisi kullanılarak, Türkiye'nin kişi başına düşen ayak izine, Türkiye'nin ekonomik gelişmişlik seviyesinin, gelişmiş ülkelere ihracat ağırlığının, kentleşme oranının ve askeri harcamaların etkisine bakılmaktadır. Bu etkilere bakmak için Johansen eş-bütünleşme tekniği analizi uygulanmıştır. Ekolojik ayak izine ekonomik gelişme seviyesi ve kentleşmenin pozitif etkisi bulunurken, çevresel Kuznets eğrisi, ekolojik eşit olmayan değişim ve askerileşmenin ile herhangi bir ilişki bulanamamıştır.

Anahtar Kelimeler: çevre sosyolojisi, ekolojik iktisat, ekolojik ayak izi

# Acknowledgements

First of all, I owe a great debt to my advisor, Assoc. Prof. Dr. K. Ali Akkemik and co-advisor Assoc. Prof. Dr. Özgür Orhangazi who always supported with their valuable ideas and critiques in every step of my thesis. Furthermore, I also thank Asst. Pof. Dr. Çağla Diner in my thesis committee for her support and Asst. Prof. Aslı Şen-Taşbaşı for giving me great inspiration for environmental and ecological studies. I was especially fortunate to work with Assoc. Prof. Mustafa Eray Yücel who assisted me a lot in the econometric part of my thesis. I thank my dear family, they have always supported me. Last, but not least, my special thanks go to Songül Ayaz who always supported encouraged and helped me in writing my thesis. I dedicate this thesis to these people.

# List of Tables

## List of Figures

## List of Abbreviations

| | |
|---|---|
| **CFC** | Chlorofluorocarbon |
| **CO** | Carbon Monoxide |
| **$CO_2$** | Carbon dioxide |
| **DCs** | Developed Countries |
| **EFPP** | Ecological Footprint Per Capita |
| **EKC** | Environmental Kuznets Curve |
| **FDI** | Foreign Direct Investment |
| **FE** | Fixed Effect |
| **GDP** | Gross Domestic Product |
| **GLS** | Generalized Least Squares |
| **IMF** | International Monetary Fund |
| **IPCC** | Intergovernmental Panel on Climate Change |
| **LDCs** | Developing Countries |
| **MNC** | Multinational Cooperation |
| **NAFTA** | North American Free Trade Agreement |
| **$NO_x$** | Generic term of the mono-nitrogen oxides |
| **OLS** | Ordinary Least Squares |
| **$PM_{10}$** | Atmospheric Particulate Matter |
| **PPP** | Purchasing Power Parity |
| **SIPRI** | Stockholm International Peace Research Institute |
| **$SO_2$** | Sulfur Dioxide |
| **SPM** | Suspending Particular Matter |
| **TSCS** | Time Series of Cross Sections |
| **TURKSTAT** | Turkish Statistics Institute |
| **UNCED** | United Nations Conference on Environment and Development |
| **VEC** | Vector Error Correction |
| **WB** | World Bank |

| | |
|---|---|
| **WDI** | World Development Indicators |
| **WTO** | World Trade Organization |
| **WWF** | World Wildlife Fund |

# Chapter 1

## INTRODUCTION

The man's massive exploitation of nature is not new; actually it is based on first human settlements and empires (Hornborg et al. 2007:27; Foster 1999:36). Sumerians, known as the cradle of civilization, had led to exploit regional environmental catastrophes that have in turn led to the fall of whole civilizations (Foster 1999:37). Furthermore, increasing size of the empires and centralization of power, for example the Roman Empire, had increased and spread environmental harm and natural resource extraction in Europe, Asia and Africa. Exploitation of forests, hunting and fishing, mining and metallurgy, pastoralism and agriculture were all conversion of core elements of the way of exploiting nature. The effects of these economic activities had been very dramatic for nature and ecological system. Disappearance of lions from Europe, tigers from Iran and Armenia and elephants, rhinoceroses, and zebras from North Africa, and on the other hand, landscape deterioration arising from abandoning olive trees from North Africa are the major examples of the early massive exploitation of nature by humankind (Hornborg, McNeill, Martinez-Alier, eds 2007:27).

Another case in environmental degradation is China almost around the same time with the Roman Empire. Hornborg et al. (2007:41) examine how land and habitat in South China changed dramatically in last two thousand years caused by farming, immigration, and more significantly, exports of silk. In the two thousand year, the disappearance of tropical and semi-tropical forests was seen together with the reshaping of landscape according to commercial activities. As Hornborg et al. (2007:41) argue *"A landscape in Guandong province that had been covered with rice fields thus was re-worked under the demands of commerce into a new landscape, one that said 'trade' rather than 'food'"*. Between fifteenth and seventeenth centuries, the relation between man and nature became more exploitative (Hornborg et al. 2007:123; Foster 1999:41). A case in point is the moving of silver mining in Central Europe to Central and South America which helps understand the origin of the modern world and high rate of environmental degradation in Central and South America. The main reason for moving silver mining is unstable cocktail of rapid commodification and agrarian revolts against this process. As we see in ecological modernization theory and ecologically unequal exchange theory, the core countries (the Western and Central European countries) wanted to protect their environment while transferring the externalities from mining and natural resource extraction. Up until the industrial revolution, the great transformation and capital accumulation started with European colonization for the greater part of the globe. Expansion of European colonization to the 'New World' (Asian, African and American countries) is explained by Foster (1999:41) as: *"led to the extraction of vast quantities of economic surplus-whether in the form of precious metals, such as gold and silver, or agricultural products, such as sugar, spices, coffee, tea, and many more—therefore to the social and ecological transformation of the colonized regions"*.

With the industrial revolution, Western countries (specifically the Great Britain at the beginning) successfully accelerated GDP growth and expanded massive production and consumption (Maddison 2005). As a consequence of the industrial revolution, production technique changed with the emerging new technologies and this caused the dissolution of previous economic and political institutions, and subsequently, the relation between man and nature. Growing cities, increasing production and consumption resulted in massive use of natural resources and drove more resource-extracting activities out of the Europe.

Environmental awareness in industrial countries started during the 1960s and 1970s. Local environmental movements gained momentum in these countries. The first major event was held in Stockholm in 1972. In this conference, 'sustainability' and 'sustainable development' topics were opened to discussion. Energy crisis in the 1970s, air and water pollution and destruction of ecosystems for timber, minerals and other concerns forced capitalist countries to consider future renewable energy resources more seriously and less environmentally destructive economic activities (Dunlap and Jorgenson 2012). In 1980, the term sustainable development was introduced and gained popularity after the publication of Our Common Future, also known as Brundtland Report (WCED 1987). Industrial production led to a concentration in greenhouses and other harmful gases for ozone layer, quickening the extinction of species, deforestation, the breakdown of biogeochemical cycles and natural resources extraction (Aşıcı 2012; Spangenberg 2007). IPCC (1990) demonstrates the four sources of anthropogenic greenhouses gases as: energy, industry, agriculture and forestry. According to the calculations by IPCC Group I, in between 1980-1990 energy constitutes the largest proportion (46%) of greenhouses gases and industry, forestry, agriculture and others follow respectively.

High-level greenhouse gas in the air, natural resource exploitation and hazardous wastes at the global level compelled countries to find common solutions at some level. In 1992, Rio de Janeiro hosted the United Nations Conference on Environment and Development (UNCED). The aim of this conference was to find political solutions for environmental problems by mixing science and economics. The major objective in Rio was to stabilize the level of greenhouse gas in the atmosphere at a point that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner (Meakin 1992). At the end of the conference, 27 principles were declared. These principles emphasize international cooperation, involving more civil society and following international laws in the solution pattern of environmental problems. Furthermore, United Nations set 10 millennium development goals for sustainability which also include environmental quality. The seventh goal is 'Ensure Environmental Sustainability' and it includes three targets (i) integrating the principles of sustainable development into country policies and programs and reverse the loss of environmental resources, (ii) reducing the proportion of people without sustainable access to safe drinking water and basic sanitation, (iii) significant improvement in the lives of at least 100 million slum dwellers which will be achieved in 2020. The first target has five indicators, namely the proportion of land area covered by forest, the ratio of area protected to maintain biological diversity to surface area, energy use (kg oil equivalent) per $1 GDP (PPP), carbon dioxide emissions per capita and consumption of ozone-depleting CFCs and proportion of population using solid fuels.

## 1.1 Outline of the Thesis

This thesis aims to investigate how anthropogenic activities affect the environment and the ecology through ecological footprint. This investigation focuses on Turkey for the period of 1970-2010. In order to discuss political ecology and policy suggestions, I test some environmental sociology hypotheses for the case for Turkey. These hypotheses are the environmental Kuznets curve, ecological modernization, treadmill of production, treadmill of destruction, ecologically unequal exchange. I employ the Johansen cointegration analysis to investigate the association between environmental degradation in Turkey and various indicators. I use ecological footprint per capita (EFPP) as an environmental indicator to measure the effect of human activities to nature. EFPP is used by several studies as an environmental impact and sustainability indicator by these hypotheses (Jorgenson 2003, 2005, 2006, 2009; Jorgenson and Burns 2007; Jorgenson and Clark 2009, 2012; Jorgenson and Rice 2007, 2012). In chapter 2, there are definitions and calculation methods of ecological footprint. Furthermore, brief information about ecological footprint analysis and trends in the world and Turkey are also provided. In the third chapter, hypotheses are explained with the underlying assumptions and criticisms. In addition, chapter 3 provides a review of the literature including previous empirical studies with relevant theories. Chapter 4 is the empirical part of the study. In this chapter, I explain the methodology, the data set and present the estimation results. Finally, in the conclusion, I evaluate the relevant theories with results and provide final remarks and ideas for rethinking environmental problems we face.

# Chapter 2

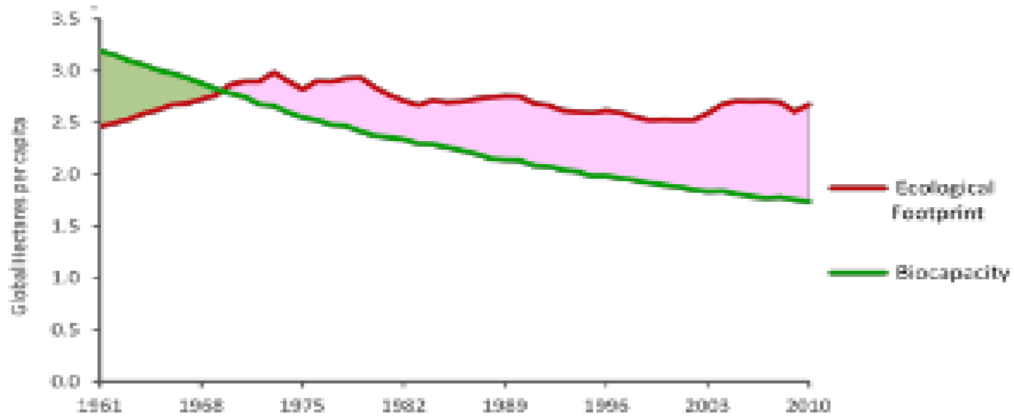
# ECOLOGICAL FOOTPRINT

## 2.1 Definition of Ecological Footprint

Since the term ecological footprint was established, it became an important environmental indicator (Wackernagel and Rees 1996). Footprints have been calculated for nations, regions, cities and as well as at the global level (Global Footprint Network 2000; Loth 2007; Mcdonald and Patterson 2004; Simpson et al. 2000; Wackernagel 1998). Wackernagel and Rees (1996) and Rees (2000) define ecological footprint as *"how much biologically productive land and water area an individual, a city, a country, a region, or humanity uses to produce the resources it consumes and to absorb the waste it generates, using prevailing technology and resource management"*. Global hectares are used to express the ecological footprint. Wackernagel et al. (2007) mention that a global hectare is a hectare that is normalized to have the world average productivity of all biologically productive land and water in a given year. Because of international trade and the dispersion of wastes, hectares demanded can be physically located anywhere in the world.

Many studies use ecological footprint as a 'sustainability' indicator. McDonald and Patterson (2004) show that there are two reasons to make the ecological footprint as a sustainability indicator. First, ecological footprint measures the ecological cost (in land area) of supplying all goods and services to a human population. This recognizes that people not only directly require land for agricultural production, roads, buildings and so forth, but that land is indirectly embodied in the goods and services that people consume. In this sense, the footprint can be used to make visible the 'hidden' ecological cost of an activity or population. Secondly, ecological footprint invokes the idea of carrying capacity. ‘Carrying capacity’ in ecology is the maximum population a given land area can support indefinitely. For example, a certain number of hectares are required to support cattle. If the number of cattle exceeds their carrying capacity then the population is said to be in ‘overshoot’. Resources will become scarce and population die-back will occur. If it is applied to human societies, using more biologically productive land than is available within borders result in ‘overshoot’, or in other words, ‘ecological deficit’. In ecological footprint language, ecological arises when ecological footprint of a region, city, country or globe exceeds the available biocapacity. Figure 2.1 illustrates the World’s ecological footprint and biocapacity trend from 1961 to 2010.

Figure 2.1 Ecological Footprint and Biocapacity of the World 1961 to 2010




Source: Available online at www.footprintnetwork.org

Weckernagel et al. (2007) define biocapacity as "Biocapacity or biological capacity is the capacity of ecosystems to produce useful biological materials (meaning of 'useful' usually changes over time) and to absorb waste materials generated by humans using current management schemes and extraction technologies. Like the ecological footprint, biocapacity is expressed in units of global hectares and is calculated for all biologically productive land and sea are on the planet. Biologically productive area is land and water (both marine and inland) area that supports significant photosynthetic activity and biomass accumulation that can be used by humans. Nonproductive and marginal areas such as arid regions, open oceans the cryosphere, and other low productive surfaces are not included."

There are several methods developed for calculating of ecological footprints –e.g., Wackernagel and Rees (1996), Folke et al. (1997), Bicknell et al. (1998), Wackernagel et al (1999), Loth (2000), van Vuuren and Smeets (2000), and Ferng

(2001). I present Wackernagel and Rees's (1996) calculation method, because the ecological footprint data of this thesis is calculated by using this method.

## 2.2 Calculation Methods

Wackernagel and Rees's (1996) calculation method is based on construction of a 'consumption by land use' matrix for a given population (McDonald and Patterson 2004). The consumption land use matrix includes six types of land according to the corresponding consumption pattern. These major land use types in ecological footprint accounting are cropland, grazing land, fishing grounds, forest area, built-up land and carbon land. Before going into details about those types of use land, there is need to explain the fundamental assumptions of ecological footprint accounting.

The first assumption is that the majority of the resources people consume and the wastes they generate can be tracked. The second assumption argues that most of these resource and waste flows can be measured in terms of the biologically productive area necessary to maintain flows. The third assumption states that by weighting each area in proportion to its bioproductivity, different types of areas can be converted into a common unit of global hectares, hectares with world average bioproductivity. Fourthly, as a single global hectare presents a single use, and all global hectares in any single year represent the same amount of bioproductivity, they can be added up to obtain an aggregate indicator of ecological footprint or biocapacity. The fifth assumption is that human demand, expressed as the ecological footprint, can be directly compared to nature's supply, biocapacity, when both are expressed in global hectares. The last assumption is the overshoot situation, where ecological footprint exceeds available biocapacity (Wackernagel et al. 2002; Wackernagel et al. 2007).

An important component of ecological footprint calculation is major land use by type. There are five biocapacity components and six footprint components (carbon land is not explicitly set aside). These major land use types are: Cropland, grazing land, fishing ground, forest area, built-up land and carbon land which are explained briefly below (Wackernagel and Rees 1996; Wackernagel et al. 1999; Wackernagel et al. 2002; Wackernagel et al. 2007).

**Cropland:** Growing crops for food, animal feed, fibre, and oils requires cropland, the land type with the greatest average bioproductive per hectare.

**Grazing Land:** Raising animals for meat, hides, wool, and milk causes using of feed products grown on cropland, fishmeal from wild or farmed fish and/or range land area for grazing.

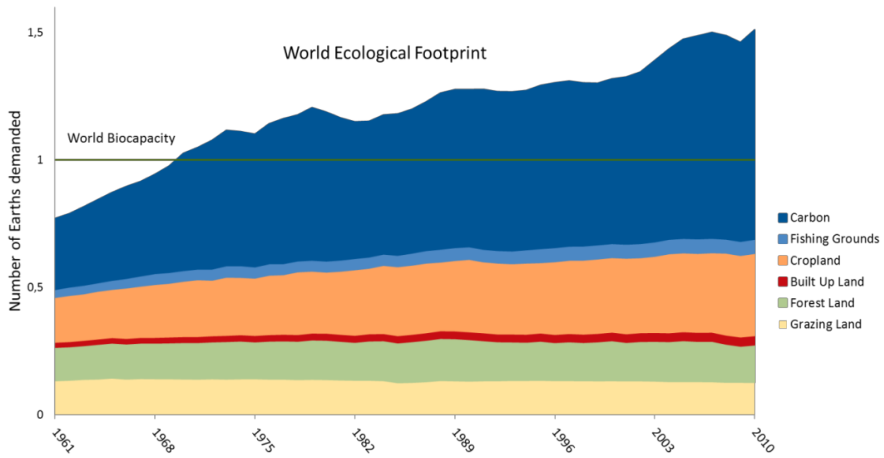
**Fishing Grounds:** It includes productive freshwater and marine fishing which are required by harvesting fish and other marine products. Marine areas outside continental shelves are currently excluded from ecological footprint accounts.

**Forest Area:** This type of land indicates natural and plantation forests that are used in harvesting timber products and fuelwood (products-sawnwood, wood-based panels, paper and paperboard, and wood pulp).

**Built-up Land:** This land is occupied by infrastructure for housing, transportation, and industrial production. Areas occupied by hydroelectric dams and reservoirs, used for the production of hydropower, are also counted as built-up land.

**Carbon Land:** The ecological footprint of fossil fuel consumption is calculated by estimating the biologically productive area needed to assimilate this waste product of the human economy. Figure 2.2 illustrates the portion of land use types in the ecological footprint of the world 1961 to 2010.

Figure 2.2 World Ecological Footprint Composition (1961 – 2010)




Source: Available online at www.footprintnetwork.org

In ecological footprint accounting, there are some activities currently excluded. Wackernagel et al. (2007) explain the reason why these activities are excluded as follows: "These activities include the release of materials for which the biosphere has no significant assimilation capacity (e.g., plutonium, PCBs, dioxins, and other persistent pollutants) and processes that damage the biosphere's future capacity (e.g., loss of biodiversity, salination resulting from cropland irrigation, soil erosion from tilling)."

Wackernagel and Rees's model of ecological footprint is calculated by Global Footprint Network for every year. Global Footprint Network has also improved National Footprint Accounts and the ongoing Footprint Standards processes. In the calculation, a nation's footprint of consumption equals that nation's footprint of primary production plus imports plus stock changes minus exports. This calculation represents the apparent consumption of biological capacity within a country.

The National Footprint Accounts include more than 200 resource categories such as crop products, fibres, livestock, wild and farmed fish, timber and fuelwood. The accounts also explicitly track one major waste product - carbon dioxide. Demand for resource production and waste assimilation rate are translated into global hectares by dividing the total amount of a resource consumed by the global average yield of the land type producing that resource. This magnitude is multiplied by the appropriate equivalence factor to express the total demand in global hectares for each resource consumed. Furthermore, manufactured or derivative products are converted into primary product equivalents for the purpose of ecological footprint calculation (Wackernagel and Rees 1996; Wackernagel et al. 2002; Wackernagel et al. 2007). A given products' ecological footprint for a country is the calculated as follows:

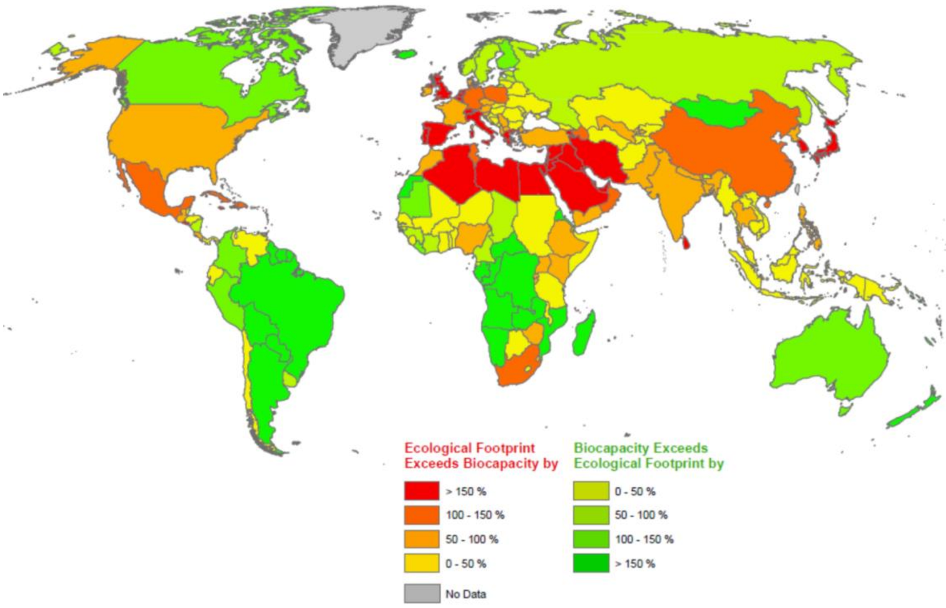
Ecological_ Component =Production + Import – Export / Yield.

Ecological footprint is measured by a single measurement unit. In order to convert into a single measurement unit, global hectares, accounting normalizes different types of areas to account for differences in land and sea productivity. Equivalence factors and yield factors are used for this purpose. Equivalence factors convert a specific type of land into a universal unit of biologically productive area, a global hectare. Yield factors take into account the difference in production of a given land type across different nations (tons of meat per Turkey or Greece hectare vs. world average) (Wackernagel et al. 1999; Jorgenson 2009). By these calculations and factors, we obtain three important terms, namely, ecological deficit, ecological reserve and ecological debt. An ecological deficit is defined by ecological footprint of a population exceeding the available biocapacity of that population's territory in a given year. This holds for nations, cities, regions and world. Ecological reserve represents the opposite situation. A population with an ecological footprint smaller than their available biocapacity has an ecological reserve. Ecological debt is the sum of annual ecological deficits that accumulate over a certain period of time. Planet years are the numeric expressions of ecological debt. According to Wackernagel et al. (2007), our planet entered into overshoot since the 1980s. One planet-year equals the total productivity of useful biological materials by the Earth given a year (Wackernagel et al. 2007). Biocapacity reserves and deficit per countries in 2010 is illustrated in figure 2.3.

### 2.3 Ecological Footprint of Turkey

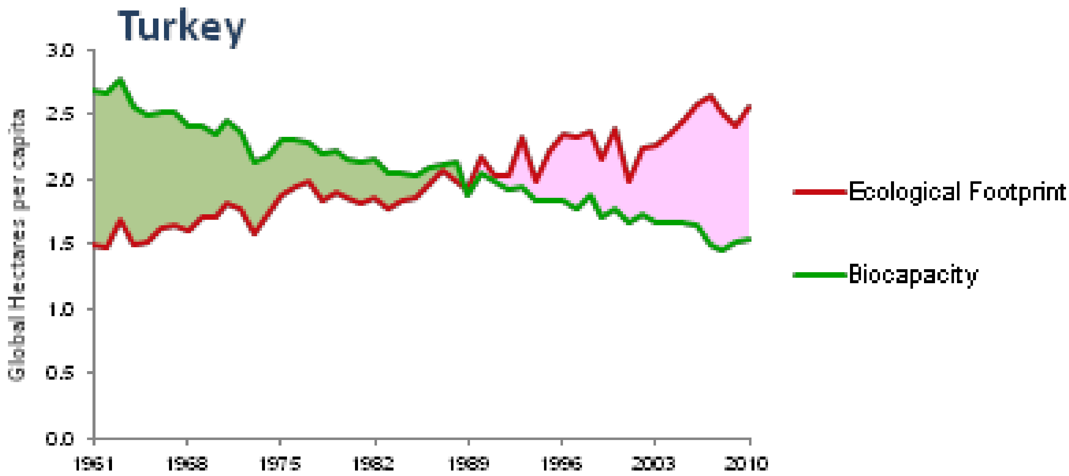
The most recent measurement of Global Footprint Network for Turkey is 2.5 per capita ecological footprints in 2010 (see www.footprintnetwork.org). In depth analysis for Turkey is reported by Türkiye'nin Ekolojik Ayak İzi Raporu (2012). In this report, components and trends in ecological footprint in Turkey are illustrated. According to this report, personal consumption generates 82% of total ecological footprint in Turkey. This implies that the main driver of Turkey's ecological footprint is consumption. Additionally, imports seem to be an important component of footprint of Turkey as it occupies 20% of footprint of goods and services. Among ecological footprint components of Turkey, carbon has the highest share with 46% in 2007 followed by cropland (35%), forestland (11%), grazing land (3 %) , built-up land (3%) and fishing land (2%) (Global Footprint Network, WWF Türkiye 2012). Figure 2.4 shows Turkey's ecological footprint and biocapacity trends in terms of global hectares per capita 1961 to 2010.

Figure 2.3  Biocapacity Reserves and Deficit Per Country in 2010




Source: Available online at www.footprintnetwork.org

Figure 2.4 Trends of Biocapacity and Ecological Footprint of Turkey (1961 -2010)




Source: Available online at www.footprintnetwork.org

# Chapter 3

## THEORETICAL BACKGROUND AND LITERATURE REVIEW

This chapter presents fundamental assumptions of hypotheses and reviews previous studies with a similar focus as in this thesis. There are numerous studies which contain theories that I discuss as well. Some of the reviewed studies investigate all these theories in the same paper, but the majority of them focus on specific theories separately.

### 3.1 THEORETICAL BACKGROUND

Various theories in the past aimed to explain the sources of environmental degradation from different perspectives. While the concept of ecological footprint is very recent, such theories can be utilized to explain the sources of ecological footprint as well. Below I list and elaborate on some of the influential theories which are closely related to ecological footprint.

#### 3.1.1 Ecological Modernization Theory

Ecological modernization theory takes post-industrial modern societies as a potential solver of environmental problems. These societies have advanced levels of technological and industrial development to solve environmental problems. According to the theory, collaboration between civil society, government and industry can solve environmental problems by creating green economy. Ecological modernization theory sees economic growth as a starting engine for solving environmental problems. Spaargaren and Mol (1992) explains that: “Economic growth and technological development, two important institutional traits of modernity, are therefore seen as compatible with and sometimes even as a condition for sustaining the sustenance base, rather than as the main cause of environmental destruction". Economic growth and technological development via institutional reforms are main components of the solution of environmental problems from the perspective of ecological modernization theorists. Ecological modernization theory also suggests political programs for governments and that makes ecological modernization theory more institutional. Buttel (2000) argues that ecological modernization is a social theory for two reasons. First, more advanced and sophisticated versions of ecological modernization theory provide great political ability to apply private eco-efficiencies and overall environmental reforms. Second, the logic of ecological modernization theory is related with embedded autonomy, civil society, and state- society synergy theories in political sociology. In ecological modernization theory, politically liberal and economically neo-liberal ideology is dominant (Buttel 2000; York, Rosa 2003). The theory also advocates that economies still should lead by private sector but with eco-regulations. Furthermore, belief in technology that increases efficiency in production and decreases input use is the crucial component of ecological modernization theory. However, Jevons' Paradox ([1865] 1965) steps in to illustrate the paradox between increasing efficiency and increasing material consumption. Systematic and theoretical criticism on ecological modernization theory comes from Schnaiberg (1980) with 'treadmill of production'. Treadmill of production theory's discourse and claims run counter to ecological modernization theory and assert that increasing efficiency or technological development bring more material consumption with economic growth. Moreover, in an important empirical study Matthews et al. (2000) found no evidence of an absolute reduction in resource throughput in any of the countries studied. On the contrary, total quantities of conventional wastes, emissions, and discharger increased by between 16 percent and 29 percent in Austria, Germany, Japan, the Netherlands, and the United States from 1975 to 1996. In addition, York and Rosa (2003) criticize ecological modernization theory at four perspectives: (1) failure of ecological modernization theorists to interpret the theoretical expectation connecting emergent institutions of modernity with genuine environmental reform, (2) limitations case studies, (3) eco-efficient improvements can occur in one industry, however this industry may affect other industries' increasing material consumption, (4) Jevons's paradox, which means that efficiency does not make lesser consumption and waste production.

There are a number of critics of ecological modernization theory. I think the most consistent criticism belongs to O'Conner (1994) who argues that sustainable capitalism is impossible. Because growth is based on expansionist structure of capitalism, more consumption and waste production will occur. As Magdoff and Foster (2010) conclude, capitalism is a system that must continually expand, in constant search for new sources of raw materials, cheaper labor and new markets. Through this logic, it is highly questionable for ecological modernization theory to sustain capitalism.

Ecological modernization theorists believe that countries such as the Netherlands, Germany, and Sweden can apply the suggestions of ecological modernization theory, just because these countries are superior in technology, economy and civil society. In conclusion, ecological modernization theory advocates that even capitalism creates environmental problems; these problems can be solved in capitalism by more economic growth, environmental state, technological development and civil society.

### 3.1.2 Environmental Kuznets Curve

The environmental Kuznets curve (EKC) hypothesis concerns the relation between income and environmental degradation or environmental harms. In the EKC, environmental damage first increases with income and then declines. This illustrates the inverted U-shape relation between income or economic growth and different types of environmental damages. The EKC hypothesis believes that after reaching a certain income level, the level of environmental damage will be smaller (Stern 2004). The perspective of the EKC hypothesis is a reductionist and does not assert the certain reasons of inverted U-shaped relation. Ecological modernization theory can explain issues that EKC do not explain with ecological modernization theory's policy suggestions. As summarized in the literature review section, there are different environmental indicators which can be used in EKC analysis. In this study, I use ecological footprint per capita as the relevant environmental sustainability indicator.

### 3.1.3 Treadmill of Production Theory

Treadmill of production theory argues that the expansion of production to maintain profit cannot be sustainable environmentally in a world with limited resources. Capital accumulation and profit are main engines of capitalism and capitalists seek ways to expand their production to accumulate capital and make profit. In contrast to ecological modernization theory which assumes that technological development and economic growth are solutions to environmental problems, according to treadmill of production theory, both technological development and economic growth cause more environmental degradation, because more investment and demand lead to depletion of resources and add waste to nature (Schnaiberg 1980; Jorgenson 2011). In treadmill of production, individual capitalists and states accumulate and absorb capital for survival and both accumulation and absorption are part of environmental degradation. Beside that we can include energy-intensive services as well (transportation, marketing). Treadmill of production theory specifically focuses on treadmill of destruction by the state.

How the state absorbs capital accumulation is the main question of the theory. Schnaiberg (1980) is highly influenced by Baran & Sweezy's (1968) Monopoly of Capital and developed ideas about the absorption of surplus by monopoly and state.

Schnaiberg (1980) pays a great deal of attention to monopoly capitalism. He points out that monopoly capitalism is the engine of the expansion in production. He constructs schematic device to comprehend the reasons behind production expansion and the expansion of the share of production in monopoly capitalism over time as well as increasing capital-intensive production. Profit-driven dependency of the structure of treadmill of production in monopoly capitalism speeds up treadmill and this involves increased environmental withdrawals and additions. Three major features of the treadmill are the role of labor force growth, technological choices and capital intensification of production. For example, he measures the effect of labor force growth on environmental degradation as follows:

$$\text{Environmental degradation} = \text{Number of producers} \times \text{Average workforce} \times \text{Capital per worker} \times \text{Production per unit capital} \times \text{Average withdrawals and additions per unit product}$$

Schnaiberg (1980) concludes that the environmental problems are mainly caused by disorganization of production and production reforms are needed to solve environmental problems.

### 3.1.4 Treadmill of Destruction Theory

Treadmill of destruction theory is a sub theory of treadmill of production theory. This theory specifically focuses on the effects of militarism on environment. York (2008) states that even if only warfare seems to affect the environment harmfully, military institutions, technologies, and behaviors can also produce ecological impacts. From the treadmill of destruction perspective, in armed conflicts it is necessary to consume considerably large amounts of nonrenewable energy and other resources to sustain their overall infrastructures and hardware (Jorgenson and Clark 2009). For ecological impacts, mass amount of fossil fuels consumption and the resulting greenhouse emissions are the most important factors in treadmill of destruction theory. In conclusion, treadmill of destruction theory draws attention to warfare consequences as chemical contamination of ecosystems and devastation of landscapes that result directly from military weaponry plus military campaigns consume enormous amounts of fossil and nuclear fuels in planes, ships, and tanks (Jorgenson et al. 2010).

### 3.1.5 Ecologically Unequal Exchange Theory

While political economy studies conflicts about economic distribution, political ecology studies as studying ecological distribution conflicts (Hornborg 1998). At that point, ecologically unequal exchange brings a new perspective to the relation between nations and nature in terms of commodities and materials. As a starting point, it is helpful to discuss the terms of unequal exchange as the deep historical background contributes to the broader theoretical perspective. Unequal exchange problem in the world system was important for classical economists (Smith, Ricardo, J.S. Mill and Marx) who wrote extensively about colonialism and conditions in the third world. From liberal economists' perspectives such as Smith, Ricardo and Mill, the criticism of colonial practices was part of a general theoretical defense of free trade (Foster and Holleman 2014). Interestingly, unequal exchange theory was originally and involuntarily developed by Ricardo with his comparative advantage theory. This famous theory postulates that in the existence of two products and two countries, each country specializes in the product that it produces more efficient and they trade with each other according to their comparative advantages. In this theory, labor and capital are immobile (Foster and Holleman 2014). Marx ([1863-65] 1981: 345) as a representative of classical radical political economists, analyze this trade differently from his liberal colleagues in the Capital. Marx argues that there is a flow of 'surplus profit' from poor countries to rich countries. Thanks to this 'free trade', rich countries can receive cheaper labor commodities. According to Marx, colonialism was the dominant ideology and colonized countries were free to be highly exploited through the use of slaves and coolies. Marx did not have chance to write about unequal exchange theory in the international arena. However, Foster and Holleman (2014) point to the Austrian Marxist Otto Bauer as the best descriptive of Marxist way of unequal exchange theory. Bauer ([1924] 2000) argued about unequal exchange theory:

*"The capital of a more highly developed region has a higher organic composition, which means that in this more advanced area a larger quantity of constant capital corresponds to the same size of wage fund (variable capital) than in the backward area. Now Marx has taught that owing to the tendency to equalization of the rate of profit, it is not the labor of each of the two areas respectively that produces the surplus value taken by each area's capitalists: the totality of the surplus value produced by the workers of both areas will be shared between the capitalists of those two areas not in proportion to the amount of labor contributed in each but in proportion to the amount of capital invested in each. Since in the more highly developed area there is more capital to the same amount of labor, this area appropriates a larger share of the surplus value than would correspond to the amount of labor it has contributed.... Thus, the capitalists of the more highly developed areas not only exploit their own workers but also appropriate some of the surplus value produced in the less highly developed areas. If we consider the prices of commodities, each area receives in exchange as much as it has given. But if we look at the values involved we see that the things exchanged are not equivalent."*

As Lenin (1939) named the highest stage of capitalism as imperialism, unequal exchange between rich and poor countries offer a theoretical perspective to this study.

There are two visible types of unequal exchange relation between the developed countries and the developing countries in a world-system. The first one involves importing raw materials from the developing countries to developed countries to increase consumption diversity, and it additionally secures natural resources and environment from degradation while the developing world faces the extreme level of natural resources extraction, low level of consumption. Secondly, when MNCs shift industrial operations to the developing world this generates pollution and low environmental quality in developing countries. In both ways, carrying capacity are appropriated from the developed from the developing countries by transferring (‘distancing’) the developed countries hazards or anti-wealth to the developing and importing natural resources from the developing countries (Frey 2003; Muradian and Martinez-Alier 2001).

Similar to unequal exchange theory, which emphasizes the exchange of more labor for less, ecologically unequal exchange theory stresses the exchange of more ecological use value (or nature’s product) for less. Two important bodies of work have emerged in sociology addressing ‘ecological imperialism’ (Foster and Clark 2009; Foster and Holleman 2014): Metabolic rift analysis and studies of ecologically unequal exchange. The first tradition is based mostly on Marxist perspective and is derived from important contributions by Foster (1999), (2000), More (2000), (2011a), Burkett (2009), (2014), Clausen (2007), Wittman (2009), Foster et al. (2010), Schneider and MicMicheal (2010), Gunderson (2011), and Dobrovolski (2012). However, metabolic rift analyses are out of scope of this study. Instead, a detailed analysis of ecologically unequal exchange theory is utilized.

This thesis discusses the ecologically unequal relation between developed and developing nations. Ecologically unequal exchange theory has deep roots in the World System Theory, which was developed by Wallerstein (1974), and ecological economics. This theory incorporates the ecological perspective to material relations between the developed north and the developing south. According to this theory, there is a vertical and asymmetric exchange relation between the core and periphery countries and this relation yields economic and ecological advantages to core countries (Bunker 1985; Hornborg 1998; 2006; Jorgenson 2009; Jorgenson and Rice

2005; 2007; Jorgenson and Clark 2009; 2012). This unequal exchange relation can be explained in more detail as follows: core developed countries do not want to extract and consume their raw materials and natural resources in their own lands. They, instead, import them from the developing countries, and transform those imported raw materials into industrial and high-valued-added commodities and export them to the developing countries. Core countries can accumulate more capital and externalize the externalities created raw material extraction during this process. Comparatively, core countries save their natural resources and labor time by trading with the developing world (Rice 2009). Jorgenson and Rice (2005) argue that this asymmetrical relationship is regulated by international trade wherein the structure of export increases the material consumption options for the industrialized developed while the non-industrialized developing is suppressed in extracting natural resources.

Historically, Foster and Clark (2009) argue that the exploitation of natural resources of the periphery has long been an important propulsive force for primitive accumulation in the developed countries. Therefore, this historical advantage provides industrial economies flexibility and adaptability while extractive economies become rigid, inflexible, and vulnerable to the shifting demands of transnational capital accumulation (Rice 2009). Furthermore, Bunker (1985) in his study on Amazons showed that high level natural resource extraction and flows to developed European countries provides great advantages for developed countries. Muradian and Martinez (2001) traumatically elucidate this situation in contemporary modern economic world as follows:

*"At the global level, there is a clear flow of primary commodities from poor to rich countries. Developed countries consume the majority (two-thirds) of all primary*

*commodity exports and these kind of products account for the majority of export earnings in the third world. Clearly, the Third World is specialized in exploitation of natural resources. Specialization in resources – intensive or environment-intensive products (especially those with low income elasticity) may generate a 'specialization trap'. When the economic activity is based on non-processed products, attempts to increase earnings need either an agreement among exporters, which is difficult to organize, or an increase in supply, which produces a downward pressure on prices and deterioration in terms of trade."*

The specialization trap does not only worsen the terms of trade of the developing countries, it also worsens their ecological system and natural resources. If material flows from, the developing to developed is conceptualized into 'ecological flows', the developed countries seem as net importers of primary goods and raw materials, broadly polluting sectors, and they can have an 'ecological deficit' especially vis-à-vis developing countries (Muradian and Martinez 2001; Muradian et al. 2002).

The ecologically unequal exchange theory aims to investigate what is really exchanged between nations. Hornborg (2014) develops a concept of ecologically unequal exchange as follows:

*"Advanced technologies exist on account of the very discrepancy between flows of money and flows of matter –energy, i.e. between economics and physics, and thus to show that theorization of "ecologically unequal exchange" is inextricably connected to understandings of technological progress."*

Hornborg (2014) claims that the exchange is controlled by a technological system and adds in fact asymmetric flows of embodied human time and embodied natural space between sectors where these assets are differently priced. Uneven technological growth must be viewed as an index of unsustainable resource dissipation and unequal exchange for his conception. Another perspective in conceptualization is the unequal exchange theory with a focus on ecological footprint (Jorgenson 2006, 2010; Rice 2007; Jorgenson et al. 2009; Jorgenson and Clark 2009, 2012). In this analysis, the developed countries with higher ecological footprints than developing countries do not extract ecologically costly materials or produce them massively. Rather, they import those from developing countries. This causes more consumption for developed countries and larger footprint and more environmental degradation with fewer footprints in developing countries. I also employ this analysis to test ecologically unequal exchange theory in this study.

The last study of interest is Odum's theory of unequal exchange. Odum (1995) uses the second law of thermodynamics which is also known as entropy and develops in his analyses the term 'emergy' to measure real wealth. Odum (1995) explains it follows:

*"In 1983, the term EMERGY, spelled with an 'M', was suggested by David Scienceman for our concept [of embodied energy] and emjoule or emcalorie as the unit… Emergy is defined as the energy of one kind required directly and indirectly to produce a service or product… For example, the production of green plants can be expressed in solar emjoules, which includes the solar energy required to make all the inputs to the plant, such as rain, wind, nutrients, cultivation efforts, seeds, and so forth".*

Developed and developing countries channel all their labor force and natural resources into specific production or services to catch up with developed countries. However, most developing countries require capital to realize this process and they usually meet this demand by inviting foreign capital. On the other hand, it is generally argued that capital seeks profitable environments and does not want to face too many regulations in an economy, particularly with regards to labor and environment. These capital inflows from developed to the developing is usually undertaken by Multinational Corporations (MNCs). MNCs tend to shift their investments from developed to developing, because of the newly designed environmental regulations in core countries which increase cost of production. To ensure the continuity of foreign capital inflows, countries do not generally regulate their economies with ecology and labor biased rules (Frey 2003). Frey (2003) emphasizes the importance of international trade agreements and organizations that help MNC investments stay profitable in the developing countries through free-trade agreements and other deregulative laws put in place in the developing countries. For example Frey's (2003) study on the environmental effects of the export processing zones in the northern part of Mexico shows that MNCs operations from the developed north in countries deregulations of certain limits cause great environmental, human health and social damages. In addition, Frey (2003) also emphasizes how IMF and World Bank forced peripheral countries to pursue export-oriented policies in an effort to attract industry from the developed countries.

## 3.2 A LITERATURE REVIEW OF EMPIRICAL STUDIES ON ENVIRONMENTAL THEORIES

This section reviews a selected list of the previous studies on environmental theories. Specifically, I review the studies that test one or several of the theories explained in the previous section. I first illustrate cross-county studies which are related to environmental sociology. Then, I review the empirical studies in the EKC literature.

Jorgenson and Burns (2007) test a series of hypotheses to examine political economic causes behind changes in per capita consumption-based ecological footprint. Their data cover the period 1991-2001 for 138 countries. The dependent variable is per capita ecological footprint of countries. Independent variables are GDP per capita, exports of goods and services as percentage of total GDP, urban population as percentage of total population, manufacturing as percentage of total GDP, services as percentage of total GDP, domestic income inequality measured as Gini coefficient, and state environmentalism. Their findings illustrate that the level of economic development increases per capita ecological footprint and that, export dependence is negatively related with growth in per capita footprints. Further results reveal that the effect of urbanization is insignificant, manufacturing intensity is inversely related to growth in per capita ecological footprint and service intensity is positive. Finally, agriculture intensity and state-environmentalism are statistically insignificant. The positive and statistically significant relation between GDP per capita and per capita ecological footprint support treadmill of production theory for this study. On the other hand, the assumption of ecologically unequal exchange theory, export dependence theory, and world-systems theory is negative relation between export dependency and per capita ecological footprint. The negative and statistically significant relation between export dependency and per capita ecological footprint support these three studies.

Jorgenson and Clark (2009) discuss different theories related to the political economy framework to examine the structural predictors of per capita ecological footprints of nations. This study investigates similar theories with Jorgenson and Burns (2007), but in different time period. In addition to Jorgenson and Burns (2007), this study also tests treadmill of destruction theory and the environmental Kuznets hypothesis. The data of the study cover period 1975-2000 for 53 developed and less-developed countries. The dependent variable is per capita ecological footprint of nation. The independent variables are GDP per capita, the quadratic form of GDP per capita and military expenditures per soldier. Furthermore, two weighted export indexes are used to examine the validity of ecologically unequal exchange theory. The first one quantifies the relative extent of a country's exports to more-developed countries. The second one measures the relative extent of a country's exports to militarily more powerful nations. The results show that the effect of urban population on per capita footprint is statistically significant and positive, contrary to Jorgenson and Burns (2007). It means that urbanization has positive effect on ecological footprint. Their findings contradict with ecological modernization theory and environmental Kuznets curve. Because, ecological modernization posits negative relation between economic development and ecological footprint, two weighted index are found statistically significant and negative with per capita ecological footprint which satisfy the main assumption of ecologically unequal exchange theory, and military expenditures are positively related with per capita ecological footprint. This positive relation between military expenditures and per capita ecological footprint supports treadmill of destruction theory for this study. Finally, the positive relation between GDP per capita and ecological footprint per capita shows the evidence of treadmill of production theory.

Jorgenson and Clark (2011) aim to investigate similar theories in Jorgenson and Burns's (2007) and Jorgenson and Clark's (2009) studies. They obtain data for 65 countries for the period 1960 to 2003. The dependent variable is per capita ecological footprint of nations and the independent variables are GDP per capita, arable land per capita, urban population, the square GDP per capita, military personnel as percent total population, military expenditures as percent total GDP, export weighted index[1], and the percentage shares of manufacturing and services in GDP. The results show that both the level of economic development and its square are statistically significant and positively affect per capita footprint of nations. These results support treadmill of production theory and contradict with ecological modernization theory and environmental Kuznets curve. Finally, their findings also illustrate that military personnel as percent total population and military expenditures as percent total GDP are statistically significant and positive, and weighted export index is statistically significant and negative. The positive relation between militarization and ecological footprint proves the validity of treadmill of destruction theory and the negative relation between weighted export index and ecological footprint supports ecologically unequal exchange theory. Jorgenson and Clark (2011) find same results with Jorgenson and Burns (2007) and Jorgenson and Clark (2009). Jorgenson and Clark (2011), Jorgenson and Burns (2007), and Jorgenson and Clark

[1] Weighted Export Index quantifies the relative extent to which a nation's exports are sent to more-developed countries.

(2009) test same theories with similar or different variables in different periods of years and all studies conclude same results except urbanization's effect.

These three studies test multi-environmental theories. In addition to them, I review three studies which focus on ecologically unequal exchange and treadmill of destruction theories. Ecologically unequal exchange demonstrates that the export dependency of developing countries to developed countries decreases their domestic consumption and it causes a negative relationship between export and ecological footprint in developing countries. Treadmill of destruction theory asserts the relation between militarization and environmental degradation.

Jorgenson and Rice (2007) argue that the less-developed countries with higher levels of exports to the more-developed countries exhibit lower domestic levels of resource consumption. They obtain data for the years 1980 to 2000 and less developed countries which are selected according to World Bank income classification in 2000. The dependent variable is combined ecological footprint per capita in 2000 and the independent variables are weighted export flows in 1990, GDP per capita, GDP per capita change (1980 to 1990), urban population in 1990, domestic income inequality measured by Gini coefficients, secondary school enrollment in 1990, services as percentage of total GDP in 1990, export partner concentration in 1990 measured by the percentage share of total exports to the single largest importing country. Their results demonstrate that export dependency of less developed countries causes less ecological footprint. The other results show that the level of economic development positively affects per capita footprints while the effect of the rate of development is statistically insignificant. In addition, the level of urbanization positively affects per capita footprints in some models, but becomes insignificant when services and export partner concentration are additional controls. The study concludes the existence of ecologically unequal exchange between less developed countries and developed countries.

Jorgenson (2009) also tests the unequal exchange theory. The study uses six observations from 66 lower-income countries for years between 1975 and 2000. The study uses per capita ecological footprint as the dependent variable and a set of key independent variables including the weighted export index for low income countries exports to high income countries for a specific time point (i.e., 1975, 1980, 1985, 1990, 1995, and 2000). According to the results, the effect of weighted export flows is negative and statistically significant. These findings confirm the existence of ecologically unequal exchange between low income countries and high income countries.

Jorgenson (2010) investigates ways of developed countries to treat less developed countries as supply depots to satisfy their consumption levels. Ecologically unequal exchange theory constitutes theoretical background of this perspective. In order to test these hypotheses, Jorgenson employs the multivariate analyses and takes deforestation in the form of percent change as a dependent variable different from his other studies (Jorgenson and Rice 2007; Jorgenson 2009) . The independent variables in the study are weighted exports index for primary goods, accumulated stocks of primary sector foreign direct investment as percentage of GDP. The results reveal that export activities and foreign direct investments have negative impacts on nature. With this result, this study supports ecologically unequal exchange theory.

Jorgenson et al. (2010) examine effects of militarization on the environment by evaluating a panel study of carbon dioxide emissions and the ecological footprint of nations for the period 1970-2000 in this study. They imply the cross-national empirical analyses to investigate the impacts of national military expenditures on carbon dioxide emissions and the ecological footprints of nations. The dependent variables are total carbon dioxide emissions (i.e., scale emissions) and carbon dioxide emissions per capita (i.e., intensity emissions) and per capita ecological footprints per nations. The independent variables are military expenditures per soldier and military participation as key factors and other independent variables, namely military expenditures as percentage of (GDP) , GDP per capita, total population, manufacturing as percentage of total GDP, urban population as percentage of total population, percentage of population aged 15-64, and exports as percentage of total GDP . According to the results, economic development and militarization are found to be positive which support treadmill of destruction theory and treadmill of production theory. However, the positive relation between economic development and environmental harm contradicts with environmental Kuznets curve and ecological modernization theory.

Environmental Kuznets curve (EKC) studies have had an important impact in environmental economics studies. The researchers investigating the Kuznets curve particularly seek a possible U-shaped relation between dangerous gas emissions (i.e., green gas) and income level.

Grossman and Krueger (1994) estimate the EKC for SO2, dark matter (fine smoke) and suspended particles to examine the effects of North American Free Trade Agreement (NAFTA) on the environment in Mexico. They involve a cubic function of real per capita. The turning points for SO2 and dark matter are found to be at around $4,000-5,000. The concentration of suspended particles declines even at low-income levels. As a result, though economic growth at middle income levels would improve environmental quality, growth at high-income levels would be detrimental. It means there is no evidence EKC in this study.

Shafik and Bandyopadhyay (1992) take ten different indicators to estimate EKC for up to 149 countries for the period 1960-1990. The indicators are: lack of clean water, lack of urban sanitation, ambient levels of suspended particular matter, ambient sulfur oxides, change in forest area during 1960-86, annual rate of deforestation during 1961-86, dissolved oxygen in river, faecal coliforms in rivers, municipal waste per capita and carbon emissions per capita. The study uses three different functional forms; log-linear, log quadratic and, in the most general case, a logarithmic cubic polynominal in GDP per capita and a time trend. According to the results, lack of clean water and lack of urban sanitation were found to decline uniformly with increasing income, and over time. Both measures of deforestation were found to be insignificantly related to the income terms. River quality tends to worsen with increasing income. The two air pollutants conform to the EKC hypothesis. The turning points for both pollutants are found for income levels of between $3,000 and $4,000. Time trend is significantly positive for faecal coliform and significantly negative for air quality. Finally, both municipal waste and carbon emissions per capita unambiguously increase with rising income which contradicts with the EKC

Selden and Song (1994) estimated the EKC for four airborne emissions: SO2, NOx, SPM and CO. The data are measured as averages for 1973-75, 1979-81, and 1982-84. Of the 30 countries in the sample, 22 were categorized as high income. The findings generally illustrate that the coefficient estimates for the income terms were significantly different from zero. The important inference form this study is that declining ambient concentrations do not necessarily meant that total emissions are declining. As a result, this study did not support EKC hypothesis.

Panayotou (1993) estimated EKCs for SO2, NOx, SPM, and deforestation. This study employs only cross-sectional data. An important aspect of the study is that afforestation is ignored. However, for many developed countries the coefficient of deforestation variable is negative and this bias improves the significance of the estimated EKC (Stern et al. 1996). According to the results, EKC is confirmed by these variables. The turning point for deforestation is $823 per capita. Deforestation has also positive relation with higher population density. For SO2 emissions the turning point is around $3,000 per capita, for NOx around $5,500 per capita, and for SPM around $4,500. After these turning points, environmental degradation and gas emissions decrease.

Cropper and Griffiths's (1994) EKC estimation is only for deforestation in three regions. The regions covered in the study are Africa, Latin America, and Asia. The data set includes pooled time series cross-section data. The dependent variable is the percentage change in forest area between two years. The data set covers 64 countries for the period 1961-1991. Rural population density, percentage change in population, timber price, per capita GDP and percentage change in per capita GDP ($PPP), the square of per capita GDP are taken as independent variables. The results show that neither the population growth rate nor the time trend is significant and turning points for Africa and Latin America are $4,760 and $5,420, respectively. It means that economic growth does not reduce environmental in any development level. Cropper and Griffiths conclude that economic growth does not solve the problem of deforestation.

Lise (2006) estimates the EKC for Turkey by looking at the decomposition of CO2 emissions over 1980-2003. This analysis mainly aims to show possible relation between a decoupling of carbon emissions and economic growth in Turkey. Lise decomposes the changes in CO2 emissions (or energy consumption) into scale effect, composition intensity effect, energy effect and carbon intensity effect. The observed data are total population in millions, GDP, total primary energy supply per technology, total primary energy consumption per sector per technology, and total CO2 emissions per sector. According to the results real GDP growth is the main explaining factor for the increase in CO2 emissions in the Turkish economy. The study also found no evidence for the EKC in Turkey.

The investigation of Soytas and Sari (2007) on the relationship between energy consumption, income and CO2 emissions between 1960 and 2000 in Turkey using Toda- Yamamoto approach to Granger causality concludes that the carbon emissions Granger cause reverse energy consumption. Shortly, there is no evidence to support the EKC.

Akbostancı et al. (2009) estimated the EKC in two different equations. The first equation is about the relation between $CO_2$ emissions and per capita income and it is examined by a time series model using cointegration techniques. In the second equation, the relationship between income and air pollution is investigated using $PM_{10}$ and $SO_2$ measurements in Turkish provinces. The data set in time series model spans the period 1968-2003 and per capita carbon dioxide. In the cointegration test, the results do not support the EKC hypothesis of inverted U shape. In the panel data model, the relation between $PM_{10}$ and income has an N shape. Similar result was found for the relation between $SO_2$ and income. Overall, they found no supporting evidence for the EKC in both analyses for Turkey.

The studies reviewed above are mostly cross-country analysis and specifically focus on the EKC. In what follows in the next section, I test these multi-environmental theories in a single country framework for Turkey.

# Chapter 4

## EMPRICAL ANALYSIS

This chapter discusses the method of analysis, data, and estimations. Several hypotheses outlined in this thesis are tested in this chapter. First, the data set are portrayed with graphs and descriptive statistics and the methodology is explained. Subsequently, the estimation technique and results are presented.

### 4.1 Data Set

The data set includes seven variables and 41 observations for each variable for the period 1970-2010. In most time series studies, variables are transformed by taking natural logarithm, because they exhibit trends of exponential growth. In this thesis, the variables are also expressed in natural logarithm for the same reason. The variables are *per capita ecological footprint* of Turkey (LEFP), *arable land per person* (LARLAND), *urban population percentage of total population* (LURBAN), *per capita gross domestic product* (logged) (LY), *quadratic form of GDP* (LY2), *military expenditures as percentage of GDP* (LMILTOF), and *weighted Export Index* (LWEXPORT). The selection of the variables closely follows the related theories. In what follows, I illustrate detailed explanations, graphs and descriptive statistics of the variables. Descriptive statistics of all variables are presented in Table 4.1

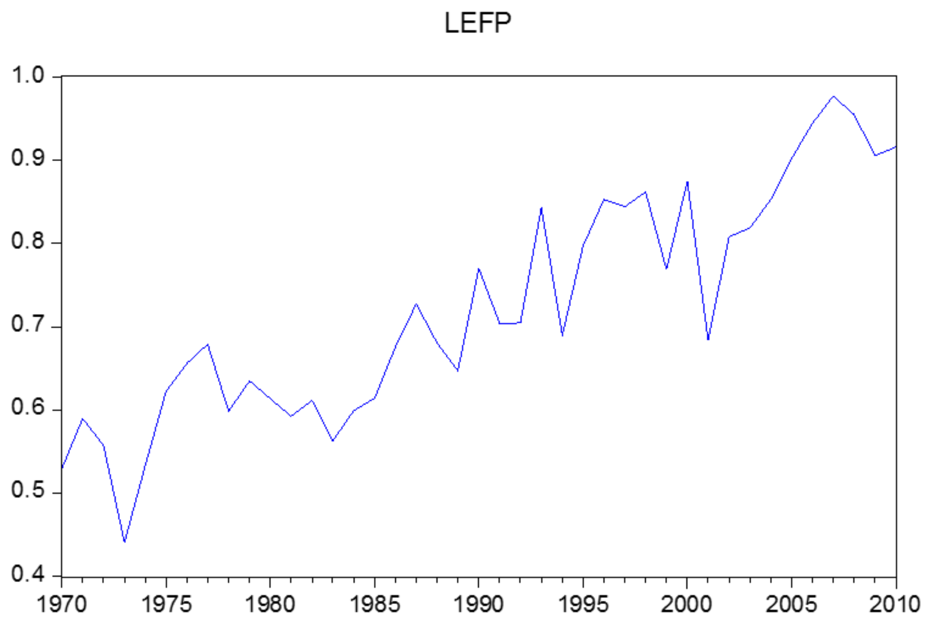
TABLE 4.1 Descriptive Statistics

| | LEFP | LARLAND | LY | LURBAN | LMILTOF | LWEXPORT |
|---|---|---|---|---|---|---|
| Mean | 0.72 | -0.77 | 8.79 | 4 | -3.35 | 27.9 |
| Median | 0.68 | -0.78 | 8.8 | 4.08 | -3.31 | 27.8 |
| Maximum | 0.97 | -0.33 | 9.26 | 4.25 | -2.97 | 28.4 |
| Minimum | 0.44 | -1.21 | 8.34 | 3.64 | -3.77 | 27.2 |
| Std. Dev. | 0.13 | 0.25 | 0.26 | 0.2 | 0.19 | 0.3 |
| Jarque-Bera (Probability) | 0.39 | 0.41 | 0.32 | 0.11 | 0.39 | 0.49 |

### 4.1.1 Per Capita Ecological Footprint

This variable measures total environmental impact and is obtained directly from Global Footprint Network. These data expressed in natural logarithm in the models. See figure 4.1.

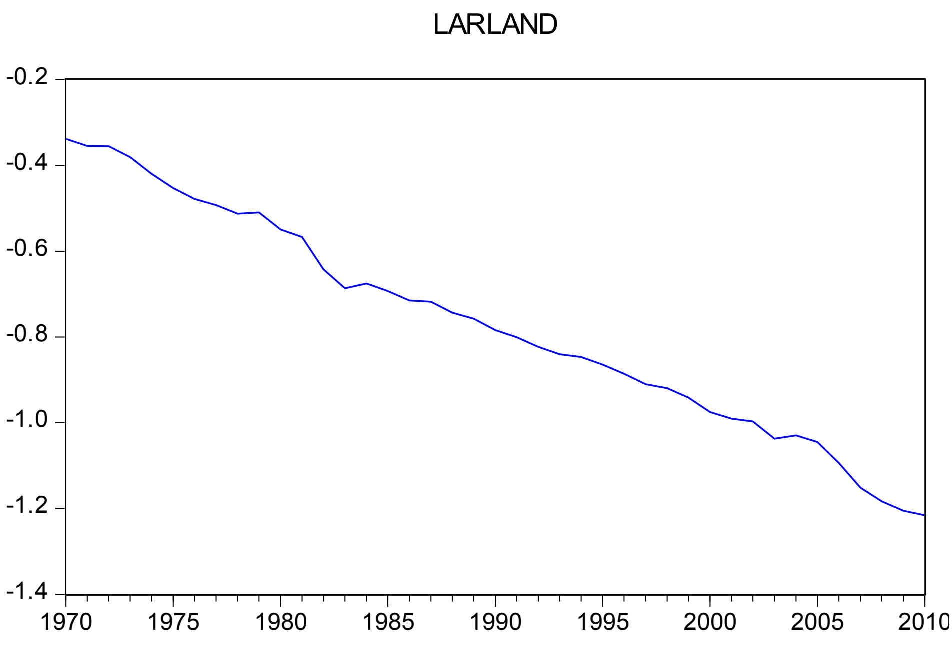
Figure 4.1: Logged per capita ecological footprint against time (1970-2010)



### 4.1.2 Arable Land per Person

This variable is an indicator of agricultural activities. Data are obtained by World Bank Indicators (WDI) and it is measured hectares per person. Food and Agriculture Organization defines arable land as land under temporary crops (double-cropped areas are counted once), temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow. Land abandoned as a result of shifting cultivation is excluded. These data are expressed in natural logarithm. See figure 4.2.

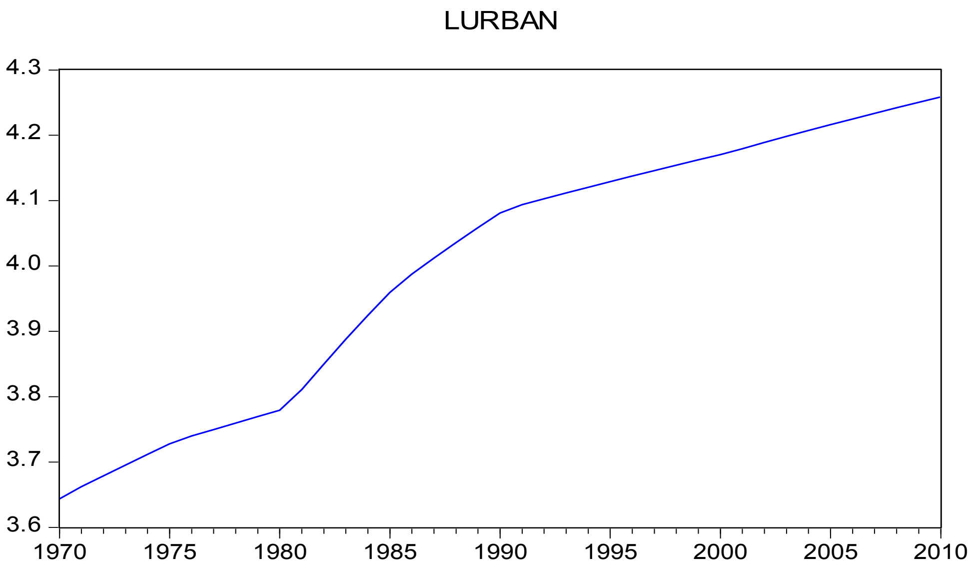
Figure 4.2: Logged per capita (hectares per person) arable land against time (1970-2010)



### 4.1.3 Urban Population Percentage of Total Population

This variable measures Turkey's level of urbanization. These data are taken from WDI and employed as expressed in natural logarithm. See figure 4.3.

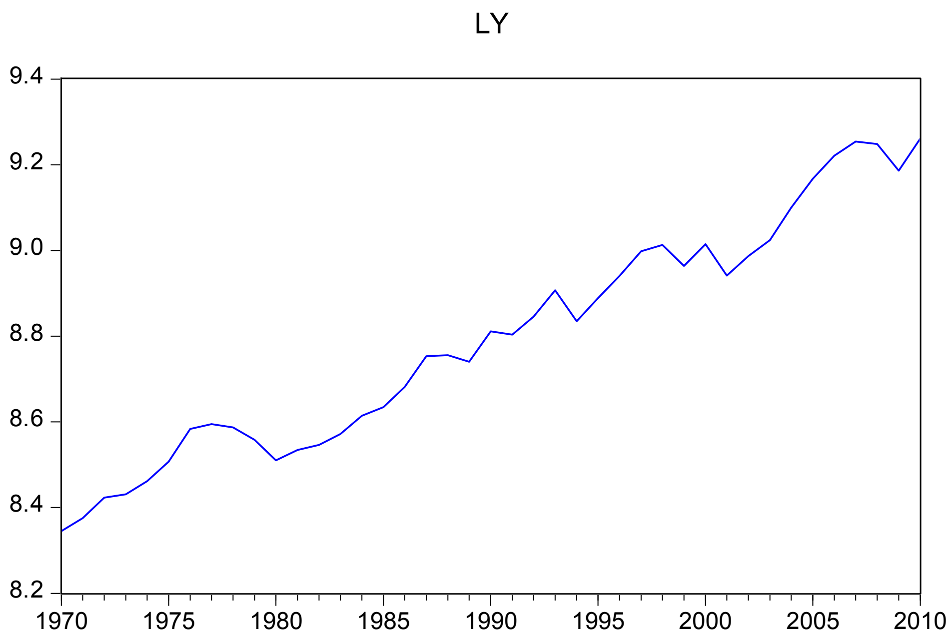
Figure 4.3: Percentage of urban population of logged total population (1970-2010)




### 4.1.4 Gross Domestic Product Per Capita

GDP per capita is taken as a measure of the level of Turkey's economic development. These data are taken from United Nations Statistics Division and are expressed in Turkish Lira at 2005 constant prices. These are also logged in the analysis. See figure 4.4

Figure 4.4: Logged per capita GDP measured in Turkish Lira at 2005 constant prices (1970-2010)

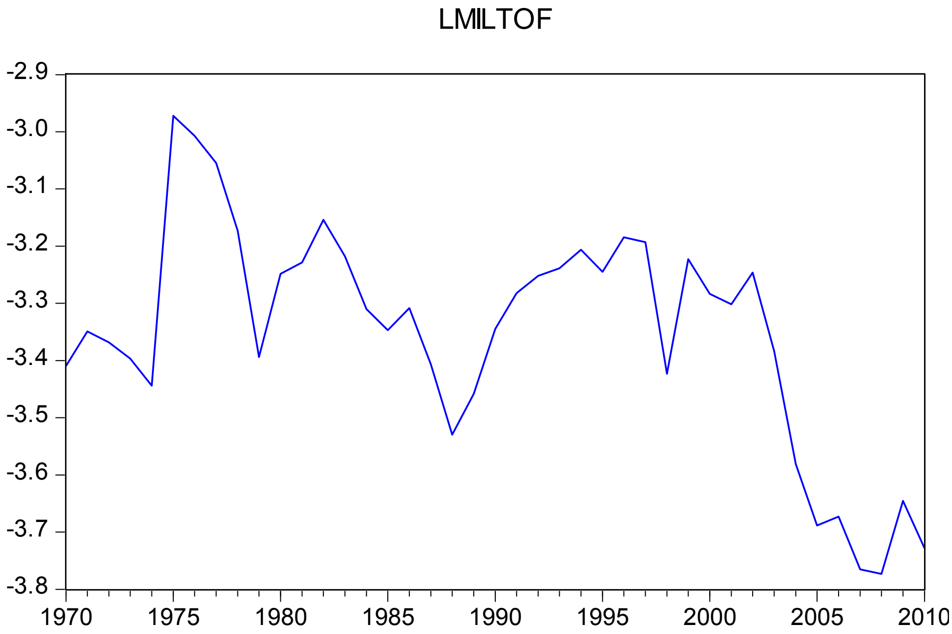



*Per capita GDP in quadratic form*: This variable is an indicator of environmental Kuznets Curve (EKC). This is squared per capita GDP. In EKC, the coefficient of this variable is expected to take a negative value. These data are also obtained by United Nations Statistics Division. See figure 4.5.

### 4.1.5 Military Expenditures as a Percentage of GDP

This variable reflects the relation of military on ecological footprint. Data are obtained from Stockholm International Peace Research Institute (SIPRI) Military Database. These data are expressed in natural logarithm. See figure 4.6.

Figure 4.5 Logged military expenditures as a percentage of GDP against time (1970-2010)




**4.1.6 Weighted Export Flow Index**

This index is firstly developed by Jorgenson and Clark (2005) to quantify the relative extent to which exports are destined to high-consumption, more developed countries. The main argument of the study is that less-developed countries with higher levels of exports to more-developed countries exhibit lower levels of domestic resource consumption, measured as ecological footprints. In order to test their hypotheses, they develop weighted export flow indices to measure the effects of exports to ecological footprint per capita. This variable is computed for Turkey here as follows:

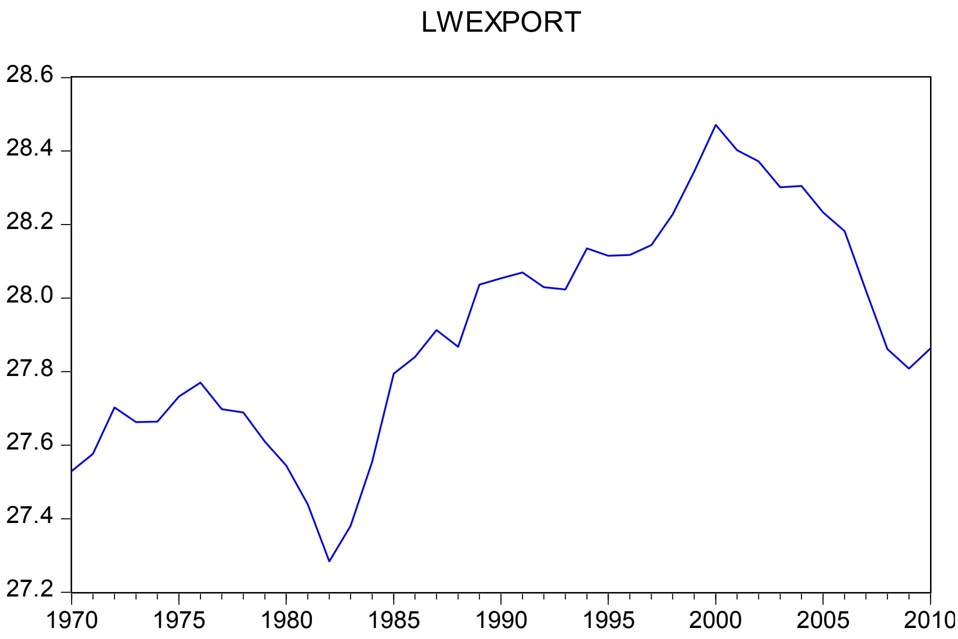
$$W_i = \sum_{j=1}^{N} P_{ij} A_j \qquad (4.1)$$

Where $W_i$ = weighted export flows for Turkey; $P_{ij}$ = proportion of Turkey's total exports sent to receiving country $_j$; and $A_j$ = GDP per capita of receiving country $_j$. Jorgenson and Clark (2005) explains this formula as follows:

"The first step is to convert the flows of exports to receiving countries into proportional scores. More specifically, exports to each receiving country are transformed into the proportion of the sending country's total exports. The second step involves multiplying each proportion by the receiving country's per-capita GDP. The third step is to sum the products of the calculations in Step 2. The sum of these products quantifies a nation's relative level of exports sent to more-developed, higher-income countries".

High income countries are taken from the World Bank's income classification. The classification begins in 1987. For years between in 1970 and 1987, the 1987 classification is used. After 1987, the status of countries according World Bank's income classification is subject to change each year. A list of high-income countries is presented in the Appendix. Data are obtained from Turkish Statistical Institute (TURKSTAT) and United Nations Statistics Division. The export data are obtained from TURKSTAT foreign trade statistics and GDP by countries are obtained from United Nations Statistics Division. GDP by countries are expressed in 2005 constant US dollars. These data are also expressed in natural logarithm. Figure 4.7 portrays the weighted export flow index for Turkey for the period 1970-2010.

Figure 4.6: Weighted Export Flows for Turkey (1970-2010)




## 4.2 Methodology

This thesis aims to investigate several environmental sociology theories using time series data for Turkey. The data is a relatively short sample for time series analyses but it is long enough to be treated as long-run (1970-2010). Following the earlier literature, long-run association is generally examined by cointegration analysis. There are several methods in cointegration analysis. The Johansen-Juselius (JJ) technique is chosen in this thesis. Engle-Granger method is not useful for multivariate studies and, among JJ and Pesaran-Shin-Smith, JJ is maintained owing to its wide-spread use in the literature. Furthermore, for the short-run association, if variables are cointegrated, I set up vector error correction models (VECM). VECM relies on one-period period lagged cointegrating equation and the lagged first differences of the endogenous variables.

### 4.2.1 Unit-Root Tests and Johansen-Juselius Cointegration Tests

The JJ test allows a researcher to test long run relationship(s) with n variables up to (n-1) cointegrating vectors. In the JJ cointegration test, all variables are non-stationary and their cointegrations in the long-run are stationary. As Brooks (2008:354) emphasizes, "If there exist *r* cointegrating vectors, only these linear combinations or linear transformations of them, or combinations of the cointegrating vectors, will be stationary. In fact, the matrix of cointegrating vectors β can be multiplied by any non-singular conformable matrix to obtain a new set of cointegrating vectors".

For this reason, it is first necessary to check stationary of the series. In order to test unit root of the series, I use augmented Dickey-Fuller (ADF) unit root tests (Dickey and Fuller, 1979). ADF test is almost standard in the literature. ADF fails especially when there are anomalies in the data. In our case, visual inspection of the data does not suggest any such anomalies. Therefore, ADF test is suitable for this analysis. Table 4.2 summarizes the results of these tests. Next, I follow the JJ technique's steps (Johansen 1995), which involve determining the rank of the impact of matrix, i.e., the long-run matrix. The number of linearly independent columns of the long-run matrix is given by the rank. The number of cointegrating relationships that exists among our variables is observed with the linearly independent columns of the long-run matrix. There are two tests statistics developed by Johansen to determine the cointegration rank are the maximum eigenvalue (max) statistics and the trace statistics, on the other side, tests the null of $r=k$ ($k=1,2,\ldots,n-1$) against the alternative of unrestricted $r$. However, because the trace statistics is superior to the maximum eigenvalue (max) statistics, I use only the trace statistics to determine cointegration rank (Lüutkepohl, Saikkonen, and Trenkler 2001). In the final step, VEC models are constructed to investigate possible associations of variables in short-run. VECM is a restricted vector autoregressive (VAR) designed for use with nonstationary series that are known to be cointegrated in long-term. In VECM, the cointegration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments.

TABLE 4.2 Augmented Dickey-Fuller (ADF) Unit Root Test for All Variables

| Variables | Lags | Levels | Lags | First Differences |
|---|---|---|---|---|
| LEFP | 1 | -0.91 | 0 | -10.03** |
| LY | 0 | -0.38 | 0 | -6.4** |
| LY2 | 0 | 0.83 | 0 | -6** |
| LURBAN | 2 | -1.66 | 1 | -2** |
| LARLAND | 0 | 0.02 | 0 | -5.67** |
| LMILTOF | 0 | -1.58 | 0 | -6.59** |
| LWEXPORT | 1 | -1.69 | 0 | -3.9** |

**Significant at 1%

### 4.3 Results and Discussion

In order to test the environmental sociological hypotheses, several equations are developed according to theories and previous studies which employed such equations (Akbostancı et al. 2009; Jorgenson and Clark 2005; Jorgenson and Rice 2005; Jorgenson 2009; Jorgenson and Clark 2011). Four equations are used for testing each hypothesis. These are named as Model 1, Model 2, Model 3, and Model 4. Model 1 is developed for testing ecological modernization, treadmill of production and urbanization theories. Model 2 is developed for testing ecological modernization theory, the environmental Kuznets curve and treadmill of production theory. Models 3 and 4 also test ecological modernization and treadmill of production theories.

Because these two models also have GDP per capita and Model 3 tests treadmill of destruction theory. Finally, Model 5 investigates ecologically unequal exchange theory.

### 4.3.1 Model 1

This model includes LEFP, LARLAND, LY and LURBAN to test the long relation between per capita ecological footprint and agricultural activities, the level of economic development and urbanization. The relation is expressed as follows:

$$LEFP = f\,(LARLAND, LY, LURBAN) \qquad (4.2)$$

The regression is written as:

$$LEFP_t = \beta_1 LARLAND + \beta_2 LY + \beta_3 LURBAN + \varepsilon \qquad (4.3)$$

Cointegration tests are conducted for Model 1. In order to determine rank for the cointegration matrix, the trace statistics are reported in Table 4.3.

TABLE 4.3 the Trace Tests for Model 1

| Rank | | | |
|---|---|---|---|
| | Trace Statistic | Critical Value | Prob.** |
| 0 | 55.63 | 47.85 | 0.0079 |
| 1 | 25.71 | 29.79 | 0.1374 |
| 2 | 4.44 | 15.49 | 0.865 |
| 3 | 0.88 | 3.84 | 0.3471 |

*Denotes rejection of the hypothesis at the 5% level

** MacKinnon-Haug-Michelis (1999) p-values

Rank 0 is rejected and Rank 1 is selected in the trace test. So, the estimated equation takes the following form:

$$LEFP = 0.96LARLAND + 1.30LY + 0.22LURBAN \quad (4.4)$$

(0.18469) (0.15416) (0.10709)

The coefficients of the long-run cointegration relationship and the standard errors given in the parentheses show that the coefficients of LARLAND, LURBAN, and LY statistically significant at 1 % level. Furthermore, all variables positively cointegrated with per capita ecological footprint in the long-run.

### 4.3.2 Model 2

Model 2 is constructed to test the EKC. This model includes per capita ecological footprint, per capita GDP and the quadratic form of per capita GDP. The EKC model can be written as a function:

$$LEFP=f(LY, LY2) \quad (4.5)$$

The regression equation for model 2 is as follows:

$$LEFP_t=\beta_1 LY + \beta_2 LY2 + \varepsilon \quad (4.6)$$

The cointegration rank test results are illustrated in Table 4.4:

Table 4.4 the Trace Tests for Model 2

| Rank | | | |
|---|---|---|---|
| | Trace Statistic | Critical Value | Prob.** |
| 0 | 36.17 | 29.79 | 0.008 |
| 1 | 11.62 | 15.49 | 0.1756 |
| 2 | 4.25 | 3.84 | 0.039 |

*Denotes rejection of the hypothesis at the 0.05 level

** MacKinnon-Haug-Michelis (1999) p-values

Rank 0 and Rank 2 are rejected and Rank 1 is selected in the trace test. So, the estimated equation takes the following form:

$$LEFP = 0.50LY - 6.10^{-10}LY2 \quad (4.7)$$

(0.09209) (9.8E-10)

Coefficient of LY is statistically significant at 1% level. However, LY2 is statistically insignificant in all levels. This model cannot find any proof for validity or rejection of the EKC.

### 4.3.3. Model 3

This model estimates a possible relation between militarization and per capita ecological footprint. This model includes LEFP, LARLAND, LY, and LPERMILITA. The functional form of the model is as follows:

$$LEFP=f(LY, LMILTOF) \quad (4.8)$$

The regression is as follows:

$$LEFP_t=\beta_1 LY + \beta_2 LMILTOF + \varepsilon \quad (4.9)$$

The cointegration rank tests are illustrated in table 4.5:

TABLE 4.5 the Trace Tests for Model 3

| Rank | Trace Statistic | Critical Value | Prob.** |
|---|---|---|---|
| 0 | 32.58 | 29.79 | 0.0233 |
| 1 | 12.65 | 15.49 | 0.1281 |
| 2 | 0.08 | 3.84 | 0.7651 |

*Denotes rejection of the hypothesis at the 5% level

** MacKinnon-Haug-Michelis (1999) p-values

According to the cointegration trace test rank 0 rejected and rank 1 is selected. The estimated cointegration equation is then as follows;

$$LEFP= 0.51LY +0.03LMILTOF \quad (4.10)$$

(0.02529) (0.03765)

The results explain that GDP per capita is statistically significant at 1%. On the other hand, military expenditure as a percentage of GDP is statistically insignificant. However, the coefficient of military expenditure as a percentage of GDP is positive, as treadmill production theory asserts.

**4.3.4 Model 4**

This model aims to examine possible long-run cointegration relation between per capita ecological footprint and weighted export flow index for Turkey. In order to estimate model 4, the following function and equations are developed:

$$LEFP= f\,(LY, LWEXPORT) \quad (4.11)$$

$$LEFP_t= \beta_1 LY \beta_2 LWEXPORT +\varepsilon \quad (4.12)$$

Rank determination for the impact matrix is based on the cointegration test results which are shown in table 4.6.

TABLE 4.6 the Trace Tests for Model 4

| Rank | Trace Statistic | Critical Value | Prob.** |
|---|---|---|---|
| 0 | 26.31 | 29.79 | 0.1196 |
| 1 | 4.55 | 15.49 | 0.8545 |
| 2 | 0.001 | 3.84 | 0.9657 |

*Denotes rejection of the hypothesis at the 1% level

** MacKinnon-Haug-Michelis (1999) p-values

Cointegration test results in table 4.8 suggest that rank 1 is selected. According to the cointegration results, the estimated equation is as follows:

$$LEFP = 0.49LY - 0.008LWEXPORT \quad (4.13)$$

(0.03670) (0.02895)

According to the findings of the equation, GDP per capita is statistically significant at 1% level and it is positively cointegrated with ecological footprint. However, no evidence is found for ecologically unequal exchange theory for Turkey, because the coefficient of the weighted export index is insignificant. However, the coefficient sign of the weighted export is negative.

### 4.3.5 Vector Error Correction Model

In this subsection vector error correction (VEC) models are estimated for each model. By doing so, we can find the number years necessary to re-align after a shock. In order to do this, the absolute value of the speed of adjustment (error correction term) is inverted. In Model 1, this is found as 0.64 years. In Model 2, it is 0.58 years. In Models 3 and 4, re-aligning takes place after 0.59 and 0.53 years. These figures demonstrate that the VECM model results are plausible and the use of VECM models can be justified from these findings.

### 4.3.6 Variance Decomposition

Finally, variance decomposition is performed and Figures 4.7, 4.8, 4.9 and 4.10 demonstrate variance decomposition of per capita ecological footprint by each model. Variance decomposition exercise was performed for 10 periods according to Cholesky ordering. Figure 4.7 illustrates variances decomposition of logged per capita ecological footprint for Model 1. In this figure, per capita GDP explains 21.3% variance decomposition of per capita footprint is after ten years. Arable per person and urbanization explain only 2.11% and 6.69 % of the variance in per capita footprint in tenth period.

Figure 4.7 Variance decomposition of LEFP in Model 1

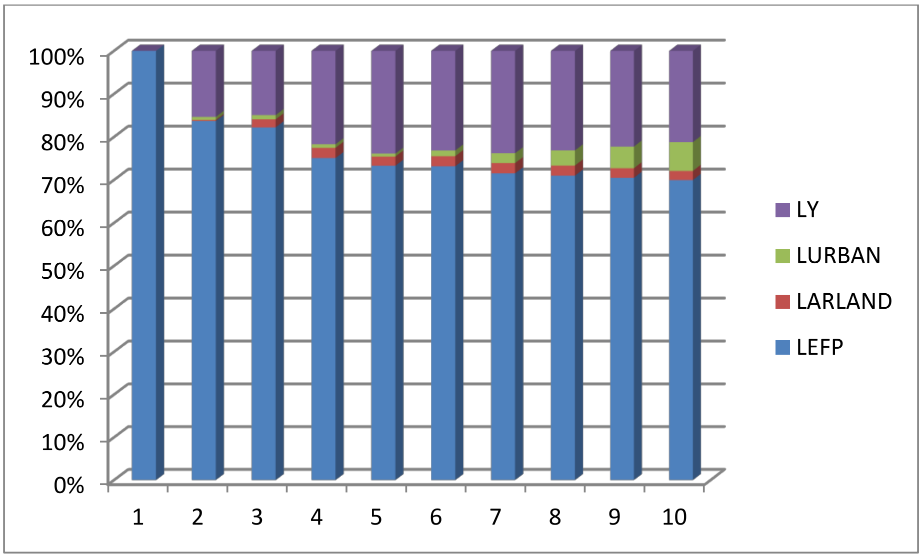
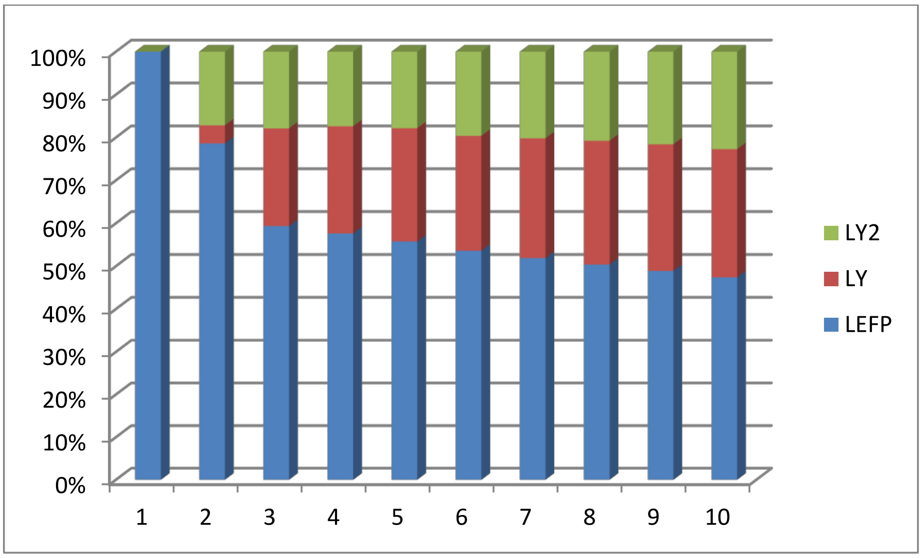


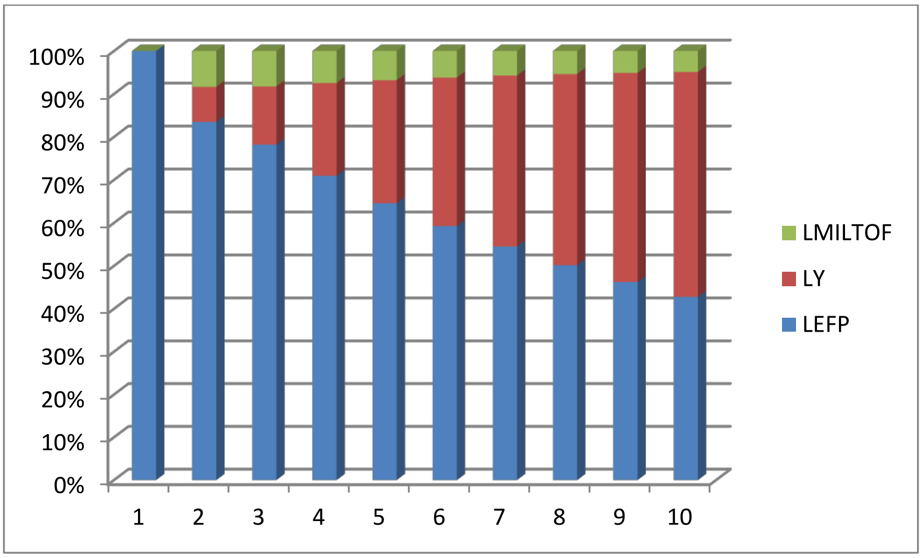

Figure 4.8 shows that GDP the main explanatory of variance decomposition ecological footprint. GDP explains 29.8% of the variance in ecological footprint, while the squared GDP explains 22.7%.

Figure 4.8 Variance decomposition of LEFP in Model 2



For Model 3, GDP per capita explains 39.2% of the variance in per capita ecological footprint in the tenth period, while logged military expenditures as a percentage of GDP explains 19.7%. These are illustrated in Figure 4.9.

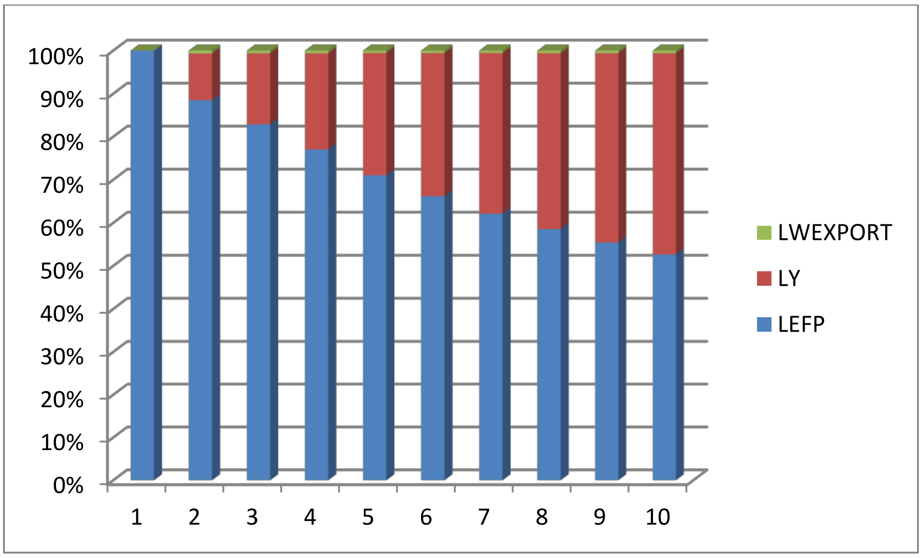
Figure 4.9 Variance decomposition of LEFP in Model 3




Finally, Figure 4.10 shows that weighted export flow index has almost zero explanatory power in the variance of per capita ecological footprint. However, per capita GDP explains 46.7% of the variance.

In all models, it is clearly seen that, after a shock is given to ecological footprint, most of the variance is explained by GDP per capita. To put differently, as GDP is the single most import factor in explaining the variance in ecological footprint, the treadmill of production theory seems to have a strong explanatory power in explaining the ecological footprint in Turkey.

Figure 4.10 Variance Decomposition of LEFP in Model 4




### 4.3.7 Discussion

The findings of the models strongly confirm the treadmill of production theory, urban political economy theory and invalidate the ecological modernization theory for Turkey. However, no evidence is found to confirm or reject the environmental Kuznets curve, the treadmill of destruction theory and the ecologically unequal exchange theory. In all models, there is a positive and significant relationship between per capita ecological footprint and per capita GDP. It means that all models confirm treadmill production theory which mainly posits that the profit seeking economic structure increases level of environmental degradation. In model 1, urbanization and arable land per capita are statistically significant and positively cointegrated with per capita ecological footprint. This model confirms urban political economy assumptions and positive relation between agricultural activities and ecological footprint. In model 2, although the coefficient sign of the squared per capita is negative, it is statistically insignificant and this model does not confirm the environmental Kuznets curve for Turkey. Model 3 shows that there is no statistically significant relation between military expenditures and ecological footprint. Finally, Model 5 illustrates that even the coefficient of the weighted export flow index is negative, it is statistically insignificant. The results of Models 4 and 5 conflict with several studies which test these theories for cross-country analysis (Jorgenson and Rice 2007; Jorgenson 2009; 2010; Jorgenson et al. 2010). These different results provide evidence towards homogeneity problem often faced in panel data studies. In panel data analysis, heterogeneity should be considered seriously.[2] In such studies Turkey is generally included in a panel of various countries. When we classify Turkey as developing country, Turkey is likely to be put into a heterogeneous panel which may well include less developed and highly developed countries

In the variance decomposition analysis of ecological footprint, GDP per capita is found to be the main explanatory factor. This finding also strongly confirms the treadmill of production theory for Turkey and runs counter to the ecological modernization theory. Turkey as a developing country aims to catch-up developed countries by performing high level GDP growth. This development process creates higher ecological footprint. As the treadmill production theory points out growth-based economies cause environmental degradation and  high level environmental exploitation.

This thesis also has limitations. First of all, it has a relatively small time span for time series regressions. This problem causes the elimination of some variables

[2] Akkemik and Göksal (2012) and Akkemik et al. (2012) offer methods that deal with the homogeneity problem in panel data.

which can be used as control variables. In the future, the findings of this study may change with additional observations.

# Chapter 5

## CONCLUSION

Global warming, poverty and hazardous wastes of industries are still big problems in the contemporary world. Nations during their development process, generally damage environment and ecosystem. The aim of the study is to investigate how Turkey exploited environment within economic development process by looking at multiple the environmental sociology theories. First of all, what we see is increasing ecological footprint per capita between 1970 and 2010. In 1970 per capita ecological footprint was 1.69, but in 2010 it increased to 2.5 and at the same time, a dramatic fall is observed in biocapacity in Turkey between 1970 and 2010. The findings of this study shed light on possible relations with ecological footprint in Turkey. Relating the findings with theories, this paper concludes that the level of economic development (per capita GDP) is positively correlated with ecological footprint. This translates into environmental degradation. This relation conflicts with the ecological modernization theory for Turkey. This conclusion can be criticized since that it can be argued economic development in Turkey is still in process and did not reach the level of developed countries yet. However, several studies illustrate similar controversies for developed countries including the Netherlands where there is a positive relation between ecological footprint and the level of economic development which runs counter to the ecological modernization theory. On the other hand, the positive relation between the level of economic development and environmental degradation confirms and supports the treadmill of production theory.

Urbanization's relation with environmental degradation is significant at the %10 level and statistically significant. Even the some studies argue that, the type of urbanization of Turkey is based on slums and *gecekondu* (shanty) houses (Adaman and Keyder 2006), this study confirms positive relation between urbanization and environmental degradation. Furthermore, Jorgenson et al. (2010) find a negative relation between the number of slums and energy consumption in less developed countries. However, the findings of this thesis contradict with these studies.

Turkish Armed Force has been influential in politics and economy in Turkey. It was not only interested with Turkey's border defense and security, it was also, the protector of interests of the middle class, and in turn, of the capitalist market economy through the integration of its top echelons into existing capitalist border (Sakallioglu 1997). However, the relation between militarization and ecological footprint is found to be insignificant. This situation cannot confirm the treadmill of production theory for Turkey.

In conclusion, I found that the level of Turkey's economic development, and the extent of urbanization correlate with environmental degradation. While this thesis does not measure the effectiveness of available policy tools to solve environmental problems, it is possible to suggest some policy conclusions for Turkey. These policy conclusions might be (i) to change economic growth pattern and to monitor the negative effects of urbanization. However, there are strong reasons to believe that the environmental problems are not limited within a nation's borders, and hence, 'global' climate change needs to be considered as well: As Hornborg (2014) puts forward, environmental problems are part of a zero-sum game without international common solutions. It seems yet hard to solve environmental problems at the global level.

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# APPENDIX A: HIGH INCOME COUNTRIES

| *Country* | *Years of inclusion in the high-income countries list* |
|---|---|
| France | 1987 - 2010 |
| Belgium | 1987 - 2010 |
| Netherlands | 1987 - 2010 |
| Germany | 1987 - 2010 |
| Italy | 1987 - 2010 |
| United Kingdom | 1987 - 2010 |
| Ireland | 1987 - 2010 |
| Denmark | 1987 - 2010 |
| Greece | 1996 - 2010 |
| Portugal | 1994 - 2010 |
| Spain | 1987 - 2010 |
| Luxembourg | 1987 - 2010 |
| Iceland | 1987 - 2010 |
| Norway | 1987 - 2010 |
| Sweden | 1987 - 2010 |
| Finland | 1987 - 2010 |
| Switzerland | 1987 - 2010 |
| Liechtenstein | 1994 - 2010 |
| Austria | 1987 - 2010 |
| Faroe Islands | 1987 - 2010 |
| Andorra | 1990 - 2010 |
| Gibraltar | 2009 - 2010 |
| Malta | 1989, 1998, 2000, 2002 - 2010 |
| San Marino | 1991-1993 , 2000 - 2010 |
| Estonia | 1987 - 2010 |
| Latvia | 2009 |
| Poland | 2009 - 2010 |
| Czech Republic | 2006 - 2010 |
| Slovakia | 2007 - 2010 |
| Hungary | 2007 - 2010 |
| Slovenia | 1997 - 2010 |
| Equatorial Guinea | 2007 - 2010 |
| USA | 1987 - 2010 |
| Canada | 1987 - 2010 |
| Greenland | 1987 - 2010 |
| Bermuda | 1987 - 2010 |
| Bahamas, The | 1987 - 2010 |
| Turks and Caicos Islands | 2009 - 2010 |
| USA Virgin Isl. | 1987 - 2010 |
| Cayman Islands | 1993 - 2010 |
| Barbados | 1989, 2000, 2002, 2006 - 2010 |
| Trinidad and Tobago | 2006 - 2010 |
| Aruba | 1987 -1990, 1994 - 2010 |
| Netherlands Antilles | 1994 - 2009 |
| Israel | 1987 - 2010 |
| Saudi Arabia | 1987- 1989, 2004 - 2010 |
| Kuwait | 1987 - 2010 |
| Bahrain | 1987- 1989, 2001 - 2010 |
| Qatar | 1987 - 2010 |
| UAE | 1987 - 2010 |

| | |
|---|---|
| Oman | 2007 - 2010 |
| Brunei Darussalam | 1987, 1990 - 2010 |
| Singapore | 1987 - 2010 |
| South Korea | 1995 - 1997, 2001 - 2010 |
| Japan | 1987 - 2010 |
| Taiwan | 1987 - 2010 |
| Hong Kong | 1987 - 2010 |
| Macao | 1994 - 2010 |
| Australia | 1987 - 2010 |
| New Zealand | 1987 - 2010 |
| New Caledonia | 1995 - 2010 |
| Northern Mariana Islands | 1995 - 2001, 2007 - 2010 |
| French Polynesia | 1990 - 2010 |
| Guam | 1987- 1989, 1995 - 2010 |
| Antigua and Barbuda | 2002, 2005 - 2008 |

Note: For years between 1970 and 1987, high income countries are selected using 1987 high income classification of the World Bank.