REPUBLIC OF TURKEY
YILDIZ TECHNICAL UNIVERSITY
INSTITUTE OF SOCIAL SCIENCES
DEPARTMENT OF ECONOMICS
MASTER'S IN ECONOMICS

MASTER THESIS

AN EXAMINATION OF TURKEY'S ENVIRONMENTAL POLICIES WITH ENVIRONMENTALLY EXTENDED INPUT-OUTPUT ANALYSIS APPROACH

VOLKAN GÜNGÖR
16729013

ADVISOR:
ASSOC. PROF. DR. YASEMİN ASU ÇIRPICI

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ÖZ

TÜRKİYE'NİN ÇEVRE POLİTİKALARININ ÇEVRESEL GİRDİ-ÇIKTI ANALİZİ YAKLAŞIMIYLA İNCELENMESİ

Volkan Güngör

Ocak 2019

Bu çalışmada, Türkiye'deki çevre politikaları çevresel olarak genişletilmiş girdi-çıktı analizi (ÇGGÇA) kullanan bir yaklaşımla incelenmiştir. Bu amaçla, Türkiye'nin yurtiçi ve ithalat girdi-çıktı tabloları ve ürün gruplarına göre yurtiçi üretim ve ithalat değerlerinden hesaplanan farklı ağırlıklar yardımıyla sektörel ayrıştırılması yapılan ülke girdi-çıktı tablosu ve bu ayrıştırılmış tabloya göre sektörel ayarlanması yapılan hava emisyon hesapları kullanılarak Türkiye'nin nihai tüketim, yatırım (gayrisafi sermaye oluşumu), ihracat ve ithalat bileşenleri için de ayrı ayrı olmak üzere toplam tüketim temelli emisyon envanteri (TTE) oluşturulmuştur. İlk olarak, tüketim temelli emisyon envanterindeki tüm değerlerin toplamına eşit olan Türkiye'nin emisyon sorumluluğu hesaplanıp ülkenin toplam emisyonlarıyla karşılaştırılmış, Türkiye'nin emisyon sorumluluğunun toplam emisyonlarından %2,4 oranında daha yüksek olduğu bulunmuştur. İkinci olarak, hava emisyon hesapları ve hesaplanan emisyon envanterleri kullanılarak kritik ürün grupları belirlenmiş ve Türkiye'nin Niyet Edilen Ulusal Olarak Belirlenmiş Katkı (NUBK) dokümanı her bir kritik ürün grubu için incelenmiştir. Bu dokümanın, çoğu emisyon kaynaklarını dikkate almasına rağmen Türkiye'nin 2012 yılındaki en büyük endüstrisi ve tüketim temelli emisyonlarda en büyük paya sahip olan inşaat sektörünü ve onun üretim zincirlerinde önemli payı olan diğer metalik olmayan mineral ürünleri imalatı ürünlerini içermediği bulunmuştur.

Anahtar Kelimeler: Tüketim Temelli Emisyon Envanteri, Girdi-Çıktı Tablolarının Ayrıştırılması, Çevre Politikaları, Çevresel Olarak Genişletilmiş Girdi-Çıktı Analizi, NUBK, Sera Gazı Emisyonları, Türkiye

ABSTRACT

AN EXAMINATION OF TURKEY'S ENVIRONMENTAL POLICIES WITH ENVIRONMENTALLY EXTENDED INPUT-OUTPUT ANALYSIS APPROACH

Volkan Güngör

January 2019

In this study, the environmental policies in Turkey are examined with an approach that employs an environmentally extended input-output analysis (EEIOA). To this end, Turkey's consumption-based emission inventory (CBI) with a decomposition of final demand components that are final consumption, investment (gross capital formation), exports and imports is created using Turkey's input-output table that is disaggregated with the help of its domestic and import decompositions and different weights calculated from Turkey's domestic outputs and imports by product group and air emission accounts that is adjusted to the disaggregated table. Firstly, Turkey's emission responsibility which equals to the sum of the elements of the consumption-based inventory is calculated and compared with its total emissions and it is found that Turkey's emissions responsibility is 2,4% larger than its own production-based emissions. Then, some critical product groups are determined with the help of both air emission accounts and calculated consumption-based inventories and the implications of Turkey's Intended Nationally Determined Contribution (INDC) is examined for each critical product group. It is found that although Turkey's INDC considers many important emission sources that contribute a large part of its total emissions, it misses the products of manufacture of other non-metallic minerals that have an important share in the supply chains of construction sector, the largest industry and the one that is the largest in Turkey's CBI in 2012.

Keywords: Consumption-Based Inventory, Disaggregation of Input-Output Tables, Environmental Policies, Environmentally Extended Input-Output Analysis, INDC, Greenhouse Gas Emissions, Turkey

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LIST OF ABBREVIATIONS

BAU: Business as Usual

CBI: Consumption-Based Inventory

CGE: Computable General Equilibrium

CPA: European Classification of Products

CRF: Common Reporting Format

EEIOA: Environmentally-Extended Input-Output Analysis

EKC: Environmental Kuznets Curve

EPA: United States Environmental Protection Agency

EU ETS: European Union Emissions Trading System

EUROSTAT: European Statistical Office

GHG: Greenhouse Gas

GWP: Global Warming Potential

INDC: Intended Nationally Determined Contribution

LULUCF: Land Use, Land-Use Change and Forestry

MRIO: Multiregional Input-Output Model

NACE Rev. 2: European System of Classification

PBI: Production-Based Inventory

SAM: Social Accounting Matrix

TURKSTAT: Turkish Statistical Institute

UNFCCC: United Nations Framework Convention for Climate Change

1. INTRODUCTION

One of the most considerable concerns in the last century is the unprecedented increases in atmospheric concentrations of greenhouse gases. Almost exponential growth in the levels of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) causes the atmosphere and the oceans to be warmer, snow and ice masses in the Arctic sea, Antarctica and Greenland to be lost, and; hence, the sea levels all over the world to rise. These phenomena all together constitute global warming. As a result of increasing temperatures, extreme events in the weather conditions occur and physical and biological systems are distorted. These phenomena are called climate change which is a result of global warming. Due to cumulative emissions of CO_2 emissions, most aspects of climate change will persist for many centuries even if emissions are stopped. The size of the global warming and climate change has substantial negative impacts on economic growth and developments of countries. The economic growth rates of countries decrease especially in poor countries and agricultural output, industrial output and investment levels are reduced (Dell, Jones, & Olken, 2008). Especially agriculture, ocean fisheries, freshwater access, migration, and tourism can be listed as some of the main activities to be affected.

As climate change is a global problem, there have been several global joint action attempts. Among them, the most important one is the United Nations Framework Convention on Climate Change (UNFCCC), which was signed in 1992. It led to two important agreements requiring commitments which are Kyoto Protocol signed in 1997 and covered 2008-2012 commitment period and the Paris Agreement signed in 2015 and still active. It covers 2020-2030 period and requests each Party to outline and communicate their climate actions, which are named Intended Nationally Determined Contributions (INDCs) (UNFCCC, 2018). Turkey, as one of the parties to the UNFCCC and the Paris Agreement, submitted its INDC in September 2015. In addition, countries annually submit their national emission inventories to the UNFCCC in a Common Reporting Format (CRF). They are production-based inventories which focus on the emissions sources in all polluting gases activity by activity. Turkey is also one of the countries that submit its national emission inventories annually.

Since those inventories are prepared in a production-based format, the international distribution of responsibilities in mitigating climate change and national strategies for combatting it are highly dependent on them. However, production-based inventories reflect only the emissions that are made in the place where production occurs and since some of those production activities are made for the consumption in somewhere else, the international responsibility distribution may not be as fair as it seems (Afionis, Sakai, Scott, Barrett, & Gouldson, 2017). In addition, the mitigation strategies determined by these inventories may not be adequate without concerning the effects of consumption. This intuition has arisen a new discussion in the literature as to whether the consumption-based inventories or production-based inventories to be used in planning the climate change mitigation policies (Franzen & Mader, 2018). For this purpose, there is a simple method that employs an environmentally extended input-output analysis (EEIOA) approach proposed for obtaining the consumption-based inventories of the countries (Kitzes, 2013).

The EEIOA methodology requires input-output tables and production-based inventories as the main data sources with identical activities. Nevertheless, the classification of activities in CRF is highly different than the input-output tables provided by most countries. Hence, some levels of aggregation and disaggregation problems occur in matching the activities for some kinds of analysis including environmentally-extended input-output models, computable general equilibrium (CGE) models based on social accounting matrices (SAM) and all other extensions of them (Lenzen, 2011).

In this study, a simple method for the disaggregation of an input-output table is proposed and applied to Turkey's table. Then, the obtained table is used to create Turkey's consumption-based inventory (CBI) which is equivalent to Turkey's emissions responsibility with its decompositions into the final demand components; final consumption expenditures by households and government, total gross-fixed capital formation and imports. In addition, if imports are replaced by exports in the inventory, its total value becomes equal to Turkey's production-based inventory (PBI) which is identical to the national emissions inventory used for the analysis. As a result, Turkey's calculated CBI and obtained PBI are compared in their sums. Moreover, the critical product groups are selected from all inventories and they are searched in Turkey's INDC document.

The purpose of the present study is to examine Turkey's INDC through the calculation of the consumption-based emissions inventory for Turkey by employing EEIOA utilizing a more detailed sectoral input-output table through the use of a simple disaggregation technique. The rest of the present study is structured as follows: Section 2 reviews relevant literature including the uses of input-output models, computable general equilibrium models and social accounting matrices for analyzing Turkey's environmental structure and policies. In addition, it presents a discussion in using consumption-based inventories (CBIs) instead of production-based inventories (PBIs) and the method for computing CBIs. Finally, it names and briefly presents some methods used to disaggregate input-output tables and discusses their reliability. Section 3 overviews Turkey's INDC document and National Emissions Inventory Report and presents the data used in the analysis including the structure of Turkey's input-output table for the year 2012 and the air emission accounts. It also presents the method used in the present study for sectoral disaggregation of the table and the air emission accounts. Section 4 explains the method for computing consumption-based inventories using EEIOA. Finally, Section 5 presents the results of the model and Section 6 concludes.

2. REVIEW OF RELEVANT LITERATURE

2.1. Discussion and Creation of Consumption-Based Inventories

Although there are some studies that do not support consumption-based inventories, the dominant tendency in the literature is in favor of them. Afionis, et al. (2017) present the cases in the literature that the consumption-based accounting is advantageous and the arguments against it. According to their review, while the proponents of consumption-based accounting suggest that it has potential to cover more emissions such as emissions arising from international aviation and marine bunker fuels, reduce strong carbon leakage defined as relocation of carbon-intensive production from developed to developing countries, encourage cleaner production in both developed and developing countries, and encourage the participation in global actions, and bring equity and justice between developed and developing countries within the global actions, the opponents claim that it would be inefficient and politically incompatible in practice. They conclude it is unlikely to switch from PB accounting to CB accounting in a near future as the position of PB accounting is strong and there is some time necessary to mature the arguments of shared responsibility and implementation of CB accounting. Fernández-Amador, et al. (2017) investigate the relationship between real GDP per capita and CO_2 emissions per capita associated with both production and consumption activities by searching for an environmental Kuznets curve (EKC). They find that consumption-based accounts have larger income elasticities than production-based inventories most probably because of carbon embodied in trade; hence, consumption-based policy instruments are necessary for national environmental actions. Davis and Caldeira (2010) present a global consumption-based emissions inventory for carbon dioxide by employing a multiregional input-output model (MRIO) and they find that 23% of global emissions were traded internationally as exports from developing countries and imports to the developed world in 2004. Davis, et al. (2011) add the extraction-based emissions to the model and find that 37% of emissions are made fossil fuels traded internationally. In both studies, it can be inferred that there is a strong possibility for carbon leakage.

Fan, et al. (2016) compare the production-based and consumption-based emissions of 14 economies and find that in some countries like France and Russia two accounting types does not have large differences while others like China have larger gaps between them. In addition, positive correlations between emissions and per capita GDPs are more apparent when CBA is used. Liddle (2018) also compares two different sets of emissions and states that most countries are net importers of carbon emissions while China is responsible for over half the global carbon emissions embodied in trade. One of the rare studies that do not support CBA is published by Franzen and Mader (2018). They compare two sets of inventories for 110 countries by using 2011 data as the latest available one. They calculate Pearson and Spearman correlations between two sets of inventories and find that they are highly correlated and statistically similar.

Although the literature in creating consumption-based accounts is not new, the present study reviews the following studies. Peters (2008) presents accounting approaches for calculating consumption-based national emission inventories. Wiedmann, et al. (2006) propose a method for the allocation of consumption-based emissions to final consumption categories. Perman, et al. (2003) and Kitzes (2013) provide introductions to environmentally-extended input-output analysis including goals of the analysis, principles, and mathematics behind it and the discussions regarding the approach.

2.2. Use of EEIOA, CGE and SAM Models Regarding Environmental Issues for Turkey

In the recent literature, the dominance of the use of computable general equilibrium models for the analysis of economy-environment interactions and environmental policies in Turkey is observed. Kumbaroğlu (2003) explores economic effects of environmental taxation by employing a dynamic CGE model of the Turkish economy and finds that emission taxation should be preferred as a policy instrument and oil and gas instead of hard coal and lignite should be preferred for a higher quality of environment and energy imports should be reduced to accelerate economic development. Telli, et al. (2008) also suggest environmental taxation with a simultaneous reduction in any other tax rather than direct carbon emission quotas. Olçum and Yeldan (2013) examine the possible integration of Turkey with the European Union Emissions Trading System (EU ETS) and find that Turkey has economic gains under EU’s 20% emission reduction target; however, if the target increases to 30%, the country faces a large output loss. Bouzaher, et al. (2015) and Kolsuz and Yeldan (2017) focus on the green growth policies and find that the utilization of environmental tax revenues for green growth policies such as green jobs and R&D induced innovation can reduce greenhouse gas emissions as well as it provides productivity gains and high employment opportunities. Acar and Yeldan (2016) consider the environmental impact of coal subsidies in Turkey and they find that the removal of those subsidies results in an apparent reduction in greenhouse gas emissions without a significant loss in its GDP.

Although the relevant literature for Turkey is mostly dominated by CGE models, there are some studies regarding the pollution sizes of the country's sectors and its international responsibilities. Akbostancı, et al. (2007) examine the pollution haven hypothesis, dirty industries have been migrating from developed countries to the developing countries, from a trade perspective for Turkey for the 1994-1997 period. They employ a panel data approach and find that as dirtiness of the producing industries increases Turkey's exports increase. The most related study to the present study is conducted by Tunç, et al. (2007). They estimate an environmentally extended input-output model for Turkey by using 1996 data including 43 aggregated sectors to detect the main sources of CO_2 emissions and discuss the shares of sectors in Turkey's total emission and compare the CO_2 emissions and CO_2 responsibilities of them. They find that Turkey's total CO_2 responsibility is larger than its own emissions and find that the manufacturing industry in total is the largest in both rankings while agriculture and husbandry are the smallest. Kucukvar, et al. (2015) conduct a time series MRIO analysis by using the World Input-Output Database covering the 2000-2009 period. They find that the most dominant sector in terms of carbon footprint is the electricity, gas and water supply sector in the supply chains of the Turkish industrial sectors. They also find that indirect emissions are larger than direct emissions in the Turkish manufacturing industry; hence, the supply chains on overall carbon footprints of the sectors have a crucial role. Alkan, et al. (2018) create an environmentally extended social accounting matrix based on 2012 Input-Output data to evaluate the emission reduction potentials of Turkey's National Climate Change Action Plan, Intended Nationally Determined Contribution and alternative policies. They find that the emission reduction target in Turkey's INDC document is not attainable with the preparation and implementation of the suggested policies in the documents.

2.3.Disaggregation of Input-Output Tables

In most of the studies regarding the environmental extensions of input-output (IO), computable general equilibrium (CGE) and social accounting matrices (SAM) models, there occur the problems in data matching between the input-output table and the environmental accounts. The easiest way to solve this problem is to aggregate the one of or both the data to eliminate the mismatch. However, this disaggregation activity reduces the strength of the study for three reasons. First, most of the criticisms to input-output models concern the assumption that the intermediate inputs are the fixed proportions of the output of the purchasing industry. It is pointed out that much of what accepted as the term “substitution” is due to the high level of aggregation in the empirical economic studies; therefore, as the model is disaggregated, the technical substitution becomes less likely in any production processes (Rose & Miernyk, 1989). The interpretation of this understanding by the present study is that if any aggregation activity is implemented to the model, the possibility of substitution increases and the employment of Leontief production function in the model which allows no substitution between inputs loses its credibility. Secondly, the environmentally extended input-output model assumes that each 1 dollar of output sold by any sector to every other sector and final consumers carry an identical environmental impact (Kitzes, 2013). Hence, as the tables are aggregated, it is highly possible to treat very different products as if they have the same environmental impacts. Finally, in order to monitor the environmental impact of a specific product, the values that belong to that product should not be embedded in any other product group. For example, the extraction of coal emits high amounts of methane (EPA, 2018) while it is embedded in the aggregated sector “Mining and Quarrying” in European classification systems (Eurostat, 2008). In addition, Lenzen (2011) shows by comparing relative standard errors that, even if when it is based on proxy information, the disaggregation of an input-output table is superior to any aggregation of an environmental account in matching the sectoral structures of data. As a result, the input-output multipliers are also more accurate than the existing input-output table.

There are some studies proposing disaggregation techniques which are based on the output weights of disaggregating sectors within the disaggregated sector. Wolsky (1984) proposes the sum of the augmented matrix which is created by directly disaggregating the related sector into two with the output weights within it and distinguishing matrix which is parameterized by some independent variables having some bounds given by a set of inequalities. When those parameters are estimated within the given bound, the disaggregation is complete. The present study does not prefer this approach since it lets disaggregation of one sector into only two and it requires more data for estimating each point within the bounds. Lindner, et al. (2012) present a method that allows disaggregating sectors into more than two in the case when the only available information is the output weights of the newly formed sectors. They create probability distributions for the elements of the Leontief inverse matrix by using the combinations they explore through a random walk algorithm on the polytope they define. The method can really work when there is limited information of output weights; however, if the output weights reflect only the domestic production, and if the subsectors of the disaggregated sector contain high imports, the numbers cannot reflect even the disaggregation of the total output. This is also the case for the method proposed by Wolsky (1984) and the direct use of the augmented matrix, the method used by Alkan, et al. (2018) in the creation of environmentally extended SAM for Turkey.

3. DATA

3.1.An Overview of the Documents Turkey Submitted to the UNFCCC

In Turkey's Intended Nationally Determined Contribution (INDC), submitted in September 2015 to the United Nations Framework on Climate Change Convention (UNFCCC), along with the main target set as a 21 percent reduction in greenhouse gas emissions (GHGs) from the Business as Usual (BAU) level by 2030, very comprehensive targets, plans and policies were also expressed under the titles of energy, industry, transport, buildings and urban transformation, agriculture and waste (Republic of Turkey, 2015). However, except for energy consumed residentially and transportation activities as final goods, most plans and policies point out the production-based emissions rather than consumption-based ones. In other words, the effect of final demands for goods and services in the economy including the exported ones are not considered. For example, under energy title, Turkey projects to increase the capacity of its renewable energy sources, specifically solar power, wind power, and hydropower plants and decrease its electricity network losses through rehabilitation of its existing capacity and establishment of new electricity production and distribution systems (Republic of Turkey, 2015). These targets and plans clearly aim at reducing the share of fossil fuels in the production of electricity. However, since the main goal is the consumption of electricity in the present study, how much of the electricity produced is consumed residentially and how much of it is consumed in the production sectors are more essential. In 2012, Turkey's residential electricity consumption as a final demand constitutes only 23,5 percent of the energy available for final demand. The remaining part of the final demand is used mostly by industry, services, agriculture, and transport sectors to produce new forms of goods and services (Eurostat, 2018).

In the National Greenhouse Gas Inventory Report for the period 1990-2012, prepared by Turkish Statistical Institute, annually submitted under "Framework Convention on Climate Change", the largest emission sources that contribute to 95% of total emissions in Turkey in CO_2 equivalent are determined in line with the Common

Reporting Framework (CRF) for the year 2012. Excluding Land Use, Land-Use Change and Forestry (LULUCF), the most significant CO_2, CH_4, and N_2O sources were listed as public electricity and heat production (CO_2), road transportation (CO_2), cement production (mineral products) (CO_2), residential (CO_2), solid waste disposal (managed) (CH_4), iron and steel production (CO_2), enteric fermentation (CH_4), solid waste disposal (unmanaged) (CH_4), cement production (CO_2), other industries (CO_2), agricultural soil (synthetic fertilizer) (N_2O), lime production (mineral products) (CO_2), civil aviation (CO_2), iron and steel (CO_2), agriculture, forestry, fisheries (CO_2), manure management (N_2O), petroleum refining (CO_2), domestic and commercial wastewater handling (N_2O), agricultural soil (animal manure applied) (N_2O), chemicals (CO_2), manure management (CH_4), domestic and commercial wastewater handling (CH_4), fertilizer (CO_2), navigation (CO_2), ceramics (CO_2), textile (CO_2), mining (surface) (CH_4), agricultural soil (crop residue) (N_2O). The emission of HFCs (HFC-134a) is also on the list. The sources of data, estimation methodologies, tables, and graphs were explained in detail in the report (UNFCCC, 2014).

In general, the estimates in the same report indicate that, in 2012, excluding LULUCF, the largest share of the emissions came from the energy sector with 70.2%; the industrial processes had the second largest with 14.3%, followed by waste with 8.2% and the agriculture with 7.3%. Table 1 shows the emission shares between sectors including LULUCF (land use, land-use change, and forestry) sector (UNFCCC, 2014). The numbers in Table 1 clearly indicate that, in 2012, compared to 1990, while the shares of the energy and agriculture sectors had decreased, the industry and waste sectors had done the opposite. Moreover, one can clearly observe that the ability of the LULUCF sector to meet the air pollution emitted by the others had significantly declined.

Table 1: Contributions of sectors to the total emissions, %

	1990	1995	2000	2005	2009	2010	2011	2012
Energy	*92,05*	*84,45*	*85,97*	*86,26*	*88,63*	*82,49*	*82,95*	*81,2*
Industrial Processes	*10,7*	*12,66*	*9,83*	*10,24*	*10,53*	*16,11*	*16,13*	*16,52*
Agriculture	*21,05*	*15,29*	*11,23*	*9,35*	*8,29*	*7,85*	*7,94*	*8,49*
Waste	*6,73*	*12,48*	*13,16*	*11,84*	*10,44*	*10,29*	*9,72*	*9,53*
LULUCF	*-30,53*	*-24,87*	*-20,18*	*-17,7*	*-17,9*	*-16,74*	*-16,74*	*-15,74*

Source: National Greenhouse Gas Inventory Report 1990-2012

3.2.Turkey's 2012 Input-Output Tables

A typical input-output table includes an intermediate part which is a square matrix having equal number of rows and columns. This core part of the table can be prepared as an industry-by-industry table, a commodity-by-industry table, or a product-by-product table. Each element of the transactions matrix part of an industry-by-industry input-output table describes the value of the sales of an industry in the row to the one in the column of the matrix. An industry can be defined as a collection of firms or parts of firms and in most industries, more than one product type is produced; hence, in the preparation of such a table, the values in one industry might include the main product of another industry. Although data collection becomes easier in this sense, it creates heterogeneity in the analysis. Alternatively, Rosenbluth (1968) suggests the use of a product-by-industry input-output table, in which the rows of the table are the commodities rather than industries while the columns remain as industries, since the coefficients calculated through the use of industry-by-industry tables cannot represent the exact commodity inputs even if the industries are defined more narrowly. Even though this suggestion would seem to produce more homogenous input coefficients than inter-industry coefficients, since the number of rows naturally become larger than the number of columns, the table would not be symmetric. Finally, as it is more homogenous and symmetric, product-by-product input-output tables are the most useful and suitable in the most practices of input-output analysis (Eurostat, 2008).

Fortunately, the main data source, Turkey's 2012 Input-Output Table, utilized by the present study is prepared in a product-by-product dimension reflecting 64 product groups satisfying input requirements of 64 homogenous production branches in its intermediate part. The number and structure of the product groups are based on the European Classification of Products by Activity (CPA) 2008. On the right-hand side of the table, there are final demand components which are final consumption expenditures by households, non-profit institutions serving households and government, gross fixed capital formation and changes in inventories, and exports. On the bottom of the transactions matrix, there are value-added components which are taxes less subsidies on products, compensation of employees, other net taxes on production, consumption of fixed capital on operating surplus, net operating surplus and import use (Turkstat, 2016). A visual interpretation of the structure of Turkey's Input-Output Table is presented in Table 2.

Table 2: Structure of Turkey's Input-Output Table

		Product Groups						**Total Final Demand**			
		Pr. Group 1	**Pr. Group 2**	**Pr. Group …**	**Pr. Group j**	**Pr. Group 64**	**Total sales of product group i as input**	**Final Consumption Expenditures**	**Total Gross Capital Formation**	**Exports**	**Total Use**
Product Groups	**Pr. Group 1**										
	Pr. Group 2										
	Pr. Group …	Transactions Matrix (64x64)						HHG Vector	GFC Vector	Exports Vector	Total Use Vector
	Pr. Group i										
	Pr. Group 64										
	Total input use by product group j										
Total Value Added	**Taxes less subsidies on products**										
	Compensation of Employees										
	Other net taxes on production										
	Consumption of fixed capital on operating surplus										
	Net operating surplus										
	Import Use	Total Import Use Vector									
	Total Output	Total Output Vector									

In Turkey's Input-Output Table, as well as a standard input-output table, the following equations hold elementwise:

$$Total\ Use\ =\ Total\ Output \tag{1}$$

$$Total\ Use\ =\ Total\ Input\ Sales\ +\ Total\ Final\ Demand \tag{2}$$

$$Total\ Output\ =\ Total\ Input\ Use\ +\ Total\ Value\ Added \tag{3}$$

In addition to the main input-output table, the import and domestic decompositions are also published. The structure of the domestic table is very similar to the structure of the main table except that it does not have an import use part. By its definition, all elements of the table reflect only the domestic production and use (Table 3).

Table 3: Structure of the Domestic Input-Output Table

		Product Groups						**Total Final Demand**			
		Pr. Group 1	**Pr. Group 2**	**Pr. Group …**	**Pr. Group j**	**Pr. Group n**	**Total sales of product group i as input**	**Final Consumption Expenditures from Domestic Production**	**Total Gross Capital Formation from Domestic Production**	**Exports from Domestic Production**	**Total Use from Domestic Production**
	Pr. Group 1										
	Pr. Group 2										
Product Groups	**Pr. Group …**	Domestic Transactions Matrix (64*64)						HHG Vector (D)	GFC Vector (D)	Exports Vector (D)	Total Use Vector (D)
	Pr. Group i										
	Pr. Group n										
	Domestic input use by product group j										
	Taxes less subsidies on products										
	Compensation of Employees										
Total Value Added	**Other net taxes on production**										
	Consumption of fixed capital on operating surplus										
	Net operating surplus										
	Total Domestic Output	Domestic Production Vector									

On the other hand, since it reflects the purchases from the rest of the world, the import table does not include a value-added component while the structure of the remaining is identical to the main table and the domestic table (Table 4). The total import use vector of the main table is identical to the vector at the right-hand side of the import table.

Table 4: Structure of the Import Input-Output Table

		Product Groups						**Total Final Demand**			
		Pr. Group 1	**Pr. Group 2**	**Pr. Group …**	**Pr. Group j**	**Pr. Group n**	**Total imports of product group i as input**	**Final Consumption Expenditures from Imports**	**Total Gross Capital Formation from Imports**	**Reexports of Imports**	**Total Import Use**
Product Groups	**Pr. Group 1**	Imports Transactions Matrix (64x64)						HHG Vector (IM)	GFC Vector (IM)	Exports Vector (IM)	Total Import Use Vector
	Pr. Group 2										
	Pr. Group …										
	Pr. Group i										
	Pr. Group n										
	Import input use by product group j										

The relationship between the three tables is very straightforward. The sum of the elements of domestic and import tables, wherever it is possible, equals to the main table. This intuition is essential for the sectoral disaggregation of the main table which will be presented below.

3.3. Air Emission Accounts

Carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrous trifluoride (NF_3) are listed as greenhouse gases in Turkey's INDC (Republic of Turkey, 2015). In CO_2-equivalent, CO_2 emissions constituted 74,8%, CH_4 constituted 15,03%, N_2O constituted 8,44% and the sum of HFCs, PFCs, SF_6, and NF_3 constituted only 1,7% of the total greenhouse gas emissions in Turkey (Eurostat, 2018). Figure 1 shows these shares for the year 2012.

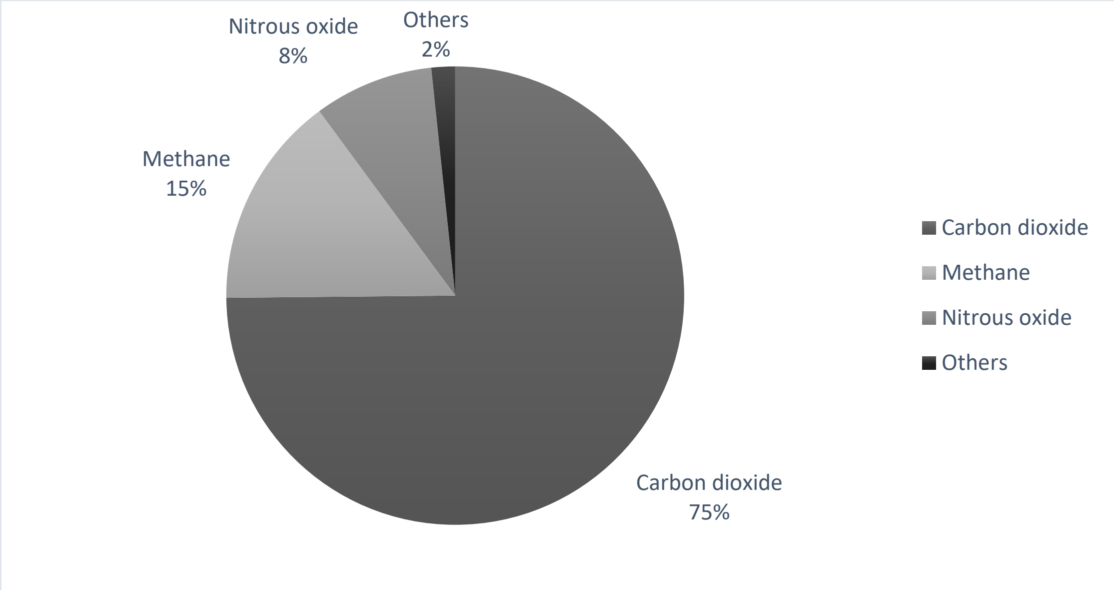

Figure 1: Shares of Greenhouse gases in 2012.

Source: Own calculations using "Air Emission Accounts by NACE Rev. 2", Eurostat

The main sources of carbon dioxide emissions, in general, are the burning of fossil fuels; namely, coal, natural gas, and oil, and burning solid wastes, trees, and wood products. In addition, some chemical reactions in industrial activities such as the manufacture of cement create substantial levels of CO_2 emissions. Carbon dioxide can be removed by plants to create food and oxygen; therefore, the role of forests is important in mitigating climate change. CO_2 has a global warming potential (GWP) of 1 as it is used for a reference value for other pollutants. CO_2 in the atmosphere remains for a long time; specifically, thousands of years. Methane emissions are mostly made by the mining and transportation of coal, oil and natural gas and by some agricultural activities. It has a GWP of 28-36 and it remains in the atmosphere for about a decade. Nitrous oxide is mostly emitted in agricultural activities although there are some N_2O emissions made by some industrial processes and fossil fuel burning. It has a GWP of 265-298 and it stays for more than 100 years in the climate system. Finally, all other greenhouse gases are emitted mostly in industrial processes having GWPs of thousands (EPA, 2018).

In the light of these background information, another data source that is utilized in the present study is the Air Emission Accounts by NACE Rev. 2 Activities (Eurostat, 2018). It is a production-based inventory which is directly adjusted from the Common Reporting Format (CRF) to the European system of classification (NACE Rev. 2) (Eurostat, 2013). While extracting the data, the present study arranges the classification as it exactly suits Turkey's 64 product groups input-output table so that the direct environmental impacts of the product groups can be monitored.

The data provides information for each product group for all greenhouse gases (GHGs) carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrous trifluoride (NF_3). Since the three pollutants (CO_2, CH_4, and N_2O) constitute over 98% of the total GHGs, the present study excludes the remaining pollutants. The values are extracted in kilotons of CO_2 equivalent. In addition to GHGs, information on acidifying gases (SOX, NOX, and NH_3) and ozone precursors (NMVOC, NOX, CO, and CH_4) can also be found in the data source; however, they are also not a topic of interest of the present study since they are not presented in CO_2 equivalent.

3.4.Sectoral Aggregation and Disaggregation

The input-output analysis is based on linear algebra and if the structure of the transactions matrix is not suitable for the calculations presented in section 4, the analysis cannot be made. Hence, the present study applies aggregation in order to eliminate them and avoid them in the disaggregation applications.

Aggregation:

One of the problems that may occur in the transactions matrix is that all the values in a row or column are zero. In the tables used in the present study, two product groups imputed rents of owner-occupied dwellings (L68A) and activities of households as employers (T) pose this kind of problem. The present study directly removes the group L68A since it does not have any non-zero value in transactions matrix, final demand and value-added components and air emissions accounts. On the other hand, the group T has some non-zero values in the household consumption and compensation of employees components, hence, it should be embedded into another product group. The present study chooses other personal service activities (S96); therefore, the product groups S96 and T are aggregated into one product group. Hence, without any disaggregation activity, the analysis would be made with at most 62 product groups. This kind of aggregation does not disturb the technical coefficients and emission intensities calculated in the sense that fixed proportions assumption gets weaker and it increases heterogeneity since they are calculated using the transactions matrix and emission inventory which are already zero for the eliminated sectors.

Disaggregation:

The importance of sectoral disaggregation has already been explained in the previous sections. For the present study, the alignment between the input-output table and national emissions inventory does not pose a problem; however, in order to monitor the individual environmental impacts of the fossil fuels (coal, lignite, oil, and gas), it is necessary to disaggregate two important sectors of both data sources: mining and quarrying (B), and electricity, gas, steam and air conditioning supply (D35). In addition, it is already explained that greater sectoral resolution increases the accuracy of the Leontief multipliers; in fact, the table should be disaggregated even further.

The present study has faced many problems in different experiences of disaggregation. First, in the experience of the method proposed by Wolsky (1984), it is understood that it provides bounds for each point of the technical coefficients of the disaggregated groups. Nevertheless, for each point, the parameters must be estimated with additional data, necessitating a large effort. In addition, the present study might apply this by using supply, transformation and consumption data (Eurostat, 2018) but it requires several aggregation activities to estimate specific parameters which serve in the opposite way. Furthermore, it enables a disaggregation of one group into only two. The process must be repeated over and over until the projected number of groups are obtained. Secondly, although the present study fails to apply the method proposed by Lindner, et al. (2012) for the moment, the idea to find one large dimensional point by applying a random walk algorithm in polytopes sounds pleasant but unrealistic. Even if the suggested method provides better results than any aggregated table with limited information, the initial estimate they utilize, which is identical to the augmented matrix Wolsky (1984) utilizes, is based on the gross output weights that cannot reflect the foreign trade. Finally, the direct use of a matrix which is obtained by the disaggregation of the domestic output weights (augmented matrix or initial estimate) or weighted average of domestic and import weights created results in a singularity problem or perfect proportionality between multiple rows and columns. This problem is similar to the problem that the transactions matrix has rows and columns without non-zero values.

In addition to the problems that may distort algebraic properties of the model, there are several structural conditions that must be protected in a sectoral disaggregation. First of all, equations (1) and (2) must hold in the disaggregated table as it holds before the disaggregation. Secondly, the total values of the new product groups must be equal to the value of the disaggregated product group for both in the rows and in the columns. In other words, the vertical sum of the rows is equal to the row of the disaggregated product group and the horizontal sum of the columns is equal to the column. Finally, the fact that all the prices in the table are all equal to 1 must hold and it is a result of the fact that equation (3) holds.

The present study suggests a simple but effective disaggregation technique by using import and domestic input-output tables with some proxy information using domestic gross outputs and import data without any claim that provides an exact disaggregation. Even though it is not exact in general, it provides closer points for the total use and total outputs; therefore, for each point in the disaggregated part of the table, the true values cannot be much far away especially for import dominant product groups such as petroleum and natural gas for Turkey. The idea is simple: if the sum of domestic input-output table and import input-output table is equivalent to the main input-output table for each transaction point, then the sum of the disaggregated domestic and import tables must be equivalent to the disaggregated input-output table. As long as different weights are used for both decompositions, it is almost impossible to face a problem like singularity in the final disaggregated table. Moreover, equation (2) holds and the total values of the new product groups become equal to the values of the disaggregated product groups. The problems that arise in this technique are that equation (1) cannot be directly observed and equation (3) may not hold due to the fact that the structure of the value-added component is not identical in domestic and import tables. The value-added component includes six different accounts and five of them exist only in the domestic table and one is taken from the import table. Hence, although the use of different weights creates an advantage in the transactions matrix and final demand component, it distorts the value-added part. These problems can be solved by assuming that equation (1) still holds and the value-added component is treated as a sum which is equal to the difference between total output and total input use in the main table. This total value-added still includes the total import use which is disaggregated with the import weights.

These ideas are applied to Turkey's tables in the present study. The product group mining and quarrying (B) is disaggregated into three product groups; mining of coal and lignite, extraction of petroleum and gas, and other mining and quarrying activities. To disaggregate this product group in the domestic table, the weights are calculated by using the production value by economic activity (NACE Rev. 2) data for the year 2012 (Turkstat, 2018), and to disaggregate the import table, the weights are calculated using imports by economic activity (ISIC, Rev. 3) data for the year 2012 (Turkstat, 2018). The product group electricity, gas, and air conditioning supply (D35) is also disaggregated into three product groups; electricity from coal and lignite, electricity from oil and gas, and electricity from hydropower, renewables and nuclear power. Since the classifications of economic activities do not provide the electricity production by its inputs, for the disaggregation of domestic table, the weights are directly taken from the electricity generation and shares by energy resources for the year 2012 (Turkstat, 2018), and for the disaggregation of import table, the weights are directly taken from the input of fuels and energy for conversion in Bulgaria, one of the trade partners in electricity, for the year 2011 (Ministry of Energy, 2013). The weights used in the disaggregation of domestic and import tables are presented in Table 5 below.

Table 5: Weights Used in the Disaggregation

		Domestic	**Import**
Mining and Quarrying (B)	**Mining of Coal and Lignite**	0,206	0,027
	Extraction of Petroleum and Natural Gas	0,127	0,934
	Other Mining and Quarrying	0,668	0,039
	Total	**1,000**	**1,000**
Electricity Generation (D35)	**Electricity form coal and lignite**	0,284	0,521
	Electricity form oil and gas	0,443	0,031
	Electricity from hydropower, renewables, nuclear power	0,273	0,448
	Total	**1,000**	**1,000**

Source: Own Calculations

Since the weights used in the two decompositions of the input-output table are different, the resulting table does not have proportional rows and columns. Therefore, the singularity problem that arises in the direct disaggregation of the main table is eliminated this way.

The sectoral disaggregation to the same product groups is also applied in the air emissions accounts. Since the data source does not include values for the subsectors of mining and quarrying and the input sources of electricity production, Turkey's National Emissions Inventory is used for disaggregation of the given product groups. As a result of all the aggregation and disaggregation applied, the analysis is made with 66 product groups as two groups are lost in the aggregation and six groups that are substituted to two disaggregated groups join to the analysis in the disaggregation.

4. METHOD

Input-output analysis method is an old but very important and still developing macroeconomic tool which is based on interdependence of different economic sectors or product groups. Since Wassily Leontief, who won the Nobel Prize in Economic Sciences "for the development of the input-output method and for its application to important economic problems" (The Nobel Prize, 1973), has published his first work on input-output relations in the U.S (Leontief, Quantitative Input and Output Relations in the Systems of the United States, 1936), many methodological extensions have been made. Over decades, the method has been proven to be so flexible and versatile that it has been used in many areas ranging from general economic analysis to regional and interregional studies, development planning and policies, technological changes, energy, natural resources, and environment. The use and extensions of input-output framework in environmental problems have started in the late 1960s (Rose & Miernyk, 1989). Leontief (1970) has made one of the first methodological extensions by employing pollution coefficients. Since then, environmentally extended input-output analysis has been developed for two main types of analysis; analysis of impacts and analysis for planning applications (Miller & Blair, 2009). More specifically, as it is applied in this study for Turkey, one of the simplest and main goals of the analysis is to evaluate upstream environmental impacts resulted from downstream consumption activities (Kitzes, 2013).

4.1.Assumptions

For the construction of a simple input-output model, a set of assumptions must be made. Firstly, as it is mentioned in section 3, it is assumed that the products of each production branch within them are identical, or homogenous. Hence, each 1 TL of output sold by a production unit represents the same amount of environmental impact. This assumption can best be reflected by a direct intensity vector, f:

$$f_{GHG} = PBI_{GHG}/TO' \tag{4}$$

where f is the vector of greenhouse gas emissions emitted by the production of 1 TL of output, PBI_{GHG} is the vector of the total production-based greenhouse gas emissions and TO' is the vector of total outputs by each production branch. The division is made elementwise.

Secondly, it is assumed that the intermediate inputs are the fixed proportions of the output of the purchasing industry. The matrix of those constant proportions is called the technical coefficients matrix, denoted as A. The technical coefficients matrix can be calculated with the following formula:

$$A = IIT/TO' \tag{5}$$

where *IIT* is the matrix reflecting intermediate transactions between production units and *TO'* is the vector of total outputs by each production branch. The division is made elementwise.

Third, a constant returns to scale production function that allows no substitution between inputs; namely, a Leontief production function is assumed. In other words, it is assumed that the inputs are perfect complements. The function that describes the production in the input-output system can be formulated as follows:

$$X_i = \sum_j X_{ij} + FD_i, \qquad i = 1,2, \ldots\ldots,66 \tag{6}$$

where X_i represents the total sales of product i, X_{ij} is the sales of product i to production unit j as inputs, and $FD_i = HHG_i + GCF_i + EX_i$ is the sales of the product i to the final demand. The three components of final demand used in the study are HHG_i, the sum of household and government consumption of product i, GCF_i, the total gross capital formation including gross fixed capital formation and changes in inventories of product i, and EX_i, the export demand for the product i.

4.2.Model Structure

An input-output analysis is based on the multiplying impacts of consumption activities. A one-point change in the final demand of any given product requires a change in the activities of the most sectors in the economy. The total change of the economy resulted from a given change in final demand is equivalent to the Leontief inverse matrix, the element of which are the input-output multipliers. From the equations (5) and (6), the Leontief inverse can be calculated as:

$$L = [I - A]^{-1} \quad (7)$$

where I is the identity matrix.

The transformation of the direct intensities of each product to the total intensities is made through the elementwise multiplication of the transpose of the direct intensity vector with the Leontief inverse matrix. The total intensity vector is the transpose of that multiplication:

$$F_{GHG} = f_{GHG} * L \quad (8)$$

From the total intensity vector F_{GHG} and the vectors of sales of the products to final household and government consumption (HHG), gross capital formation (GCF), and the amount of sales to the rest of the world (EX), the vectors of consumption-based emissions of each final demand component can be calculated as:

$$E_{HHG} = F_{GHG}' * HHG \quad (9)$$

$$E_{GCF} = F_{GHG}' * GCF \quad (10)$$

$$E_{EX} = F_{GHG}' * EX \quad (11)$$

where E_{HHG} is the vector of emissions resulting from the final consumption activities by households and government, E_{GCF} is the vector of emissions resulting from total gross capital formation, and E_{EX} is the vector of consumption-based emissions resulting from the sales of domestic production to foreigners. Among these, Turkey is responsible for the consumption-based emissions E_{HHG} and E_{GCF}; however, E_{EX} is the result of foreign final demand for Turkish products. In other words, that amount of production-based emissions are made in order to satisfy the needs of rest of the world. Therefore, it is not a component of Turkey's consumption-based inventory. The component that must be added to Turkey's CBI is the foreign emissions made to satisfy Turkey's needs; in other words, consumption-based emissions arising from Turkey's import. It can be calculated as:

$$E_{IM} = F_{GHG}' * IM \quad (12)$$

where IM is the vector of import use.

From the information above, the consumption-based inventory can be calculated as follows:

$$CBI_{GHG} = E_{HHG} + E_{GCF} + E_{IM} \tag{13}$$

In addition, the following equation is satisfied:

$$\mathrm{PBI}_{\mathrm{GHG}} = \mathrm{E}_{\mathrm{HHG}} + \mathrm{E}_{\mathrm{GCF}} + \mathrm{E}_{\mathrm{EX}} \tag{14}$$

Finally, to compare the impacts of the final consumption in all the products in the input-output table, it is necessary to take a difference between consumption-based emissions and the production-based emissions of each sector.

$$D = CBI_{GHG} - PBI_{GHG} \tag{15}$$

The interpretation of equation (15) provides insights in both the condition of Turkey's carbon responsibility against the world and the responsibilities of each product group to be consumed or formed as capital. First, if the sum of all the elements of vector D is positive, it means Turkey's carbon responsibility is larger than its domestic emissions; otherwise, it is lower. This part informs whether Turkey's international responsibility which is determined by production-based emissions is underestimated or overestimated. Secondly, if one element of D is positive, the environmental impact of the corresponding product group is larger than the one observed in production-based inventory. In such a condition, the policies that reduce the use of the related product might be much more effective than any other reduction policies than the products that are observed as the most responsible in production-based inventories.

5. RESULTS

5.1.The Largest Emission Sources in Different Inventories

One of the main findings of the study is that the total consumption-based emissions of Turkey are slightly larger than its production-based emissions made in the boundaries of the country. Figure 2 summarizes the contributions of final consumption by households and government, total gross capital formation, exports and imports of the emissions of Turkey. It can be understood from the figure that the difference between the two accounts is equivalent to the difference between import-based emissions and export-based emissions.

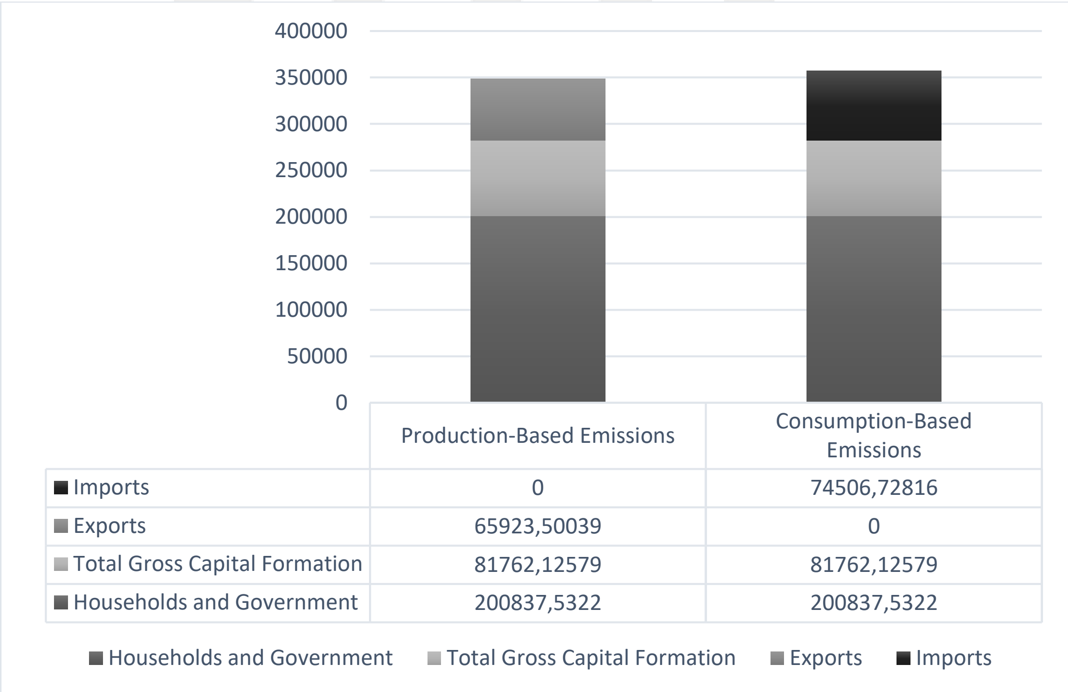

Figure 2: Production-based emissions and consumption-based emissions compared
Source: Calculations within the model

The difference between the total values of inventories constitutes only 2,42% of total domestic emissions with the value 8583,23 kilotons of CO_2-Equivalent. The ratio is even smaller when it is evaluated in terms of consumption-based emissions. Hence, the argument that the production-based inventories should be replaced by the consumption-based inventories is not a consideration for Turkey in this sense. Such a transformation in global attempts does not increase Turkey's responsibility as apparent as it is expected.

For the examination of the sectors individually and the determination of the critical sectors, it is essential to know what product group directly contributes the greenhouse gas emission inventories in what size. Table 6 provides the largest emission sources that contribute more than 90% of total emissions. The table reflects the disaggregated air emission accounts.

Table 6: Largest Production-Based Emissions by Product Group (%90 of Total)

Rank	NACE Code	Description	PBI
1	D35_COL	Electricity from Coal and Lignite	66130,2116
2	C23	Manufacture of other non-metallic mineral products	62467,7894
3	D35_PG	Electricity from Oil and Gas	58643,7726
4	A01	Crop and animal production, hunting and related service activities	57709,7233
5	E37-E39	Sewerage, waste management, remediation activities	18038,1184
6	H49	Land transport and transport via pipelines	16146,4120
7	C24	Manufacture of basic metals	15361,8823
8	C20	Manufacture of chemicals and chemical products	8753,0648
9	F	Construction	5267,1177
10	C10-C12	Manufacture of food products; beverages and tobacco products	5211,3982

Source: Air Emission Accounts by NACE Rev. 2 Activities

The four sectors that constitute the 70% of total direct emissions can be considered as the most critical sectors in Table 6. Those are electricity from coal and lignite (D35_COL), Manufacture of other non-metallic mineral products (C23), electricity from oil and gas (D35_PG), and Crop and animal production, hunting and related service activities (A01).

However, when the indirect emissions are computed individually from equation (13) in the model, the shares of those product groups that constitute 70% of total direct emissions decline as the embedded emissions in interindustry transactions arise; as a result, the importance of some other product groups can be observed. The largest contributors to consumption-based emissions are listed in Table 7.

Table 7: Largest Consumption-Based Emissions by Product Group (%67 of Total)

Rank	NACE Code	Description	CBI
1	F	Construction	58048,3509
2	A01	Crop and animal production, hunting and related service activities	37834,44315
3	C10-C12	Manufacture of food products; beverages and tobacco products	28518,12986
4	D35_PG	Electricity from Oil and Gas	22089,71625
5	D35_COL	Electricity from Coal and Lignite	20454,62503
6	C24	Manufacture of basic metals	17143,59881
7	E37-E39	Sewerage, waste management, remediation activities	13084,60274
8	H49	Land transport and transport via pipelines	12068,11655
9	C13-C15	Manufacture of textiles, wearing apparel, leather and related products	10424,43163
10	L68B	Real estate activities	9950,777561
11	C23	Manufacture of other non-metallic mineral products	9849,536515

Source: Calculations within the model

Table 7 shows that although the four critical product groups determined before, D35_COL, C23, D35_PG, and A01, are still in the list, they are far smaller than their direct contributions to Turkey's total emissions. The values in the table for those product groups are lower because they include only the final consumption activities of households and government, the total gross capital formation and imports, and exclude the emissions made to support the sales of other product groups and exports. On the other hand, the largest product groups in the consumption-based inventory such as the products of the construction industry use the largest emission sources as their inputs.

The differences between the two emission inventories are calculated by using equation (15). Table 8 reflects the differences between consumption-based emissions and production-based emissions for largest product groups as sides of emission transfers. While top 6 product groups represent 62,4% of positive differences as they are the largest input users of the main emission sources, bottom 6 product groups are the greatest input suppliers with the largest direct emissions. In detail, the product group construction (F) sector is the largest underestimated group in the production-based inventory, followed by the manufacture of food, beverages and tobacco products (C10-C12). On the other hand, manufacture of other non-metallic mineral products (C23), electricity produced by using coal and lignite (D35_COL) and by using oil and natural gas (D35_PG), and crop, animal production, hunting and related service activities

(A01) are the largest product groups that make most of their emissions to support the sales of the ones that have positive differences.

Table 8: Largest Product Groups as Sides of Emission Transfers

Rank	NACE Code	Description	Difference
1	F	Construction	52781,23323
2	C10-C12	Manufacture of food products; beverages and tobacco products	23306,73163
3	L68B	Real estate activities	9867,996541
4	I	Accommodation and food service activities	9373,921258
5	G47	Retail trade, except of motor vehicles and motorcycles	9055,272724
6	O84	Public administration and defense; compulsory social security	7454,215144
61	H49	Land transport and transport via pipelines	-4078,295463
62	E37-E39	Sewerage, waste management, remediation activities	-4953,515635
63	A01	Crop and animal production, hunting and related service activities	-19875,2801
64	D35_PG	Electricity from Oil and Gas	-36554,05632
65	D35_COL	Electricity from Coal	-45675,58659
66	C23	Manufacture of other non-metallic mineral products	-52618,2529

Source: Calculations within the model

These results are not surprising for the top two groups since it is intuitively known that a large amount of cement which is included in the group C23 is used by the construction sector and the main inputs of food manufacturing industry come from the agricultural products. A closer look at the input-output table shows that 48,6% of the total value of the production and 60% of the total value of inputs supplied by the product group C23 is directly used by the product group F as input. In addition, 30,6% of the total value of the production and 58% of the total value of inputs supplied by the product group A01 is directly used by the product group C10-C12 as input. If the direct use of electricity is examined in the input-output table, it can be understood that the values of electricity from all the sources are distributed homogeneously among the product groups that do not include electricity production. In other words, there is no dominant product group that highly uses electricity as input to its production.

From the equations (9) to (12), the present study calculates the individual environmental impacts of the final demand decompositions; namely, final consumption expenditures by households and governments, total gross capital formation, and exports, and the total import use of Turkey in both final demand and imports as input use in total. Table 9 shows the consumption-based emissions that arise from the final consumption expenditures by households and government. The largest 10 groups that represent the 73,9% of the emissions in this group show that food, energy, transportation, and clothing needs are the main determinants. Among all, the food providing groups A01, C10-C12, and I are the largest followed by electricity producing groups and the transportation-related groups respectively.

Table 9: Consumption-Based Emissions (Final Consumption Expenditures by Households and Government)

Rank	NACE Code	Description	CBI_{HHG}
1	A01	Crop and animal production, hunting and related service activities	26050,0833
2	C10-C12	Manufacture of food products; beverages and tobacco products	25823,60831
3	D35_PG	Electricity from Oil and Gas	22059,47283
4	D35_COL	Electricity from Coal	19744,95997
5	H49	Land transport and transport via pipelines	11186,6925
6	L68B	Real estate activities	9950,777561
7	I	Accommodation and food service activities	9238,097165
8	G47	Retail trade, except of motor vehicles and motorcycles	8582,273497
9	C13-C15	Manufacture of textiles, wearing apparel, leather and related products	8216,304843
10	O84	Public administration and defense; compulsory social security	7467,494286

Source: Calculations within the model

Table 10 shows the consumption-based emissions that arise from the total gross capital formation including gross fixed capital formation and changes in inventories. The product group construction (F) is responsible for more than 70% of the emissions made in this group. In fact, almost all consumption-based emissions from that product group are made under total gross capital formation activities. It is not surprising since the nature of final demand for construction is not open for neither foreign trade nor final consumption. The group mostly produces investment goods. Other prominent parts of the emissions arising from investment activities are made mostly for the manufacture of machinery, equipment, and vehicles.

Table 10: Consumption-Based Emissions (Total Gross Capital Formation)

Rank	NACE Code	Description	CBI_{GCF}
1	F	Construction	57392,83554
2	A01	Crop and animal production, hunting and related service activities	6156,293412
3	C28	Manufacture of machinery and equipment n.e.c.	3641,98593
4	C25	Manufacture of fabricated metal products, except machinery and equipment	2586,640984
5	C29	Manufacture of motor vehicles, trailers and semi-trailers	2147,347274
6	C31_C32	Manufacture of furniture; other manufacturing	1362,674993
7	C27	Manufacture of electrical equipment	1188,669117
8	C23	Manufacture of other non-metallic mineral products	1123,07981
9	G46	Wholesale trade, except of motor vehicles and motorcycles	1049,508034
10	H49	Land transport and transport via pipelines	826,6363961

Source: Calculations within the model

Table 11 shows the emissions that arise from the foreign use of domestically produced products. In other words, the size of this group of emissions is not related to Turkey's consumption-based inventory but related to other countries that import Turkish products. The largest consumption-based emissions in this list are made by the group manufacture of basic metals (C24). The reason why it is large is that it mostly produces intermediate goods used by other product groups both in Turkey and other countries. In other words, its products are made for neither final consumption nor gross fixed capital formation but changes in inventories and foreign trade. Another important product group in Turkey's export-based emissions is C23, having the second largest position in the list, which has already been signed as a critical product group. Another product group that is worth mentioning in this list is the manufacture of textiles, wearing apparel, leather, and related products (C13-15), which is Turkey's an important export component.

Table 11: Foreign Consumption-Based Emissions from Turkey's Exports

Rank	NACE Code	Description	CBI_{EX}
1	C24	Manufacture of basic metals	15812,23034
2	C23	Manufacture of other non-metallic mineral products	10174,09558
3	C13-C15	Manufacture of textiles, wearing apparel, leather and related products	8427,469666
4	C10-C12	Manufacture of food products; beverages and tobacco products	4125,111031
5	A01	Crop and animal production, hunting and related service activities	3763,667799
6	C29	Manufacture of motor vehicles, trailers and semi-trailers	2940,619693
7	H49	Land transport and transport via pipelines	2659,56303
8	C27	Manufacture of electrical equipment	2256,290291
9	C25	Manufacture of fabricated metal products, except machinery and equipment	2158,78481
10	C22	Manufacture of rubber and plastic products	1818,474004

Source: Calculations within the model

Table 12 shows the emissions that are not directly made in Turkey but made by foreign production processes for the satisfaction of Turkey’s import uses. The emissions of this group are compensated by the emissions made for Turkey’s exports. Not surprisingly, the largest in this list is again C24, which is an intermediate good highly subject to foreign trade. Sewerage, waste management, and remediation activities is another large component of the import-based emissions as almost half of its total use by Turkey is imported and mostly used by the product group C24 as input.

Table 12: Domestic Consumption-Based Emissions from Turkey's Imports

Rank	NACE Code	Description	CBI_{IM}
1	C24	Manufacture of basic metals	16337,20253
2	E37-E39	Sewerage, waste management, remediation activities	9732,569219
3	C20	Manufacture of chemicals and chemical products	7427,950481
4	A01	Crop and animal production, hunting and related service activities	5628,066438
5	C23	Manufacture of other non-metallic mineral products	4660,540293
6	C19	Manufacture of coke and refined petroleum products	3280,327062
7	C28	Manufacture of machinery and equipment n.e.c.	3242,484108
8	C29	Manufacture of motor vehicles, trailers and semi-trailers	3124,509035
9	B_PG	Extraction of Petroleum and Natural Gas	3091,72938
10	C13-C15	Manufacture of textiles, wearing apparel, leather and related products	2595,736806

Source: Calculations within the model

Finally, Table 13 shows the net emissions in trade by product groups. This table shows how Turkey's consumption-based emissions in import uses are compensated by the domestic production-based emissions to satisfy the needs of the rest of the world. While the top six product groups are the ones that increase Turkey's consumption-based emissions against production-based emissions, the bottom six does the reverse. According to this, the largest product group that increases Turkey's consumption-based emissions and production-based emissions of the rest of the world is E37-E39 while C13-C15 is the largest of the other side.

Table 13: Net Consumption Based Emissions from Foreign Trade by Product Groups

Rank	NACE Code	Description	Difference (Trade)
1	E37-E39	Sewerage, waste management, remediation activities	9357,300936
2	C20	Manufacture of chemicals and chemical products	5731,430845
3	B_PG	Extraction of Petroleum and Natural Gas	3050,049053
4	C19	Manufacture of coke and refined petroleum products	2207,439353
5	C28	Manufacture of machinery and equipment n.e.c.	1890,048538
6	A01	Crop and animal production, hunting and related service activities	1864,398639
61	H51	Air transport	-805,8618414
62	H50	Water transport	-896,4935914
63	C10-C12	Manufacture of food products; beverages and tobacco products	-1579,278038
64	H49	Land transport and transport via pipelines	-2604,775376
65	C23	Manufacture of other non-metallic mineral products	-5513,555291
66	C13-C15	Manufacture of textiles, wearing apparel, leather and related products	-5831,732861

Source: Calculations within the model

So far, some product groups are determined as the most critical ones that should have a voice in Turkey's environmental policy documents. The present study examines only Turkey's INDC in whether there is a plan related to the specific product group or not.

5.2.Matching Critical Product Groups with Turkey's INDC

Electricity from coal and lignite (D35_COL):

In Turkey's published input-output table, the product group is included in the aggregated group electricity, gas, steam, and air conditioning supply (D35). As electricity is produced from different sources, the group D35_COL refers to the electricity generated in the thermal power plants, the main input of which is coal. Although its value is estimated to be lower compared to the group D35_PG, probably since the emission intensity of burning coal is much higher than burning natural gas, its direct environmental impact is larger. In fact, it is the largest product group that directly contributes to the size of the emissions in Turkey. In other words, it is the group that has the largest share in Turkey's PBI. In addition, it has the fifth place in Turkey's CBI, mostly reflecting the final electricity consumption by households and government. Still, consumption-based emissions constitute only 30,9% of total production-based emissions and remaining part is embedded in the production of other product groups. Since the use of electricity supplied from this group is distributed homogeneously among other product groups, any emission reduction policy applied to this group decreases the consumption-based emissions by other groups as well as its own.

The emission reduction policies from the product group can be related to plans and policies to be implemented for Turkey's INDC under energy title. It includes increasing the capacity of Turkey's renewable energy sources (solar and wind power and hydroelectric potential) and installing a nuclear power plant. These are electricity generation sources that result in substantially lower amounts of emissions and if these plans become successful, the share of electricity produced by thermal power plants will decrease provided that the rate of growth of electricity generated by thermal power plants is less than these developments. However, these developments do not decrease the amounts of emissions from the thermal power plants and its position in the PBI. In addition, the document includes reducing network losses to a given amount and rehabilitating existing power plants. They probably have positive effects in reducing emissions, but the size of the reduction is not clear with available information. Overall, the present study suggests that the use of thermal power plants should be the last choice of electricity generation since it is the largest emission source in Turkey. However, as it is pointed out in the document, Turkey experiences financial and technological constraints and energy imports constitute a large share in Turkey's deficit account, Turkey must use its limited energy sources which include coal and lignite. Therefore, this suggestion appears to be unrealistic for the moment.

Manufacture of other non-metallic mineral products (C23):

The group C23 includes three important sources that contribute to Turkey's total emissions which are cement, lime, and ceramic production. It is already stated that chemical reactions in the manufacture of cement create a substantial level of CO_2 emissions. The group has the second place in PBI and eleventh in CBI. CBI constitutes 15,8% of PBI mostly arising from final consumption activities and imports. In addition, emissions arising from exports are larger than imports; therefore, the trade of this product group results in relatively larger production-based emissions than consumption-based ones. Almost half of the production-value of the group is demanded by the sector construction (F); hence, almost half of the direct emissions are directly transferred consumption-based emissions of the product group F.

The emission reduction policies from the product group are expected to be related to plans and policies to be implemented for Turkey's INDC under the title "Buildings and Urban Transformation". Nevertheless, there is no plan or policy neither under this title nor any other that is directly or indirectly related to the product group. In fact, if the use of some materials like cement continues in constructing new buildings, it is expected in the future that the share of this product group grows even larger in Turkey's both PBI and CBI.

Electricity from oil and gas (D35_PG):

Another component of the disaggregated group D35 is electricity generated using oil and natural gas (D35_PG). It has the third place in PBI and fourth place in CBI and CBI which mostly arise from consumption expenditures by households and government constituting 37,7% of PBI. Even though the total production value of the group is much larger than D35_COL, it results in slightly lower emission since natural gas is a relatively cleaner source than coal in electricity generation. Since the use of electricity supplied from this group is also distributed homogeneously among other product groups, any emission reduction policy applied to this group decreases the consumption-based emissions by other groups as well as its own.

The emission reduction policies from the product group can also be related to plans and policies to be implemented for Turkey's INDC under energy title. The renewable energy sources planned to be increased in their capacities and the installment of a nuclear power plant provides cleaner energy in terms of GHGs than electricity generated using oil and gas and any reduction in network losses and rehabilitation activities provide a reduction in emissions from the group. Although it is not the best in terms of mitigating climate change, the plants that use natural gas as input are better than thermal power plants. Nevertheless, as it is pointed out before, since oil and natural gas are important components of the deficit account of Turkey, their uses are limited.

Crop, animal production, hunting and related service activities (A01):

The production of the commodities under the group can be related to some of Turkey's important GHG emission sources that are enteric fermentation in animal production that emits high amounts of methane, agricultural soil to which synthetic fertilizers, crop residues and animal manure applied that result in high emissions of nitrous oxide and other agriculture and husbandry activities that contribute to carbon dioxide emissions. It has the fourth place in PBI and second place in CBI and the size of consumption-based emissions from the product group constitutes 65,6% of production-based emissions mostly coming from the final consumption expenditures. Since this ratio is very high compared to other emission sources mentioned before and as the products of the group represent an essential need of individuals, the environmental policies that can be applied to this product group are expected to be limited. Moreover, the production value supplied to the final demand components represent 47,3% of the total value produced in the group; therefore, it can be inferred that there are other inputs that contribute to the consumption-based emissions of the group. The groups that directly contribute to the consumption-based emissions of the group can be listed as chemicals and chemical products (C20), land transport (H49) and retail trade services (G47). Furthermore, the group supplies large values of inputs directly to important sectors such as manufacture of food, beverages and tobacco products (C10_C12) and manufacture of textiles, wearing apparel, leather and related products (C13_C15).

The emission reduction policies from the product group are related to plans and policies in the INDC document under the title "Agriculture". These include land consolidation in agricultural areas in order to save fuel, controls on the use of fertilizers, modern agricultural practices and support for minimum tillage methods in order to protect soils and rehabilitation of grazing lands that is related to husbandry activities.

Sewerage, waste management and remediation activities (E37-E39):

Although its total environmental impact is relatively much lower than the groups mentioned above, it is still worth mentioning as it has the fifth place in PBI and the largest in net import-based emissions. This implies that Turkey's waste management activities are insufficient for itself and Turkey sends more waste to the rest of the world to be reused and recycled than its imports of wastes. The development of this sector in Turkey is expected to increase its production-based emissions in this product group while to decrease the ones in all other groups as solid waste disposal activities grow. Overall, the cumulative environmental impact of the group is expected to be positive as recovery activities decrease the demand for solid fuels and raw materials. The largest input user of the group is manufacture of basic metals (C24) in 2012.

The emission reduction policies from the product group are related to plans and policies in the INDC document under the title "Waste". Some part of it includes sending wastes to managed landfill sites, recovery of raw materials and methane gas, utilization of industrial wastes through industrial symbiosis approach. In short, overall development in waste management is intended in Turkey's INDC.

Land transport and transport via pipelines (H49):

The product group has the sixth place in PBI, the eighth place in CBI, and fifth place in consumption-based emissions arising from final consumption activities by households and government. In total, its direct and indirect emissions are relatively lower than the emission sources mentioned before although it is a key product group for the whole economy and has direct linkages with all sectors.

The emission reduction policies from the product group are related to plans and policies in the INDC document under the title "Transport". It includes increasing the share of maritime transport and rail transport against land transport, high-speed railway projects, urban railway systems, tunnel projects to save fuels and removing old vehicles from the traffic. The fuel savings through these projects are expected to have positive benefits for the environment; however, some of these projects require high investments in the construction sector.

Manufacture of basic metals (C24):

The product group has the seventh place in PBI and sixth place in CBI that is mostly arising from imports. It appears in the final demand component in mostly foreign trade since its products are used as neither final goods nor investment goods but as intermediate goods. In addition, it has the first place in both imports and exports in terms of GHGs arising from the production of the commodities of the group. Moreover, it is one of the important input suppliers to the construction sector and the most important input user of waste management activities.

The emission reduction policies from the product group are related to plans and policies in the INDC document under the title “Industry”. The title mostly considers energy efficiency in industrial processes and use of waste as an alternative fuel at appropriate sectors. Since the group is the largest input user of the group E37-E39, the policy of use of waste in the industry can best be observed in this product group.

Manufacture of food, beverages and tobacco products (C10-C12):

Although its direct emissions are very low compared to other product groups mentioned above, it has the second place in the CBI and consumption-based emissions arising from the group is as much as around 5,5 times its production-based emissions. The main reason behind it is that the group is the largest input user of the group A01.

Therefore, any emissions reduction policy implied in the group A01 results in a decrease in the consumption-based emissions of the group. In addition, since it includes industrial production, it is subject to the possible developments in energy efficiency in industry.

Construction (F):

The last but not the least critical product group that is important in Turkey’s greenhouse gas emissions is construction (F). The group includes the construction of not only residential and non-residential buildings but also roads, railways, bridges, tunnels, utility projects and power plants. Hence, it is a key product group in Turkey experiencing rapid industrialization and urbanization process over the last 30 years. As large projects such as construction of roads, bridges, tunnels, airports and power plants take place in Turkey, the sector has the largest production value in 2012.

Despite its low value in Turkey’s production-based inventory, it is the largest group in Turkey’s consumption-based inventory. Its size of indirect emissions is 11 times more than its direct emissions since the group directly uses very important emission sources in Turkey’s emission inventory. The most important one is manufacture of other non-metallic mineral products (C23) which is the second largest emission source in the country. In addition, since the products of the group are mostly not subject to foreign trade and final consumption, almost all consumption-based emissions are made by the group in Turkey's gross capital formation activities. As a result, it dominates Turkey's investment-based inventory with a share of more than 70%.

The emission reduction policies from the product group are also expected to be related to plans and policies to be implemented for Turkey's INDC under the title "Buildings and Urban Transformation". However, the emission potential of this product group is not considered in terms of the size and emission characteristics of the materials used in construction activities under the title. In fact, all plans and policies consider only the energy performances of buildings, not the materials used in the construction of them. Furthermore, under the titles "Energy" and "Transport", some plans and policies to reduce fuel use in energy and transportation sectors require large construction projects. Specifically, construction of solar, wind and nuclear power plants, road, railway and airport projects, and construction of new residential and non-residential buildings with high energy saving performances eventually reduce Turkey's GHGs from the energy use provided the slowdown of the uses of thermal power plants take place; however, all these projects result in extensive use of cement, lime and ceramics and some of the gains from the energy savings in terms of emission reductions are lost in the use of materials in investment activities. Therefore, for better environmental policies, it is essential for Turkey to consider the supply-chain of construction activities.

6. CONCLUSION

In this study, environmental policies in Turkey are examined through an approach that employs a simple environmentally extended input-output analysis (EEIOA) methodology. As they are primary requirements of the methodology employed (EEIOA), Turkey's input-output table and air emission accounts are used as main data sources. Carbon dioxide, methane and nitrous oxide emissions are selected as the total value of these gases constitutes almost all greenhouse gas emissions in Turkey with a share of more than 98% in air emission accounts.

From the literature that is related to the theoretical implications, strengths, and weaknesses of input-output models, it is determined that the sectoral disaggregation of the input-output tables and the air emission accounts are necessary. In addition to the need for observing the environmental impact of important product groups, it is theoretically suggested that sectoral resolution of the input-output tables increases the accuracy of Leontief multipliers and reduces the heterogeneity of the groups in the model. Therefore, two essential product groups that include the production and use of large amounts of fossil fuels in their processes are determined to be disaggregated. The disaggregation of other important product groups is left to future studies as the larger the number of the product groups in the analysis, the more accurate the results the analysis would produce.

From the literature that is related to the disaggregation techniques and a set of trials for disaggregation, it is found that disaggregation of domestic production and import components of the input-output table produce a better-disaggregated table for at least in terms of the true values of the total use and total output values of the related product groups. In addition, as it directly solves the problem of singularity that arises from the perfect proportionality between rows and between columns, the use of the disaggregated table that is obtained by the sum of disaggregated domestic and import tables in the analysis does not pose a problem.

By using the disaggregated table above, Turkey's consumption-based inventory (CBI) is created along with its decomposition into final demand components that include final consumption expenditures by households and government, total gross capital formation, exports, and imports.

Firstly, Turkey's production-based inventory and consumption-based inventory that is equivalent to Turkey's emission responsibility is compared in total and it is found that Turkey's emission responsibility is slightly larger than its domestically produced emissions. Despite the dominant literature that defends the use of CBIs instead of PBIs, Turkey's responsibility does not change substantially supposing that such a transformation occurs globally.

Secondly, from those inventories calculated through a simple environmentally extended input-output model and initial air emission accounts that is identical to Turkey's production-based inventory, nine critical product groups are determined.

Finally, those nine product groups determined are searched in Turkey's Intended Nationally Determined Contribution (INDC) document that is submitted to UNFCCC in 2015. It is found that an essential product group, construction, that is the largest in both Turkish economy and Turkey's consumption-based inventory is not considered in a similar situation to the product group that is the largest input supplier of the construction industry, manufacture of other non-metallic mineral products including cement, lime, and ceramic production. As the environmental impact of the supply chain of these product groups is substantially large, a consideration of these groups in the preparation and implications of the environmentally policy documents make large contributions to the environmental quality that Turkey experience.

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APPENDIX

Annex1: Turkey's Production-Based Inventory and Consumption-Based Inventory by All Product Groups

Table 14: Turkey's Production-Based Inventory and Consumption-Based Inventory by All Product Groups

NACE Code	Description	PBI	% PBI	PBI Rank	CBI	% CBI	CBI Rank
A01	**Crop and animal production, hunting and related service activities**	57709,72325	16,55836115	4	37834,44315	10,594726	2
A02	**Forestry and logging**	117,82316	0,033806408	32	142,8851631	0,040011932	59
A03	**Fishing and aquaculture**	108,44423	0,031115358	33	160,1254805	0,044839714	57
B_COL	**Mining of Coal and Lignite**	3657,86117	1,04953174	14	1479,908938	0,414416822	32
B_MQ	**Other Mining and Quarrying**	10,36835	0,002974939	62	520,6172845	0,145787727	45
B_PG	**Extraction of Petroleum and Natural Gas**	2578,51499	0,73984036	15	3319,048107	0,929428382	25
C10-C12	**Manufacture of food products; beverages and tobacco products**	5211,39823	1,495280329	10	28518,12986	7,985891869	3
C13-C15	**Manufacture of textiles, wearing apparel, leather and related products**	4804,07701	1,378409697	11	10424,43163	2,919138955	9
C16	**Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials**	481,83678	0,138251008	26	498,0731786	0,139474733	46
C17	**Manufacture of paper and paper products**	1003,89803	0,288043421	22	1556,496644	0,43586357	30
C18	**Printing and reproduction of recorded media**	403,24557	0,115701227	27	-46,42251327	-0,012999631	66
C19	**Manufacture of coke and refined petroleum products**	4583,96565	1,315254249	12	3976,834586	1,113627406	24
C20	**Manufacture of chemicals and chemical products**	8753,06481	2,511472939	8	8348,550701	2,337832933	14
C21	**Manufacture of basic pharmaceutical products and pharmaceutical preparations**	318,45611	0,091373013	28	1372,314665	0,384287349	33
C22	**Manufacture of rubber and plastic products**	1023,75075	0,293739663	20	2599,042811	0,72780631	27
C23	**Manufacture of other non-metallic mineral products**	62467,78942	17,92356918	2	9849,536515	2,758151883	11
C24	**Manufacture of basic metals**	15361,8823	4,407707761	7	17143,59881	4,800697908	6
C25	**Manufacture of fabricated metal products, except machinery and equipment**	1651,81648	0,473947409	16	4573,885301	1,28081868	22
C26	**Manufacture of computer, electronic and optical products**	283,80707	0,081431338	30	1270,739254	0,355843329	35
C27	**Manufacture of electrical equipment**	749,8154	0,215140768	24	4627,020219	1,295697976	21
C28	**Manufacture of machinery and equipment n.e.c.**	987,12953	0,28323212	23	6963,922074	1,950097322	17
C29	**Manufacture of motor vehicles, trailers and semi-trailers**	1019,0309	0,29238542	21	6996,88203	1,959327053	16
C30	**Manufacture of other transport equipment**	313,43472	0,089932251	29	1207,85004	0,338232551	37
C31_C32	**Manufacture of furniture; other manufacturing**	1478,24577	0,424145637	18	5009,66163	1,402848514	20
C33	**Repair and installation of machinery and equipment**	34,96869	0,010033391	52	626,743346	0,175506059	42
D35_COL	**Electricity from Coal**	66130,21162	18,9744096	1	20454,62503	5,727879931	5
D35_PG	**Electricity from Oil and Gas**	58643,77256	16,82636323	3	22089,71625	6,18575223	4
D35_REN	**Electricity from Hy+Rn+Nuc**	0	0	64	6961,264904	1,949353239	18
E36	**Water collection, treatment and supply**	60,19538	0,017271558	41	2092,690198	0,586013098	29
E37-E39	**Sewerage, waste management, remediation activities**	18038,11837	5,175586739	5	13084,60274	3,664062935	7
F	**Construction**	5267,11767	1,511267628	9	58048,3509	16,25519821	1

Table 14: Turkey's Production-Based Inventory and Consumption-Based Inventory by All Product Groups (Cont'd)

NACE Code	Description	PBI	% PBI	PBI Rank	CBI	% CBI	CBI Rank
G45	**Wholesale and retail trade and repair of motor vehicles and motorcycles**	703,64787	0,201894151	25	1500,667252	0,420229744	31
G46	**Wholesale trade, except of motor vehicles and motorcycles**	254,18244	0,072931291	31	2326,204865	0,651403883	28
G47	**Retail trade, except of motor vehicles and motorcycles**	74,53761	0,021386702	39	9129,810334	2,556607971	13
H49	**Land transport and transport via pipelines**	16146,41201	4,632808931	6	12068,11655	3,379417735	8
H50	**Water transport**	1641,2015	0,470901706	17	234,5433988	0,065678859	52
H51	**Air transport**	3755,7666	1,077623254	13	3220,764361	0,901906123	26
H52	**Warehousing and support activities for transportation**	94,30235	0,0270577	34	228,5320356	0,063995505	53
H53	**Postal and courier activities**	0	0	65	119,7191952	0,033524798	62
I	**Accommodation and food service activities**	52,69546	0,015119644	47	9426,616718	2,639722246	12
J58	**Publishing activities**	25,18487	0,007226168	59	285,8470198	0,08004534	49
J59_J60	**Motion picture, video, television program production; programming and broadcasting activities**	38,83197	0,011141862	51	273,1713612	0,076495793	51
J61	**Telecommunications**	0	0	66	1233,178431	0,345325225	36
J62_J63	**Computer programming, consultancy, and information service activities**	25,18487	0,007226168	60	130,1922636	0,036457557	61
K64	**Financial service activities, except insurance and pension funding**	55,12298	0,01581616	44	912,5408429	0,255537531	40
K65	**Insurance, reinsurance and pension funding, except compulsory social security**	45,31983	0,013003391	50	191,5772279	0,053647102	55
K66	**Activities auxiliary to financial services and insurance activities**	25,58635	0,007341363	58	78,76666849	0,02205692	63
L68B	**Real estate activities**	82,78102	0,023751942	37	9950,777561	2,786502271	10
M69_M70	**Legal and accounting activities; activities of head offices; management consultancy activities**	52,76749	0,015140311	45	142,3347761	0,039857808	60
M71	**Architectural and engineering activities; technical testing and analysis**	27,16882	0,007795413	55	204,896509	0,057376882	54
M72	**Scientific research and development**	51,71488	0,014838291	48	638,4814414	0,178793062	41
M73	**Advertising and market research**	27,16882	0,007795413	56	0	0	65
M74_M75	**Other professional, scientific and technical activities; veterinary activities**	55,4104	0,015898628	43	157,1560122	0,044008177	58
N77	**Rental and leasing activities**	1429,57595	0,41018105	19	285,1319505	0,0798451	50
N78	**Employment activities**	27,16882	0,007795413	57	12,16102844	0,003405436	64
N79	**Travel agency, tour operator reservation service and related activities**	83,14824	0,023857307	36	1273,38294	0,356583637	34
N80-N82	**Security and investigation, service and landscape, office administrative and support activities**	52,76749	0,015140311	46	166,9103103	0,04673966	56
O84	**Public administration and defense; compulsory social security**	85,79673	0,024617225	35	7540,011874	2,11141894	15
P85	**Education**	79,89239	0,022923122	38	4055,303305	1,135600892	23
Q86	**Human health activities**	29,81173	0,00855373	54	5527,243418	1,547786215	19
Q87_Q88	**Residential care activities and social work activities without accommodation**	58,05331	0,016656945	42	378,8217964	0,106080936	48
R90-R92	**Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities**	22,04079	0,006324053	61	496,9646305	0,139164308	47
R93	**Sports activities and amusement and recreation activities**	8,39369	0,002408359	63	950,8640101	0,266269114	39
S94	**Activities of membership organizations**	48,39778	0,013886532	49	541,3691511	0,151598843	44
S95	**Repair of computers and personal and household goods**	74,53761	0,021386702	40	556,2599834	0,155768702	43
S96 + T	**Other personal service activities + Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use**	34,82176	0,009991233	53	1162,49804	0,325532694	38
	Total	**348523,1584**	**100**		**357106,3862**	**100**	

Source: Calculations within the model

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Güngör, V. (2018), Environmentally Extended Input-Output Analysis for Turkey. Turkish Economic Association International Conference on Economics 2018, Antalya, Turkey, November 2018