IMPACT OF CARBON LEAKAGE ON TURKISH CEMENT EXPORT: A GRAVITY MODEL APPROACH

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ABSTRACT

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Global climate agreements which have been agreed on to take measure against climate change problem evaluate and classify parties with differentiated responsibilities. This differentiation causes asymmetric climate policies among countries. The major source of discussion is the burden of climate policies in terms of production cost increase. This burden produces the risk of distortion in competitiveness and leads countries to provide emission intensive products from outside. This risk is called carbon leakage in the literature and it can be observed within trade flows. In this respect, cement industry draws attention because of high level of consumption and excessive export volume in Turkey. This thesis investigates the existence of the carbon leakage in the cement export flows of Turkey.

Gravity model which is frequently preferred in the international trade literature is conducted to analyze this effect. Model estimates cement exports within the panel data framework and it covers 118 countries for the period of 2001-2012. Estimation results indicate that countries which have emission targets, have a positive effect on the export flow of Turkish cement industry. This finding confirms the existence of carbon leakage in the industry.

Keywords: Carbon Leakage, Cement Industry, Gravity Model

ÖZ

KARBON SIZINTISININ TÜRK ÇİMENTO İHRACATI ÜZERİNDEKİ ETKİSİ:
ÇEKİM MODELİ YAKLAŞIMI

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Küresel iklim değişikliği sorununa önlem almak adına yapılan iklim antlaşmalarının tüm ülkeleri aynı şartlar altında değerlendirmemesi sonucunda asimetrik iklim politikaları ortaya çıkmıştır. Söz konusu politikaları uygulayan ülkelerde bu politikalar sonucu artan üretim maliyetleri dolayısıyla rekabetçiliğin azalacağı ve karbon yoğunluğu fazla olan ürünlerin dışarıdan temin edilebileceği riski tartışılmaktadır. Literatürde karbon sızıntısı olarak geçen bu risk, dış ticaret akışları üzerinden gözlemlenebilmektedir. Bu kapsamda, karbon yoğunluklu ürünlerden biri olan çimento, Türkiye'de artan üretim ve dış ticaret hacmiyle dikkat çekmektedir. Bu tez Türkiye'nin çimento ihracat akışları üzerinde karbon sızıntısının varlığını araştırmaktadır.

Bu etkinin analiz edilmesi için son yıllarda dış ticaret çalışmalarında sıklıkla kullanılan çekim modeli kullanılmıştır. Model kapsamında 2001-2012 yılları arasında 118 ülkeye yapılan çimento ihracat miktarları panel veri seti çerçevesinde tahmin edilmiştir. Tahmin sonuçları emisyon hedefi olan ülkelerin Türkiye'nin çimento sektörüne ait ihracat akışlarına pozitif yönlü bir etkisi olduğunu göstermektedir. Bu sonuç, sektördeki karbon sızıntısının varlığını doğrulamaktadır.

Anahtar Kelimeler: Karbon Sızıntısı, Çimento Sanayi, Çekim Modeli

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CHAPTER 1

INTRODUCTION

It has been a scientifically proven fact that climate change is one of the most serious global environmental problems which requires urgent measures. By recognizing this matter, countries began to search for an immediate and effective solution to handle this issue. With this purpose, they started to discuss policy options in order to combat climate change collectively. As a consequence of these discussions, the Kyoto Protocol which is considered as an extensive international movement was established. With the Protocol, it is aimed to build the largest scale of measures against climate change by involving 192 countries. Moreover, the Protocol provides a binding mechanism to limit greenhouse gas emissions for the first time. However, during establishment of the agreement, it is acknowledged that the responsibilities of developed countries must be surpassed the developing ones. In other words, from the beginning of industrialization period, developed countries have contributed to pollution much more than the developing countries. Due to this fact the consensus over the principle of sharing responsibilities has been established regarding the development levels involved countries. Thus, countries which have continued to develop, have been exempted from any required limitations under the Protocol.

In this scope, the Protocol does not compel all parties to define quantitative emission targets. Countries which have emitted large amounts of greenhouse gases during their development and have had historical responsibilities, are legally binded within the context of Kyoto Protocol. At the same time other countries are not enforced for such binding. Although, this differentiation between countries and their responsibilities can be interpreted positively from economic, social and ethical perspectives, through time it has led to adaption of asymmetric climate policies. In other words, while some countries started to implement different policies for climate change because of their commitment under the Protocol, others have been more flexible in their policies. It has been argued that this asymmetry in terms of climate policies among countries give rise to new risks.

From this aspect, one of the risks implied can be counted as carbon leakage. Countries which determine emission reduction target under the Protocol; widely prefer some instruments and policy options to diminish their emissions. According to the carbon leakage framework, because of these tools and their implementation, countries might have a tendency to shift their production of emission intensive sectors to other countries in where laxer climate policies. It is also observed that the majority of countries, which are exposed to this shift, are in the group of developing countries. The reason behind this is that developing countries have also a sufficient production capacity for emission intensive products. Therefore, this circumstance leads to an increase of emissions in other countries. As a result of this, global reduction in total GHG emissions is not provided adequately. Therefore, this production and emission shift causes to maintain the threat of global climate problem.

On the other side, in 2009 Turkey had ratified the Kyoto Protocol with its special circumstance that prevents Turkey from submitting a binding emission reduction target. In line with this development, Turkey has maintained its economic development process without any emission constraint on its industry and energy sectors. During this time period, Turkey has become one of the top countries which have a high rate of increase in greenhouse gas emissions. It is reported that industrial activities have played an important role in this increase. In this respect, with its emission intensive structure and large production capacity, Turkish cement industry has an important share in industrial emissions in Turkey.

In fact, cement industry which is one of the leading industries in Turkey, also draws attention with its increasing export volume in recent years. When it is considered that the carbon leakage has occurred through trading in the short run, it is suspected that the Turkish cement industry is exposed to this leakage risk. In this study, the export of Turkish cement industry is analyzed and the existence of carbon leakage is investigated. To achieve this, gravity model which has a significant role in trade literature, is employed in order to explain the export flow of cement industry. The study has contributed to literature in both analyzing sector specific exports and carbon leakage effect on Turkish cement industry.

The thesis consists of seven chapters. In the second chapter, the theoretical background of international trade theories and pollution haven hypothesis are presented. In Chapter 3, the measures taken against climate change, carbon leakage and the fundamental reasons of this leakage are discussed. In following chapter, specific indicators and evidences about carbon leakage are provided for cement industry. The information and statistical indicators are given in Chapter 5 in order to give a snapshot of Turkish cement industry. Chapter 6 gives detailed information about the literature related to the methodology used, the characteristic features of data and the estimation results. Lastly, Chapter 7 briefly presents the results of the conducted research.

CHAPTER 2

THEORETICAL PERSPECTIVE

The main aim of this chapter is to present a literature review on theoretical studies which are the roots of the main concern of this thesis. Section 2.1 discusses traditional international trade theories considering how and why trade arises among countries. Section 2.2 covers theories about the impact of environmental constraints on the international trade. Finally, Section 2.3 emphasizes pollution haven hypothesis.

2.1. Fundamentals of International Trade Theories

Classical international trade theory is a departure from mercantilism, which mainly introduces the idea that free trade could be mutually beneficial for trading countries. The notion that depends on absolute advantage was initially developed by Adam Smith, in his book titled "Wealth of Nations" (1776). According to Smith, countries should produce goods only if they can produce them at a lower cost compared to any other country in the world. This idea briefly states that when a country is capable of producing a product at a lower cost than any other country, that country has an absolute advantage in the production of that good.

This simple concept was revised by David Ricardo and then he developed a new notion namely the comparative advantage. According to Ricardo, countries have comparative advantage in the production of a specific good, if its productivity in terms of production is higher than other countries. Basically, Ricardian trade theory examines the trade relation between countries by taking technological differences into consideration and uses them to explore the principle of comparative advantage. Therefore, it is claimed that using different technologies provides a comparative advantage to a country and this ensures that the country specializes in a given industry due to low cost of associated technology. With these approaches Ricardian trade theory contributes a basic but robust framework to international trade theory.

Another breakthrough in international trade theory occurred with the introduction of the neo-classical approach which was established by Heckscher and Ohlin. In this approach, instead of cost differences among countries, sources of these cost differences are taken into consideration and it is claimed that these sources depend on relative factor endowments of the countries. Therefore this approach is called theory of factor endowment in the trade literature. Briefly, Heckscher-Ohlin (H-O) theorem states that factor endowment is the key source of comparative advantage and the ways of trade when it is assumed that countries have the same technology (Feenstra, 2004). Although there are several assumptions on constraints, this theory brings an important point of view by questioning the reasons of cost differences and as a consequence it has become a noteworthy approach among new trade theories.

2.2. Relation between Trade and Environment

In mid-20th century, issues related to environment and foreign trade started to attract interest. As a consequence, the literature about the relation between trade and the environment has begun to evolve. According to the international trade theories which are mentioned above, it can be stated that commodities are produced where the cost of production is the lowest. In this scope, price of a commodity may change when countries start to implement environmental regulations with different levels of technology and this brings an additional cost especially on pollution intensive products. As a result, countries with laxer regulations gain a comparative advantage over others. Earliest theoretical studies which have focused on this argument are summarized and evaluated in this section.

In order to widen the scope of international trade theories towards an environmental approach, one of the very first studies in this field was conducted by Siebert (1974), in which he analyzed the relationship between the prices of commodities considered and environmental effect of production process of them. Siebert claims that environmental impact and pollution risk are also crucial factors in the determination of the price of a commodity. If the less polluting products are produced more efficiently than the more polluting ones, the price ratio of former to latter is an increasing function of shadow price of assimilative capacity. Since more capacity means lower shadow price, the country which has resources, has also the comparative advantage. As a result, country can increase the production and export of pollution-intensive products.

Pethig (1976) also developed one of the initial trade and environment models which was conducted by using the general equilibrium framework. There are two countries and pollution is also included as an input in the model. In addition to these, environmental policy tools such as regulation on emissions and taxation are used. As a result, introducing a control constraint on emissions for a country, led other countries which have low emission restrictions to export their pollution intensive products. In fact, Ricardian basis for trade is replaced by factor endowment approach. Result of the study, briefly states that strict environmental regulation leads to comparative disadvantage in pollution intensive goods. Besides, additional output of the study clearly indicates that changes in environmental policies affect the location of the facilities.

Another study which provided parallel results with Siebert and Pethig was conducted by Baumol and Oates (1988). Their model has two countries producing the same commodity but these countries lead pollution during the production process. In this respect, the study carries out the pollution abatement analysis by using one of the market instruments which is called “tariff”. Result of the analysis indicates that application of unilateral tariff leads to a friction in trade behavior. The reason of this friction is the pollution abatement policy which decreases abating country’s comparative advantage in producing high abatement cost goods. Baumol and Oates concluded that if a country has laxer environmental regulation in comparison with others, it will have comparative advantage over other countries in pollution intensive industries.

Moreover, Carraro and Siniscalco (1992) touch another essential point in their study and argue that technological investments and arrangements are required if pollution intensive industries face with environmental regulation. In the study it is used open economy model by assuming there is only one commodity in the market. Also one of the major assumptions in their model is that all countries have the same technology before the implementation of obligatory technology requirement for emission reduction. It is obvious that obligation of using a new technology in the production process, will cause a raise in the price of the commodity. It can be concluded that environmental regulation and thus technological requirement as a result of these regulations adversely affect competitiveness of industries. In order to overcome this problem, they offer the government intervention in the form of subsidies.

Studies previously discussed had mainly focused on the negative impact of trade. However, they omit the possibility for development in the environmental quality. To observe this development, Siebert (1977) builds a model with two production sectors engaged in international trade. As a result of this study, he concludes that trade of the country is negatively affected from environmental regulations but by this way environmental degradation has declined. He also underlines that in terms of production, if the marginal social cost is higher than the marginal value of consuming, applied environmental policies will lead to a social gain in welfare. Furthermore Siebert states that strict environmental regulation and policies lead to a reallocation in terms of resource of the production.

There is variety of options to provide an adjustment in environment resources. Property right is one of the alternatives that can be used for an efficient control mechanism to avoid environmental degradation. Chichilnisky (1994) analyzes the relationship between property right and international trade in his work. In the model, in addition to the original H-O framework, environmental resources are usable and inputs depend on price. Chichilnisky assumed that there is not any difference between technologies and resources in countries yet they are diverged in terms of the level of regulation on property rights. The result of the study underlines that under lack of regulation supply of resources has increased which indicates that there is contradiction with the comparative advantage concept. Moreover, it is argued that free trade condition clearly accelerates the use of resources. It is suggested that property rights may be a more effective tool to keep the use of environmental resources under control.

2.3. Pollution Haven Hypothesis

Several studies cited in the previous section implies that implementation of stringent environmental regulation increases the cost of production and this leads to reduction in specialization of pollution intensive industries (Siebert, 1974; Pethig, 1976; Baumol & Oates, 1988). This may cause a difference in trade patterns and also in the location of the production which gives rise to another essential concept in trade and environment literature that is called pollution haven hypothesis (PHH). PHH claims that low environmental standards become a reason of comparative advantage and this causes a shift in trade, foreign investment and the production of pollution intensive industries to the countries which have relatively weaker environmental policies.

There are several reasons of having lower level of environmental regulation in developing countries. Lack of experienced experts, expensive technical equipment and high cost of sustaining these environmental standards, make the cost of implementation of environmental regulations higher in developing countries. Furthermore, the clean and sustainable environment has not a priority for citizens of developing countries because they mainly focus on improving their wealth. In fact, environment is a luxury good which people demand for improvements in their quality of living once their other needs are met (Pearce & Atkinson, 1993). Hence, it can be interpreted that demand for environment with high level quality is relatively lower in developing countries. Recently, developing countries maintain economic progress by shifting from the agricultural sector to the manufacturing sector, which creates a demand for urbanization and infrastructure, both increasing pollution. However, in advanced economies provision of services replace the manufacturing of goods as the dominant production activity (Inman, 1985). In other words, the pollution intensity decreases in developed countries. All of the statements above cause country specific implementation on environmental regulation which reveals the notion of comparative advantage and also the pollution haven hypothesis.

An important study in this area was conducted by Grossman and Krueger (1993) and it focuses on the trade and environment of Mexico which has involved in a significant trade agreement. The North American Free Trade Agreement (NAFTA), came into effect on January 1, 1994 and it has established the largest free trade region in the World at that time. Study examines the change in trade pattern and environmental quality of Mexico after the period of NAFTA. Due to its labor-intensive structure which can be interpreted as cleaner than the other countries' capital intensive models, Mexico has a comparative advantage in agriculture and manufacturing. However, after joining NAFTA, Mexico had turned into a pollution haven. According to Grossman and Krueger, the reason of this development was the high demand for environmental quality in the United States. With the increasing importance of environmental quality expectations in northern countries, it had influenced trade flows towards new destinations where there are more lenient environmental regulations. As a result of this demand, while the pollution in northern countries was decreasing, in Mexico the pollution level was raising.

Copeland and Taylor (2004) also provide a remarkable contribution to the PHH literature and this study includes a model which takes the relation between income and environment into account. Result of their study shows that the pollution haven hypothesis and the factor endowment hypothesis. It is stated that regulation on pollution affects the trade and investment and there is an evidence to support the PHH. However, it should be clearly identified that the difference between pollution haven effect and pollution haven hypothesis. The former stands for the impacts of environmental regulation on location of facilities and trade flows, but the latter one is a stronger version of pollution haven effect. It occurs when location of polluted industries of developed countries transferred to developing countries which have lenient environmental regulations.

Beside these studies, there are also a number of studies[1] which shed light on the background of pollution haven hypothesis. In fact, pollution haven hypothesis has become a crucial subject within the literature when it is considered that some countries have started to implement strict environmental policies and enforce environmental laws with an increasing rate. The objective of the thesis is very similar to the pollution haven hypothesis and it deals specifically with climate change problem by focusing on limitation of greenhouse gas emissions. Details of these issues are mentioned in next chapters.

[1] Robinson (1988), Low and Yeates (1992), Birdsall and Wheeler (1997), Suri and Chapman (1998), Hettige et al.(2000) and Cole (2004).

CHAPTER 3

BACKGROUND OF CARBON LEAKAGE

Although the awareness of climate change leads most countries to take precautions and to adapt low carbon development path, balanced and fair climate policies and strategies have not been provided yet at the global level. Some countries certainly give priority to climate change issue and comprehensively adapt climate friendly perspectives in their entire national policies. However, others do not even have any established policies or any solid aspects for this global problem. This contrast among countries has induced asymmetric attitudes in international debate about climate change (Reinaud, 2009). Best expression of this circumstance is observed by analyzing international agreements. In this chapter in the first place background information on climate change is provided and then explanation about asymmetric climate policies and carbon leakage is given in details.

3.1. Climate Change and Kyoto Protocol

Climate change had been defined as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (UNFCCC, 1992). In the definition, it is clearly stated that climate change is a result of human induced activities because as a consequence of these activities, some chemicals have been released to the atmosphere. In the first assessment report (AR1) of Intergovernmental Panel on Climate Change (IPCC)[2], a

[2] Intergovernmental Panel on Climate Change (IPCC) is an international institution for the scientific evaluation of climate change, It was established by United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988.

similar expression was also used and within the scope of the report the authors are certain that emissions resulting from human activities are considerably accumulating the concentrations of these chemicals that are known as Greenhouse Gases (GHG). These gases are listed in the IPCC AR1 as Carbon Dioxide, Methane, Chlorofluorocarbons and Nitrous Oxide. However, conducted studies and researches expanded the scope of this list as follows;

- Carbon dioxide (CO_2),
- Nitrous oxide (N2O),
- Methane (CH4),
- Sulphur hexafluoride (SF6).
- Perfluorocarbons (PFCs),
- Hydrofluorocarbons (HFCs)

The effects of GHGs are investigated in many scientific researches and it is widely expressed that the rising trend in the greenhouse gas emissions enhances the greenhouse effect, and this causes an increase in the temperature level of the Earth's surface. This rise cause observable changes in climate pattern and therefore it is called climate change problem. According to the scientific testimonies, in order to prevent adverse and crucial effects of climate change, the increase in global temperature level should be held below 2 degree Celsius in following years.

In those scientific studies, it is also indicated that level of total GHG emissions had been increased around 78 per cent between 1970 and 2010. The reasons behind this high rate of increase were specific sectors which are energy, industry and transportation. (IPCC, 2014) This circumstance leads to the rise in global concerns about polluting activities which are mostly emanating from those sectors.

After recognizing that the climate change is a global issue and arising from mainly human activities, in order to find a solution with a broad-based consensus, in 1992, countries reached a consensus on an international treaty which was the United Nations Framework Convention on Climate Change (UNFCCC). The objective of this treaty was defined as to cooperatively identify the options to limit average global temperature increase that leads to climate change. In order to reach to this aim, emission reduction targets were included in the scope of the Convention. However, by 1995, countries acknowledged that the emission reduction targets declared in the Convention were not sufficient in furtherance of achieving the temperature target. Henceforth, new negotiations were launched to strengthen the global action for climate change. Two years later, in 1997, Kyoto Protocol which legally binds countries to fulfill emission reduction targets was adopted and it is entered into the force in 2005.

Kyoto Protocol, followed and adapted the main aim of the UNFCCC. In other words, it was also established to prevent the climate change by reducing and limiting GHG concentration in the atmosphere. However, in this case it clearly identified the responsibilities of each parties. The approach behind the main aim of the Kyoto Protocol, is based on the principle of common but differentiated responsibilities. Mainly, the Protocol enforces developed countries to reduce their emission levels relying on their historical responsibilities about greenhouse gases in the atmosphere. In order to determine responsibilities of parties, Protocol prefers to use classification methods.

3.1.1. Annex B countries under Kyoto Protocol

Kyoto Protocol and UNFCCC offer an annex methodology to classify the country groups easily. UNFCCC divided countries into three groups: Annex I, Annex II and Non Annex I countries. In the same manner, Kyoto Protocol classified countries regarding the division method of UNFCCC. According to the Protocol, there is a specific group which is called Annex B countries. Country group which includes highly developed countries and transition countries has different levels of emission reduction targets under Kyoto Protocol. However, other countries that are excluded from Annex B do not have any quantitative commitments regarding the mitigation. It is argued that these classifications are the main reason of asymmetric climate policies. Since it has a unilateral approach in terms of emission reduction commitment, it brings unilateral perspective to the global issue of climate change.

Since 2005, Kyoto Protocol calls Annex B countries to reduce their emission in two commitment periods. First commitment period of the Protocol involves years between 2008 and 2012 and Table 1 presents the details of each country's numerical targets for this period. The average reduction target of these countries was around 5 per cent below the 1990 level.

Table 1: Targets of Annex B countries for 2008-2012 period

Country	**Target (1990-2008/2012)**
EU-15, Bulgaria, Czech Republic, Estonia, Latvia, Liechtenstein, Lithuania, Monaco, Romania, Slovakia, Slovenia, Switzerland	-8%
United States*	-7%
Canada, Hungary, Japan, Poland	-6%
Croatia	-5%
New Zealand, Russian Federation, Ukraine	0
Norway	+1%
Australia	+8%
Iceland	+10%

* The US has indicated its intention not to ratify the Kyoto Protocol.

In 1997, the very first draft of Annex B included 38 countries. However, United States stated its non-ratification of the Kyoto Protocol. Therefore, 37 countries which correspond to almost one quarter of global GHG emissions, have promised to implement limitation on their GHG emissions. Among these countries; at the end of

2012[3], only nine[4] of them could not fulfill their targets and emitted higher levels of emissions in this period. Moreover, all of the transition countries in the list of Annex B such as Russian Federation, Poland, Ukraine, decrease their GHG emissions more than their initial commitment level. Lastly, as it is expected, United States which had not participated eventually emitted larger amount of emissions than its non-ratified target.

3.1.2. Policies of Annex B countries

Articles of the Kyoto Protocol states that countries which are listed in Annex B, should adapt domestic policies and measures to meet their quantified emission reduction commitments. However, general approach of the Protocol provides flexibility in the implementation of these policies and measures. In fact, specific policy tools or specific sectors and energy options are not defined by the Protocol. This flexibility allows countries to form their own climate policies according to their national and special circumstances, and supports them to find the most efficient way in order to decrease their emissions. There are different types of emission reduction tools that are used by these countries but most of them focus on the most efficient and powerful ones according to their special domestic circumstances. This section presents information on economical instruments for climate change problem. Moreover this section also presents some examples from Annex B countries which had implemented different instruments to achieve their targets for the first commitment period.

Under the Protocol, some market-based mechanisms were introduced in order to provide an assistance to reduce emissions. One of the mechanisms is international emission trading system. This mechanism is the most attractive one for the scope of the thesis. According to this system, countries which have commitments under the Kyoto Protocol can acquire emission units from other countries with commitments

[3] See Appendix for list of countries with their realized emission level by 2012.

[4] Austria, Denmark, Luxembourg, Spain, Japan, Liechtenstein, Norway, Switzerland, Canada.

under the Protocol and use this mechanism to achieve their targets. By this mechanism, a new commodity was created in the form of emission reductions or removals and since the carbon dioxide is widely accepted as the principal greenhouse gas, this mechanism is called as “trading in carbon” or “carbon market” (UNFCCC, 2014). In the emission trading scheme, the price for carbon per ton is determined to be traded by taking into account of the supply and demand dynamics of current market conjuncture. Due to this implementation, emission trading schemes are counted as one of the effective carbon pricing tools.

In addition to the trading scheme, another market based instrument that provides a limitation on emission level is the carbon tax. It has not been covered by the market mechanisms of the Kyoto Protocol. However, it is also a widely used tool for keeping emission level under control. Actually, using tax system in order to eliminate or diminish negative externalities like pollution is not a new method. In 1990s especially in the Scandinavian countries, an earlier application of pollution taxation can be observed. After the success of these practices had been seen, the taxation of environmentally negative externalities has gained importance and the taxing schemes have started to focus on carbon taxation by putting a price on per ton CO_2 equivalent. In the practice, carbon tax may be applied as the sole instrument or as a complementary tool to other instruments which includes emission trading schemes.

When it is compared as the two different approaches of carbon pricing, carbon taxation ensures the price of carbon in the market while an emissions trading scheme determines a cap for emissions with flexible prices. By this way, certainty about the environmental quality is provided. In addition to these methods, countries also implement alternative approaches which consist of laws, regulations and standards. Policy makers commonly use these direct interventions to provide efficient and immediate solutions to the environmental problem. To combat climate change, similar interventions are implemented by governments, such as standards for emission intensive processes and products, specifications and requirements of technical equipment and so forth. However, this approach is also not included in the Kyoto Protocol as a binding method. Therefore, countries domestically decide on these types of implementations.

In this respect, below table represents Annex B countries which prefer to use instruments of carbon tax and emission trading system. Beside these carbon pricing instruments, several standards and regulations for climate change, are also implemented in these countries.

Table 2: Instruments for Climate Change in Annex B countries

Carbon Tax	Emission Trading System
Australia	EU ETS (28 EU Countries)
Finland	Switzerland
Poland	New Zealand
Sweden	Japan*(Tokyo, Saitama,Kyoto)
Norway	Canada* (Alberts,Québec)
Denmark	
Latvia	
Slovenia	
Estonia	
Switzerland	
Canada* (British Colombia)	
Ireland	
Iceland	
Japan	

*Limited with local implementation

Source: Carbon Pricing Watch,2015

As it is also observed from the table, the leadership role of the European Union cannot be ignored. With the ratification of the Kyoto Protocol in 1997, preparation has started for the launching of first emission trading scheme in the world. In 2005, it became operational as the largest trading system and since then it has become the main policy mechanism of the Union, with regarding the fact that it covers around

45% of total GHG from 28 EU countries (EC, 2014). In fact, the system monitors GHG emissions from electricity producers and energy and emission intensive industrial sectors including iron and steel, aluminum and cement and ensure that total amount of emissions does not exceed the maximum cap. The main aim of the trading scheme is to reduce GHG emissions of those energy and industrial sectors with lowest cost. However, implementation of this mechanism causes a further cost to related sectors due to limitation of emission.

For an another example, in 2008 Japan also began to implement emission trading system which was similar to the European scheme but it was entirely domestic and based on voluntary participation. According to the Japanese system, installations can determine their emission target level without any restrictions. In 2010, mandatory domestic trading system was discussed at national parliament; however, it was decided to use this system after detailed evaluation. Additionally, in 2011 Japan has faltered with an accident of nuclear power plant. Thereafter, by considering negative side effects of nuclear power plants as it was seen in this case, Japan has shifted its national energy policy towards other emission-intensive energy sources. To compensate this shift, following year Japanese government introduced a global warming countermeasures tax with the aim of limiting emissions from energy consumption (Kuramochi, 2014). Despite these efforts their emission reduction target under Kyoto Protocol failed to be fulfilled. Nevertheless, Japan had achieved a limited reduction in her emissions which was around 2.5 per cent in comparison with 1990 level.

Among transition economies under Annex B, Russia is one of the leading countries in the area of energy and industry. It also plays a significant role in total GHG emissions by taking the fifth place in terms of GHG emitters ranking. Therefore, it can be said that Russia has taken a vital step towards combating climate change by ratifying Kyoto Protocol. However, Russian Federation has followed a different path without using either emission trading or carbon tax. Russia established its emission reduction policy which is based on using energy efficiency and renewable energy by affecting energy demand and supply conjuncture. The main policy aims to increase energy efficiency in emission intensive sectors and promote emission reduction. In general, amelioration of energy efficiency and emission reduction in industry relies on new technologies and equipment and therefore in the short term, the renewal cost of these capitals is partly a determinant of the energy prices. Thus, electricity prices are predicted to be in an upward trend and this will affect the production cost in energy intensive industries.

Some countries have also apply carbon tax as the main tool in order to reduce emissions. For instance, Australia, which had a target for the first commitment period, can be taken into account in this respect. At the beginning of the commitment period, Australia has gathered its strategies and policies under a package which is called “The Clean Energy Future”. This package includes the implementation of carbon pricing mechanism. The related mechanism is similar to the European model. However, it diverges from their mechanism at some points particularly in terms of the way of pricing. Australian mechanism has a permit system which limits installations with annual emission threshold. Installations which are involved in the coverage of the mechanism confront with pressures.

3.2. Carbon Leakage

At first sight it seems that the Kyoto Protocol presents an adequate solution to climate change problem although it cannot force all parties to take climate action. This noncooperation in the implementation side leads asymmetric climate policies and new concerns are ensued in the period of Kyoto Protocol. One of the major concerns is carbon leakage. By definition, carbon leakage refers to an increase in the emissions of a country as a result of the production transferred from another country due to unilateral climate policies. Although the Kyoto Protocol aims to decrease the greenhouse gas emissions, due to carbon leakage risk this aim may encounter with a failure at the end of the Protocol. In addition to the global concern, countries also have anxiety about their economic conditions. Eventually, this fact legitimizes the concern about losing market share for sector associations and also policy-makers. This section explains details of carbon leakage that possibly takes place in recent years and indicates the factors behind this leakage.

Carbon leakage can be detected by analyzing two different indicators. These indicators are competitiveness and international fossil fuel prices (Dröge et al.,2009). Since the main concern of the thesis is related to the former one, this section concentrates only on the relation between carbon leakage and competitiveness. Literally, the idea behind the indicator of competitiveness relies on the comparative advantage concept of international trade theories. International trade literature explicitly states that the increase in the cost of production causes a comparative disadvantage within trade perspective. Therefore this disadvantage leads to a change in trade balance in some noticeable ways which depend on decreasing export volume and increasing import volume in general.

In this respect, Figure 1 includes a flow chart which shows the steps of carbon leakage related to the change in competitiveness. In the short term, carbon leakage takes place with the difference in trade pattern of emission intensive products while in the long run it is detected in investment pattern. This study mainly focuses on the short term results of the carbon leakage.

According to the studies and technical researches, evidence of carbon leakage is actually observed in the trade flows between constrained and unconstrained countries where constraints are implemented on GHG emissions. The main reason of carbon leakage is distorted competitiveness due to adoption of various climate policies. While losing market share in domestic market causes a shrink in export activities, it increases import volume of emission intensive products. In fact, if competitiveness is highly affected by those emission constraints, a sharp shift might be seen in all trade flows. It could occur because of large increases in the cost of emission intensive products, similar to the case of pollution haven hypothesis that is mentioned in Chapter 2.

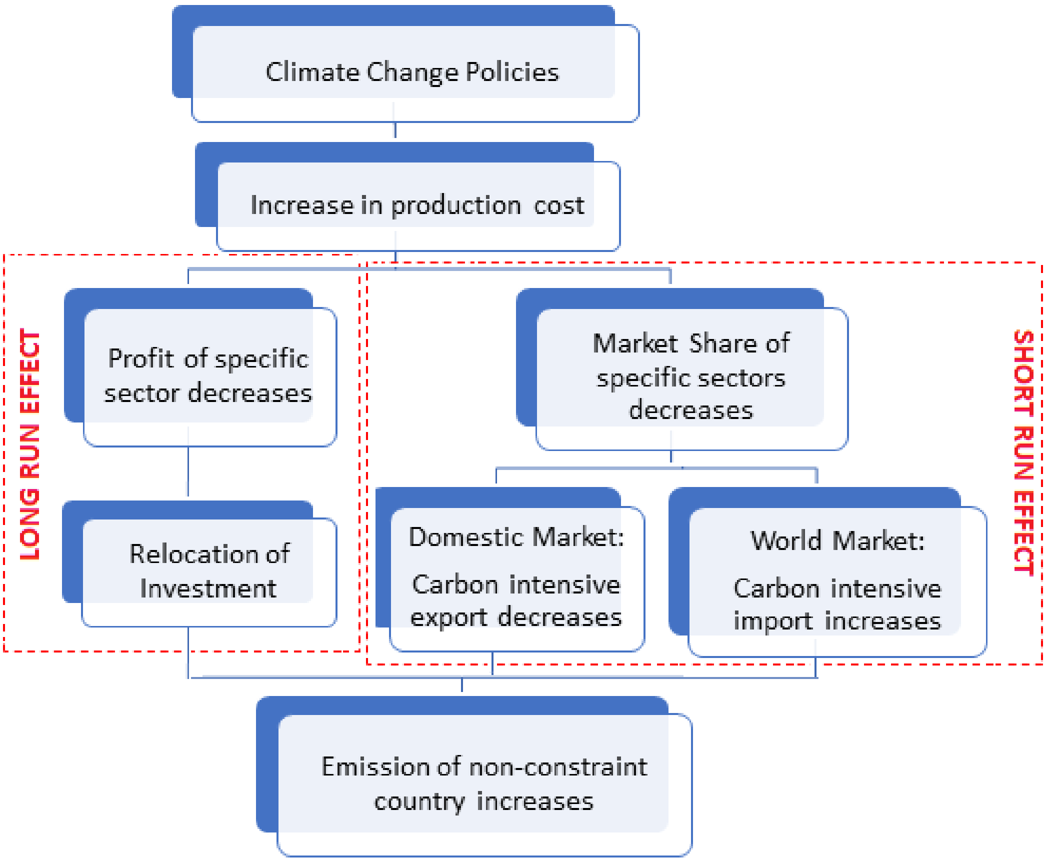

Figure 1: Flow Chart of Carbon Leakage

Source: Author's interpretation based on Dröge et al. (2009)

As pollution haven theory states that countries which impose strict climate policies shift their production to environmentally non-constraint countries. According to the literature, carbon leakage is a special case of the pollution haven effect (Aichelle and Felbermayr, 2012). Pollution haven hypothesis considers wide range of environmental problems while concept of carbon leakage analyzes only the problem of greenhouse gas emissions. However, there is also another difference between the pollution haven and the carbon leakage, which must be taken into account. In the carbon leakage case the location of the polluter is insignificant because emission is a type of air pollutants that affects quality of global environment. In other words, examining the case with a wider perspective shows that shifting the production does not decrease the global stock of carbon dioxide emission and thus it does not finalize the climate change problem of that country. In short, carbon leakage reverses the main objective of climate change policies and continues to damage global environment.

3.2.1. Competitiveness

As it is mentioned, relevant countries implement mandatory climate policies associated with fulfilling their emission targets while rest of the world do not have any legally binding target. It is obvious that current agreement cannot present a global solution towards a global problem. This differentiation causes a major concern about the disturbed competitiveness. The main argument is that introducing tools for emission reduction increases the cost of a product and thus largely damages the competitiveness of some sectors. In this respect one may argue that the competitiveness of a sector depends on some basic factors in the presence of climate change strategies. One of them is the level of emission and energy intensity of the sector. The other one is the potential of the sector in terms of cost pass through capability. In this section, these factors that affect the level of exposure in terms of competitiveness are examined.

3.2.1.1. Emission and Energy Intensity

It is important to identify the degrees of energy and emission intensities of a sector because these intensity levels directly influence the production cost. In this respect, industrial sector is one of the most energy intensive sectors around the world. At global scale, the sector ranks at or near top in the final energy consumption and this constitutes around half of the global energy use. In this regard, it is observed that some of the sectors are more energy intensive than others. According to the latest data, energy consumption of sub-sectors such as iron and steel, cement, pulp and paper, primary aluminum, glass, refining correspond to 70 per cent of energy usage of the global industry.

In this regard, cost of energy resources is significant for those sectors because it is a vital determinant of total production cost. Energy resources that are used in the industrial processes are mostly composed of fossil fuels. Therefore, carbon pricing which triggers an increase in fossil fuel price, causes various costs to sectors. As expected, this depends on industries' energy consumption structure. Sectors which sustain their production with the least climate friendly energy resources, encounter a further cost.

In addition to these direct costs, during the implementation of climate policies, some indirect costs are also occurred for the products. Particularly, pricing carbon can primarily affect the wholesale electricity prices by boosting the cost of electricity (Reinaud, 2003). However, facilities belonging to the same industry may experience different costs regarding the source of electricity. For example, a facility which satisfies its electricity needs from a hydro power plant is not affected as much as a similar facility that receive its electricity from a coal-fired power plant. Therefore, this indirect cost may vary among facilities and also it depends on their level of electricity intensity.

However, examining the energy structure of sectors is not sufficient to observe the total impact of climate change policies. In most policy cases, sectors are evaluated with regards to their emission levels. Therefore, in the presence of emission reduction policies, direct cost has emerged mainly for emission intensive sectors. Combustion of fossil fuels is the main driver of emissions from those sectors. However, some activities belong to those sectors also emit emissions while specific processes are carried out. Therefore, facilities also face with direct costs related to their total emissions.

The majority of analyses rely on investigating details of specific sectors by regarding their sectoral structures. These studies indicate that different sectors have different levels of pressure under climate change policies. By considering the energy and emission intensive features, mainly the sectors listed below are discussed in the studies;

- Iron and Steel
- Cement
- Aluminum
- Paper and Pulps
- Chemicals
- Refineries

3.2.1.2. Cost Pass Through

Another factor that determines the level of impact on competitiveness of industry is the capability of passing the additional cost to the final price of the product. Similarly in the emission intensity case, this ability also varies with respect to industry. While some of them succeed to pass some part of their additional cost to the consumers, others need to absorb it. This condition depends on the demand elasticity of the industry.

Demand elasticity means how the demand for a good or service changes when its price increases or decreases. In this framework, there are two possible elasticity conditions which are elastic price behavior and inelastic price behavior. If consumers of a good or service are responsive to price changes in terms of shifting their demand from that good to another one, this is called elastic price behavior. On the opposite way, if consumers are insensitive to prices while determining their consumption behavior, it is called inelastic price behavior.

Due to these facts, companies' abilities in passing through the costs into prices are differentiated by their products' elasticities. A company which produces price elastic goods or services cannot be able to reflect its costs into prices without affecting demand towards its products. On the other hand, a company which produces inelastic products may change prices by reflecting its cost changes, without a shift in demand of consumers. For example, electricity has relatively an inelastic price characteristic so this sector may pass any additional costs to final price in most cases. In other words, demand for electricity does not change in the case of increasing price. However this condition is altered within other sectors. Demand may easily be shifted, especially if substitution is available for that product belonging to those sectors.

CHAPTER 4

OVERVIEW OF CEMENT INDUSTRY

Taking into consideration the list of stated industries under carbon leakage risk, cement industry attracts attention because of having distinguished sectoral features and conditions. The industry has shown an enormous growth since the industrial revolution because it has started to be used as a fundamental input for building and infrastructure constructions. This development has made the industry one of the leading and indispensable sectors in countries where they have settled. Furthermore the sectoral analysis indicates that growth of the industry will maintain in following years due to the upward trend in urbanization demand.

In this respect, this chapter presents the specific features of cement industry when it is encountered with climate change policies. To do this, two primary factors that make the industry capable to compete under carbon policy are explained in the first place. Then the detail of the alternative factor which is mitigation action in the industry is given. And lastly, climate change actions of cement industries belonging to specific countries are addressed.

4.1. Cement Industry: Emission Intensity and Ability of Cost Pass Through

As it is mentioned, there are two main factors which determine the ability of competition of sectors when national policies and strategies include emission reduction target. One of the factors is the degrees of energy and emission intensities of the industry. To identify these intensities of the cement industry, details of fuel usage in the production is needed to be reviewed. In regard to sectoral outputs, it is conveniently stated that the primary fuels used in the cement industry are coal and petroleum coke. Consequently excessive usage of these solid fossil fuels has led to high carbon dioxide emissions. From Figure 2 it is observed that industry meets its energy needs with dirtiest fossil fuels in large proportion. It also uses electricity substantially in the production process.

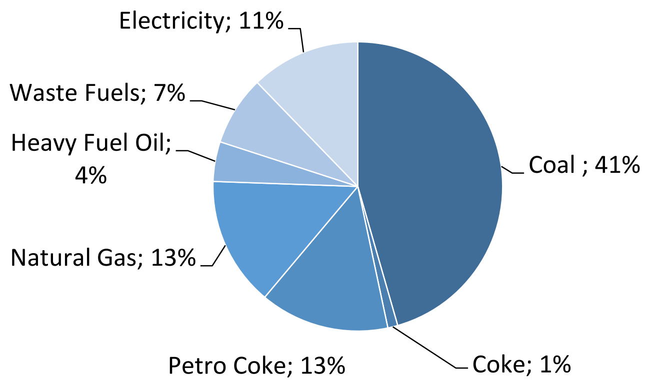

Figure 2: Average Fuel Consumption of Cement Production

Source: Energy Consumption Benchmark Guide (NRC, 2001)

In fact, around 75 per cent of the energy is consumed by the cement production within the subsector of non-metallic minerals. This makes cement industry to have a large share in the carbon dioxide emission of the total mineral sector. Additionally, according to the statistics, cement industry contributes almost 7 per cent to global anthropogenic carbon dioxide emissions by itself (E.Benhelal, 2013). All these statements that are mentioned above, confirm that cement industry has high level of energy and emission intensities.

Besides, Figure 3 indicates the distribution of average cost components of cement production. From this figure, it is recognized that energy cost is the largest cost variable in the production phase. Cost breakdown surely can be different for each cement facility in accordance with their technology and capacity. However, technical analysis states that the cost of energy of cement industry varies between 25 percent and 35 percent of total direct costs. Therefore, general assessment of the sector illustrates that energy has been detected as a crucial element in total expenditures.

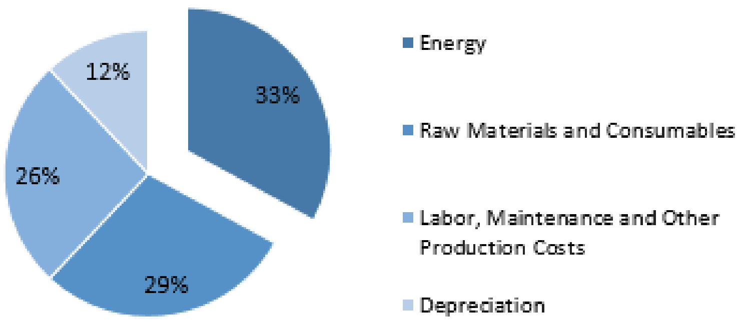

Figure 3: Average Cost Breakdown of Cement Production

Source: Lafarge, 2012

It is certain that industry possesses an energy and emission intensive structure which is the main reason of sensitivity towards the emission constraints. This structure affects the cost breakdown and thus energy has a large share in total costs as expectedly. These evidences on energy consumption and cost breakdown confirm the fragility of the cement industry. From this point of view, industry does not have an extensive ability to compete when it faces with emission and energy constraints. This could lead a significant increase in the carbon leakage risk for the industry.

Some policy makers in the European Union have already been aware of the possible results of climate policies for industry; therefore European Commission has prepared and published several documents about carbon leakage risk. According to the related document (EC, 2011), sectors under carbon leakage risk are defined as: “sectors that may suffer a competitive disadvantage against competitors located in areas outside the EU which do not have similar emission reduction commitments, which could in turn lead to an increase in greenhouse gas emissions”. In fact, this formal definition that was published by the Commission has revealed the seriousness of the risk and has initiated discussions among facilities that are involved in emission trading system in the Union.

In the document, it is stated that determination criteria for the carbon leakage risk depends on two main elements: total cost and trade exposure. In the document, total costs due to emission trading system are calculated and trade exposures are estimated for each sector. In this respect, Figure 4 shows the results of quantitative analysis of carbon leakage risk for selected sectors (EC, 2011). The result indicates that notable case is observed for the cement industry. As it is seen, although cement has a low value for trade exposure, sector is highly affected by emission constraint. It has higher level of total cost divided by gross value added (GVA) than others which reveals extreme impact of climate policies on cement sector. Therefore, it is claimed that while other sectors are much more resilient when they are faced with emission constraints, cement sector is more vulnerable to such cases. The reason behind this issue is high emission and energy intensive structure of the sector which directly affects the cost of production, as it is mentioned above.

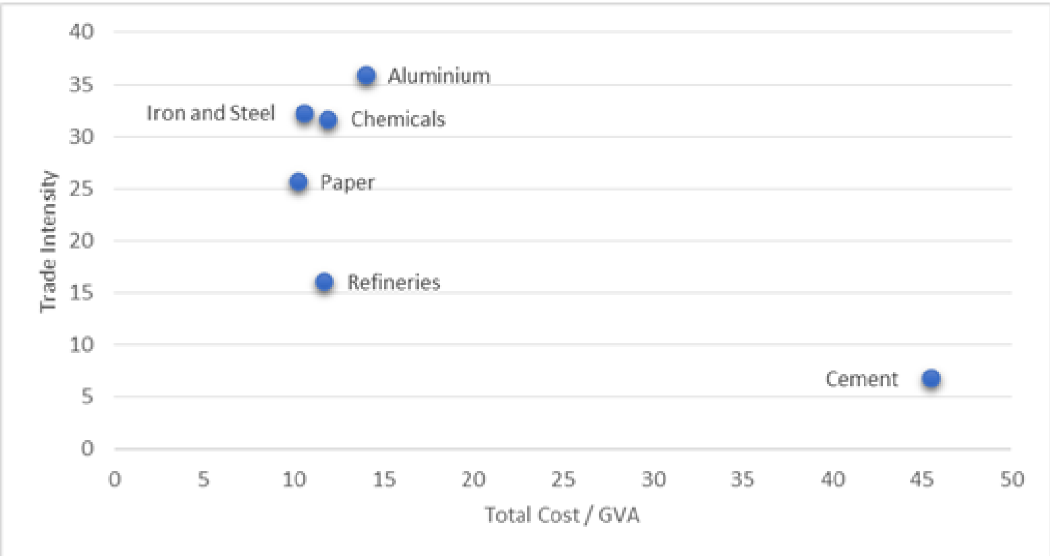

Figure 4: Analysis of Carbon Leakage Risk for Selected Sectors

Source: Author’s calculations based on European Commission (2009)

In the previous chapter, it is stated that ability of cost pass through is also a significant matter to understand the sectoral behavior. In the analysis of carbon leakage risk which is conducted by EC, trade exposure is counted as an indicator to identify the ability of cost pass through of the sectors. Nonetheless, it is argued that trade intensity has an imperfect form to be such an indicator (Neuhoff, 2011). Trade intensity is not a static parameter. In contrast, it has a dynamic relation and specifically depends on structure of the industry. Therefore, it could mostly change its form if it confronts with any limitation or oppositely with any incentive. Because of these reasons, trade intensity is a basic indicator that stands just for the initial static condition of the sector and it cannot ensure an extensive evaluation for the carbon leakage (Neuhoff, 2011). Moreover, it is also statistically provided that the carbon leakage risk is highly correlated with emission intensity but not with overall trade intensity (Martin et al, 2014).

Since trade intensity cannot implicitly correspond to the capability of cost pass through, another indicator should be analyzed instead of this intensity. In fact, it is still important to determine the capability of the cement industry to observe the actual effect within the competitive market. For this purpose, elasticity of demand for cement products is required to be examined. Neuhoff and Sato, estimate the impacts of price changes for several commodities by reviewing the literature and using their own methodology. Cement is also one of the commodities that is examined in their study. They find that demand for cement is relatively elastic. This means that an increase in price causes a reduction in demand, for cement producer it is difficult to pass these costs into the consumer price without having an obstacle in the competitive market.

Customer behavior towards the increase in the price of cement product seems strict and sensitive according to the result of study that is noted above. However, this behavior may vary depending on the accessibility to other suppliers. If consumer cannot easily access to substitution of the product, above argument will be invalid. For this case, especially cement producers in the countries with coastlines can become vulnerable due to imported products. Since other suppliers can reach the country by shipping which may provide lower transportation costs than the carbon cost. Studies also support this fact and indicate that ability of cost pass through is low for cement producers located in coastal regions (Demailly and Quirion, 2006) and estimate that amount of cement imports to those regions is more than to other regions (Ponsard and Walker,2008).

As a consequence, the main concern in the cement market is the limited ability of cost pass through because of having a plenty of external suppliers in international market. Cement is accepted as a construction product which is relatively homogeneous, even though it can vary by type of used raw materials and technological level of plants (Demailly and Quirion, 2005). For this reason, cement producers compete with others in prices, rather than the quality of the produced cement. If cement producers in countries which have emission target, will pass carbon cost into the cement prices, domestic market is distorted and imported cement can become more advantageous (Neuhoff et al, 2014).

Current overview indicates that cement industry has a tendency to be affected in negative manner in terms of competency when there is a strict climate change policy. Emission intensive form and low capability of passing the cost to the price decrease the industries' chance to compete under emission constraint and increase the carbon leakage risk. Nevertheless, apart from these two options there is another factor that could be investigated to increase the chance of the industry against global market. This factor is the mitigation ability of the carbon dioxide emissions sourced from cement industry. For this reason, this ability is examined for the cement industry in the next section.

4.2. Mitigation Options in the Cement Industry

Ability to provide effective mitigation response to emission constraint can definitely change industry's position under carbon leakage risk. High capability of mitigation offers cement industry to reduce the cost and competitiveness pressure of climate change policies. However, in order to fully understand the approach of emission reduction ability, technical details of cement production need to be presented in the first step.

Statistical facts state that global cement production has been increasing intensively. This high production level is also an indicator of carbon dioxide emissions from the industry. To examine the case, emissions of the production process need to be reviewed. In cement manufacturing, total emissions can be divided into two groups: process emissions and combustion emissions. In fact the main step that emits large amount of emission during the entire process is the step of clinker production. In this step, raw material is burned in the kiln at high temperature, to change its physical and chemical constitution. For high level of temperature, required heat is provided by using fuels. Therefore, it can be concluded that combustion of fossil fuels and calcination of raw materials are the reasons of this high level emissions.

Hence, to reduce emissions of the industry, technical improvements and policy measures are developed mainly for this stage of production. Within the scope of climate change policies, cement industry in those countries tries to adapt the following options:

Allocating a budget for renewal and improvement of production technology is significant option for the industry. The efficiency of the process highly depends on technological level of the cement facility. Therefore rising investments on new technologies certainly provide an opportunity to reduce fuel consumption level and increase the energy efficiency. Potential reduction in emission level can be achieved by this way. However, the enhancement of the cement facility requires a considerable investment. Due to budgetary issues, facilities do not find this way feasible, especially when they find out that the higher efficiency arrangements raise the capital costs by approximately 6 per cent (Worrell and Galitsky, 2008).

Changing type of fuel used is also another useful and effective emission reduction method. The process of cement production commonly uses fossil fuels that cause high level of emission. Therefore, replacing fossil fuels with alternative fuels such as fuels derived from wastes; present an opportunity for emission reduction.

However, this method reduces the capacity of the kiln and thus, it adversely affects the quality of the output (Krennbauer, 2006). Also burning non-homogenous waste can largely damage equipment and increases the operational cost. Besides, changing the type of fuel mostly lead to an increase in other pollutants and this pollution degrades the environment in another way (ECRA, 2009).

Moreover, producing blended cement is one of the direct ways in order to emit low emission. To produce blended cement, facilities need to have lower clinker-cement ratio by using alternative materials in the production. Technical studies propose that cement facilities have much more potential in emission reduction by choosing this method. It is argued that around 15 per cent of the clinker can be substituted by pozzolans, fly ash and slag (OECD, 2008). Since the main source of the emission is the phase of clinker production, decreasing the proportion of the clinker in the cement will certainly reduce the emission level. Nevertheless, this implementation decreases the quality of the cement and damages its standards and also its performance. This may distort the acceptance of the product in the market. Additionally, availability of substitution material has an importance in this option. Cement facilities should be located close to the source of these materials but it is technically limited in most areas (EPA, 2010).

Points mentioned above are the most commonly used policies and implementations in the cement industry for emission reduction while there is a growing climate change concern in global aspect. Yet, all of these face with economical and technical limitations eventually. Because of this reason, mitigation options cannot adequately contribute to the required emission target. It shows that in general ways cement industry is unable to escape from the economic impact of the climate change policies and strategies. Due to this fact, for current case one may conclude that countries which have a commitment on emission target under Kyoto Protocol are highly exposed to a competitiveness pressure on their cement sector.

4.3. Policies and Strategies towards Kyoto Protocol

Following statements present an overview of specific climate policies for cement industry and its emission status of Annex B countries. In order to evaluate these conditions, specific cement policies of these countries are analyzed below. Those countries are chosen because of the size of their cement industry. Table 3 provides the production level of top countries in cement industry which have also commitment for emission limitation under Kyoto Protocol.

Table 3: Cement Production Level of Annex B countries

Country	**Japan**	**Spain**	**Russia**	**Italy**	**Germany**	**France**
Production(Mton)	69	50	48	46	30	21

Source: United States Geological Survey (USGS), 2007

In the earlier years of Kyoto period, in 2005, Japan had the largest cement industry among Annex B countries. First commitment period has really affected the industry. In the first place, Japanese government has prepared the Kyoto Protocol Target Achievement Plan by taking into account of the Climate Change Policy Law. The Plan includes several specific policies to ensure the fulfillment of first period of Kyoto Protocol commitment. Within these policies, there is a particular one for cement industry. According to this policy, industry should promote the use of blended cement and emission reduction measures (METI, 2014). In addition to this plan, industries also establish their own action plans for emission reduction. These action plans are voluntarily but they have a wide range of implementation area. For the industry, Japan Cement Association states their target level in energy intensity of the sector. Their target is decreasing their energy intensity by 3.8 per cent in their first commitment period of Kyoto Protocol. In fact, at the end of 2012, they achieved 4.4 per cent for average annual energy intensity reduction for commitment years in comparison with 1990. Under this action plan, to achieve the target, energy efficient equipment are introduced to the facilities and the use of alternative fuels is supported.

Besides the Japanese cement industry, other countries except Russian Federation in Table 3 are members of the European Union. All these countries are exposed to carbon cost due to EU Emission Trading System and this scheme affects the dynamics of cement industries.

In order to evaluate this effect, Spanish cement industry can be given as an example with its high level of output. In Spain, cement industry planned to decrease energy consumption in cement production by using “Best Available Techniques”. However, it faces with a limitation in terms of energy efficiency of current condition. Spanish cement sector has already produced cement products much more efficiently than other countries. Similarly Italian cement industry also has already reached high level of energy efficiency. Those two countries have low level of process emissions. They have also supported the production of blended cement. In this scope, Table 4 presents a comparison of clinker ratio in cement production for selected countries. It is observed that Spanish and Italian cement industries have low value of clinker content per unit of product.

Table 4: Clinker to cement ratio in leading cement producer countries

Country	**Italy**	**Spain**	**France**	**Germany**	**United States**	**United Kingdom**
Clinker to cement ratio	77	79	82	83	89	90

From the values of blended cement in Table 4, it can be stated that for those countries, further mitigation in carbon dioxide emission is limited with this method. This makes cement industry more fragile towards carbon policies. In this point of view, studies on Spanish cement industry indicates that industry tends to shift its policies highly to trade under carbon price case. Especially coastal clinker production can fully be replaced with imported products in Spanish cement market (Linares and Santamaria, 2012).

Germany has settled a specific emission reduction target just for herself. Accordingly, Germany reduces its total emissions by 21 per cent compare with the base year (IEA, 2007). Such an ambitious target deeply affects emission and energy intensive industries of the country. In this respect, according to the association of German cement industry, Germany is one of the leading countries in Europe which has applied maximum emission reducing measures in the cement industry. Similarly, within the scope of the climate agreement, most industries voluntarily establish their own emission reduction targets. German cement industry also published its binding declaration. For the first commitment period cement industry states that their target is to reduce energy-related emissions by 28 per cent in comparison to 1990 level. Government also supports this target and it states that any additional regulations will not be implemented on carbon dioxide emission from cement industry.

4.4. Sectoral Statistics

All of the efforts that are mentioned above and also all contributions from other committing countries, lead to an emission reduction in the cement industry for the first commitment period of Kyoto Protocol. Figure 5 illustrates the trends in carbon dioxide emissions of cement industry. As it is observed, there is a decrease in cement emission for 2008 and 2009 in Annex B countries. Moreover, it is observed that total cement emission has increased while cement emissions of annex B countries are stable for the last two years.

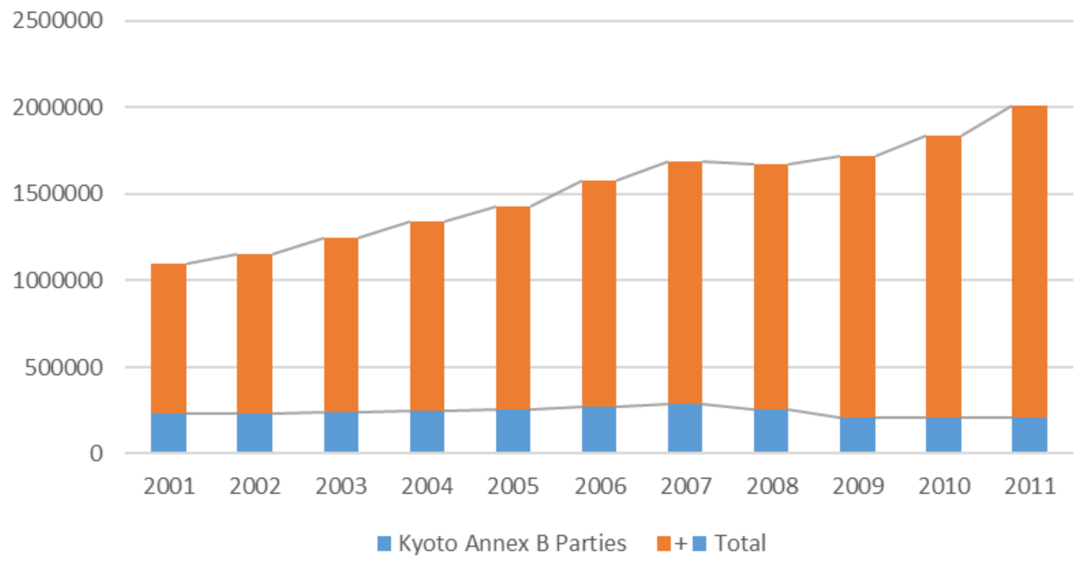

Figure 5: Carbon Dioxide Emissions of Cement Industry

Source: Author's calculations based on Carbon Dioxide Information Analysis Center (CDIAC) Data

With these trends, the above graph supports the definition of carbon leakage which is stated in the IPCC reports. In other words, there is a reduction in cement emissions of countries which have targets under the Kyoto Protocol while cement emissions of other countries are increasing within commitment period. This case is the direct indicator of the carbon leakage.

In addition to the carbon dioxide emission levels of the industry, examining the production level is a significant requirement in order to understand the sectoral trends. In fact, for one and a half decade, since 2001, the global cement production volume has more than doubled. In 2001 the global cement production was 1.7 Gt meanwhile in 2014 global cement production have reached to 4.3 Gt which means that production has risen by 53% since 2001. When the trend is analyzed, year-on-year average rate of growth of global cement production is 7%.

As in the GDP growth rates, the biggest share of this growth comes from emerging countries in which the level of production achieved a record level. According to the data provided by USGS Mineral Resources Program, top cement producers in accordance with their production levels are given in Table 5 for the year 2005 and year 2013 respectively.

Table 5: Ranking List of Top 10 Cement Producer (2005 and 2013)

Rank	2005 – Ranking	2013 – Ranking
1	China	China
2	India	India
3	United States	United States
4	Japan(1)	Iran
5	Iran	Turkey
6	South Korea	Brazil
7	Spain(1)	Russia(1)
8	Russia(1)	Viet Nam
9	Italy(1)	Japan(1)
10	Turkey	Saudi Arabia

(1) Involve in Annex B list of Kyoto Protocol

Source: Authors own presentation based on USGS Mineral Program Cement Reports for 2005 and 2013

It is obvious that the highest amount of production is provided by China in both rankings. China is the top country with 2.4 Gt of cements produced in 2013. For 2013 ranking list, India is at the second place with 300 Mt. At the third and fourth places, USA and Brazil come with 81 Mt and 72 Mt respectively. Turkey is at the fifth place with 71.2 Mt of cement production. When it is analyzed the trends of cement production among these countries, it is clear that Turkey shows the most progressive performance in terms of ranking. Besides, it is needed to be mentioned that Annex B countries except for Russian Federation, lose their places in the latter ranking. The interesting point herein is period between two rankings which includes the initial years of Kyoto Protocol and also first commitment period.

This attractive point leads study to examine the trend of cement production in countries that are involved in the list of Annex B of Kyoto Protocol. According to the figure, industries in those countries start to produce less cement products especially after 2007.

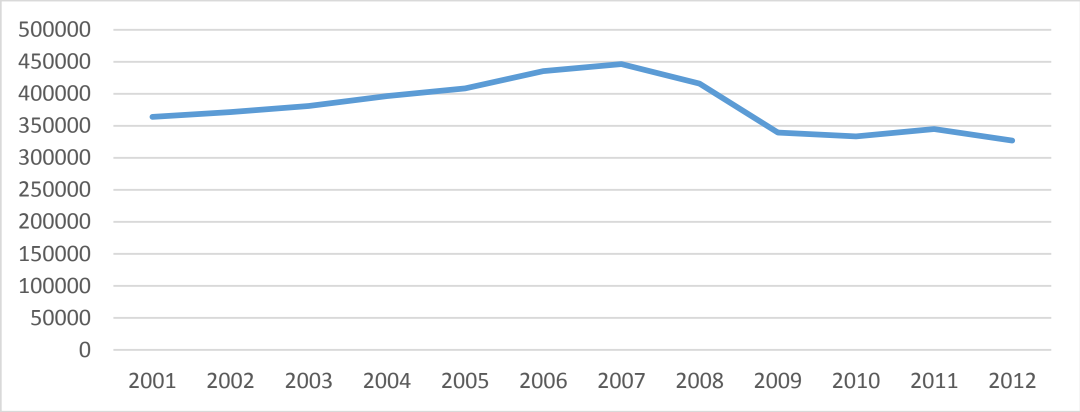

Figure 6: Cement Production (Mt) Trend of Annex B countries

Source: Author's own presentation based on CEMBUREAU Data, 2015

Trade dynamics in cement industry also plays a significant role in understanding the structure of cement industry. Cement plants are generally sized to satisfy the local demand. Due to this fact, it is possible to observe an incoherency between cement production and trade patterns. To be more specific, if a country's domestic cement demand has reached its saturation point, then the production capacity has to be allocated to export without a requirement for policy shift in short term. On the other hand, as it is mentioned examining the trade flows is one of the significant ways to evaluate carbon leakage effects. Within this approach, the trend of import flows of Annex B countries are given in Table 6.

Average rate of change per year is 6.7 per cent for the period 2002-2007. As values in the table demonstrate, it is seen that cement imports has experienced a large decline after 2008 and the import volume was decreased by 30 per cent in 2009 compared to the previous year. But however, it has reached and exceeded the average rate of change in the following years.

Table 6: Annual Rate of Change in Cement Import of Annex B Countries

Years	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Change in Cement Import (%)	4.0	5.7	10.8	4.0	7.1	8.8	-4.6	-32.2	-1.8	9.0	9. 2

Source: Author's own calculation based on UN Comtrade Data

From other point of view, Table 7 evaluates the condition of these countries import volume by taking Turkish exports into consideration. Table 7 presents the share of Turkish cement production in total cement import of Annex B countries. As it is observed that, within commitment years of the Protocol, Turkish exports account for more than 12 per cent of total imports for as annual average. Particularly in 2009, it has reached 20 per cent.

Table 7: Share of Turkish Cement in Total Cement Imports of Annex B Countries

Years	2004	2005	2006	2007	2008	2009	2010	2011	2012
Share of Turkish Cement Export (%)	14.54	12.77	6.06	6.85	13.35	20.09	13.22	12.12	12.44

Source: Author's own calculation based on UN Comtrade Data

It can be stated that Turkey is counted as a significant trading partner of these countries during the latest period. In global aspect, Turkey also takes place among top countries in terms of cement export levels, besides China, Thailand, Japan and Pakistan. It should be noted that for the years 2009, 2010 and 2011, Turkey was placed at the top of the list of cement exporters. On the other hand, the trend followed in exports was such that it fluctuated around 12 Mt but it reached its peak by 2010 by 17.8 Mt.

These sectoral statistics both on imports and exports indicate that there might be a carbon leakage case including Turkey. Nevertheless, to identify this risk explicitly export flows of Turkey needs to be analyzed in detail. Before doing this, it is important to give information about Turkish cement industry and its evolution. In this sense, next chapter presents a detailed overview of cement industry in Turkey.

CHAPTER 5

TURKISH CEMENT INDUSTRY

5.1. Historical Development

Turkish cement industry has followed new technological and productive developments since it was established and it has presented its products according to high level global standards. Within the industry, cement production has been mostly carried out by two different types of facilities: integrated and grinding. Currently, Turkey is maintaining cement manufacturing with 50 integrated and 19 grinding plants (TCMA, 2015). Integrated cement facilities include all stages of the production process and those stages require expensive technical equipment, therefore it is easily claimed that Turkish cement industry has a capital intensive structure. This settled and highly invested structure of the industry has been established step by step since the early period of 1900s.

In fact, first cement plant in Turkey was established in 1912 and it had a very low producing capacity. For many years domestic demand was not met with this limited production and mostly was supported with imported products. In 1953, ÇISAN (Turkish acronym for Turkish Cement Industry Co.) was established to gather these cement producers under a single roof. By this way, state control over the industry was provided. Meanwhile, economic activities of Turkey have been increasing parallel with the population growth. Therefore, expansionary policies for the cement industry were started to be implemented out of necessity. Due to rapid economic growth and the process of urbanization that induce increase in the demand for cement, 17 new cement plants were established in the period 1960-80 (Taymaz and

Saygılı, 2001). However, this expansionary policy caused an excess amount of cement production in 1970s and as a consequence first in its history it was used for export. Through time, this progress brought an increase in the sectoral investments which improved the industry and again accelerated its production.

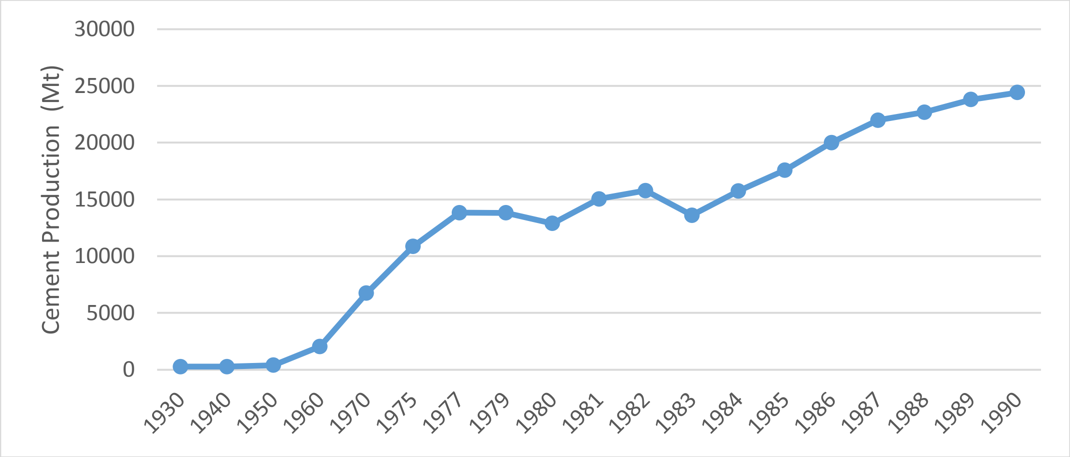

Figure 7: Cement Production for the Period 1920-1990

Source: Author's own presentation based on TCMA Data

Nevertheless, as it is also shown in Figure 7, in late 1970s, industry had a stagnation period. The reason behind this circumstance was the rise in interest rate due to monetary and fiscal policies which makes a loss of attraction to invest in real estate. This caused an excess supply of cement in the market and as a result of this, government encouraged firms to export for destocking. However, after 1984 with the foundation of Mass Housing and Investment Administration, growth of residential construction had gained acceleration and boosted the industry again. At the same year, government abandoned the obligatory policy on monopolist structure of export. This had also speeded up the volume of trade in following years.

Furthermore in 1980s, with the influence of new liberal economic policies, Turkey changed its development strategy. In other words, another remarkable change in the industry had been experienced due to liberalization. In this period, share of the public in the economy was tried to be minimized and competitive market was strengthened by privatization. Due to the effect of privatization, the increase in the private cement production recorded 97% increase with 64% increase in mixed and only 10% increase in public production from 1983 to 1990 (Cakmak and Zaim, 1992). These changes lasted approximately twenty years and by 1998 cement industry completed its privatization period. In 1998, industry had 53 active private cement facilities and produced 37 Mt of cement for that year.

However, breaking point occurred in cement production in 1999 which was the year of tremendously destructive earthquake in Turkish history. In addition to the negative impact of the earthquake, Turkey faced with economic crisis in 2001 and level of cement production declined to 29 Mt/year.

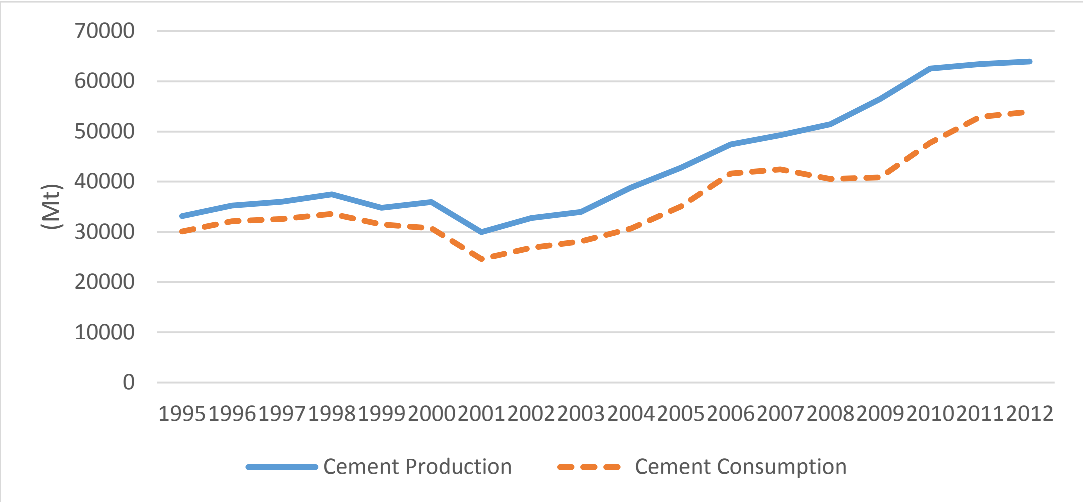

Figure 8: Cement Production and Consumption for 1995-2012

Source: Author’s own presentation based on TCMA Data

From Figure 8 it is observed that, after 2001 cement industry has recovered itself in the following years and reported a high performance with 7.8% average annual growth rate. Thus production capacity grew 2 times in size and achieved a capacity level of 110 Mt/year by 2012.

5.2. Export of Cement

Taking all of these developments into consideration, in terms of the cement exports, it is observed that Turkey has shown a great performance since it had reached a higher capacity in cement production. Particularly after 1980s Turkish cement industry had started to search for foreign markets to compensate the low level of cement consumption. In this respect, access to major and adjacent markets offers a potential advantage for the Turkish cement export.

Domestic market with dull demand led the industry to export particularly between 1995-1997 periods. Moreover, in 2001 domestic market had solidly tightened due to economic crisis and thus cement industry performed around 8 Mt of export. After 2001, cement industry has continued to expand its export volume. Between 2001 and 2012, share of exports in total cement production performed within the 15%-30% boundaries which indicates that trade has a large effect on the progress of the cement industry. Specifically 2008-2012 periods initiated a phase of growth in cement exports. Table 8 emphasizes that in 2009, exported cement had a value of 1199 million US dollars which corresponded to 20.5 Mt of cement and accounted for about one-third of total production.

Table 8: Share of Cement Exports in Total Export of Turkey
(Export values are presented in Million US Dollars)

Years	2008	2009	2010	2011	2012
Total Export	132002	102138	113979	134915	152536
Export of Cement Products	1132	1199	1131	911	797
Share of Cement Exports (%)	0.8581	1.1745	0.9924	0.6757	0.5231

Source: Author’s own calculation based on UN Comtrade Database

From these results, it is also observed that cement export volume plays a significant role in the economy of Turkey. Table 8 clearly indicates that when it is compared with export value of all commodities, export value of cement products has a notable part in trade. In 2008 share of cement export value reached 1% of total export value.

Moreover, Table 9 obviously indicates that, for 2009 amount of Turkish cement exports were recorded as 17,6 Mt, which is a remarkably high figure when it is compared with global cement exports and it corresponds to 11,62% of total global amount.

Table 9: Share of Turkish Cement Exports in Global Cement Exports (Export values are presented in Mton)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Global Cement Export	138.4	150	174.4	189.6	184.3	171.7	151.7	174.1	150.1	140.1
Turkish Cement Export	10.4	10.6	10.5	7.1	8.1	12.5	17.6	17.8	13.5	12.5
Share of Turkish Cement Export (%)	7.51	7.11	6.02	3.79	4.44	7.30	11.6	10.2	8.98	8.92

Source: Author’s own calculation based on UN Comtrade Database

It can be stated that in cement export volume, it has been observed a fast progress according to these indicators. This progress led Turkey to become one of the largest cement exporters in the world. As it is stated in the previous chapter global rankings states that Turkey has taken the first place in worldwide cement exports for 2007-2011 period.

5.3. Specific Features of the Turkish Cement Industry

There are apparent reasons behind these improvements and achievements in the cement industry. To begin with, it should be considered that in recent years Turkey has given a high importance to policies which support renewal of the urban areas. This promotes an increase in the public investments on construction. Therefore construction sector, has presented growth due to the increasing rate of new urbanization projects and also increasing housing demand. According to this fact, cement industry improved itself parallel to the construction sector. As a result, Turkey reached a high level capacity of production which can meet any extra and urgent need.

Another reason of the growth in the sector is the closeness of the raw material reserves which has a high quality. The primary raw material for cement clinker manufacture is limestone and Turkey has a great advantage because of having suitable cement grade limestone reserves. Moreover, cement plants should be located nearest to the main raw material reserves to sustain their production efficiently. With this point of view, Turkey has a chance to locate cement plants close to raw material reserves which presents a great opportunity to the industry.

Last but not least, the significant reason behind the considerably large amount of export is geopolitical features and geographical position of Turkey. First of all, industry has a strategic advantage due to its closeness to the main markets which are primarily European, Asian and African regions. Furthermore, since it has long coastlines, Turkey can decrease the cost of transportation substantially because sectoral reports indicate that transportation of cement is much more efficient when it is transferred by shipping. In fact, land transportation is not preferred; experts clearly state that cement could not be carried economically beyond 300 km with using road transportation. As a consequence, Turkey has already been aware of this advantage and adopted sea freight for transportation. In 2012, around 80 per cent of exported cement was hauled by shipping and the rest of it, was performed with trading partners which share a common border with Turkey such as Iraq, Syria, Georgia and Bulgaria (TCMA, 2015)

All these points that are mentioned above have played an important role and have had an observable effect on the development of Turkish Cement Industry. Turkey has a sufficient technical capacity and it is very close to the almost every country which implies emission limitation policies. For that reason, cement exports should be analyzed from the Turkish side to observe the effect of implemented emission reduction policies of the outside countries. Therefore following chapters will present the methodology of the thesis and provide the econometric analysis of the Turkish cement export which is subjected to the climate change issue.

CHAPTER 6

ESTIMATION OF THE GRAVITY MODEL

6.1. Literature Review on Gravity Model

This section reviews early versions of the gravity model approach and its evolution into a major econometric tool that is frequently used in the explanation of the international trade concept. The basis of the gravity model is similar to Newton's law of gravity. Newton states that force between two particles depends proportionally on their masses and inversely proportional to the distance between them. Similarly, basic gravity equation investigates the trade potential between two countries by considering the economic sizes of countries and the distance between them.

The fundamental issues of the gravity model approach have relied on Tinbergen's work in 1962. It was the first study which applies a gravity equation in order to analyze international trade flows. In the model established by Tinbergen, it was claimed that countries which are located close to each other have more trade flows with each other than the faraway countries.

Tinbergen's model is given as follows:

$$X_{ij} = A\,\frac{Y_i^{\alpha} Y_j^{\beta}}{D_{ij}^{\gamma}}$$

In this equation, Tinbergen used the variables in logarithm. Thus, the model cites the elasticity of the trade flow. While Y_i is used for GDP of exporting country, Y_j is for GDP of importing country and D_{ij} is for distance between exporting and importing countries. The superscripts α, β and γ respectively stand for elasticity of GDP of the exporting country, elasticity of GDP of the importing country and the elasticity of the distance. The established model implies that the direction of causality for trade runs from income and distance.

As a result of Tinbergen's study, it is stated that bilateral trade flows are positively related with economic sizes of any trading countries and negatively related with the distance between them. It should be also mentioned that economic size of a country is often measured by its GDP, GNP or income per capita and it is seen as an important indicator of demand dynamics for both export and import markets at which trading takes place.

On the other hand, the "distance" between trading partners is generally measured by the distance between capital cities or geographical distance among them. The distance component of the model has a very crucial role because it is a proxy for transportation or transaction costs (Head and Mayer, 2013) and this role is also mentioned by Tinbergen as "The factor of distance may also stand for an index of information about export markets" (Tinbergen, 1962).

However, Tinbergen's model consists of some defects particularly due to the standard assumption of Heckscher Ohlin model which states that the relative prices of goods are equalized through trade. Also they were constructed under the assumption of perfect competition. Anderson (1979) was the first researcher who tried to fix these assumptions which were proven to be faulty a few years later from Tinbergen's study. Indeed, by his approach Anderson became the first who built the argument on a theoretical rationale in order to explain bilateral trade flows by using gravity model. He integrated prices with the equation regarding product differentiations among countries. It is also claimed that there are homothetic preferences. In his study, he discussed the demand component in a more detailed way, and he proved the existence of income variable in the gravity model based studies. He indicated that the products are discriminated by origin country, and this differentiated production path affects consumers' choices. Consequently, for this reason, Anderson argued that volumes of both imports and exports are higher in larger countries than the smaller ones. Furthermore, he also provided a solid background for gravity model by taking all other possible trade flows into consideration while establishing the model.

The approaches developed by Anderson influenced Bergstrand (1985) who evaluated the gravity methodology in a more supply side approach in order to improve explanatory power of the gravity equation. These developments leaded him to include prices via GDP deflator variable in the gravity methodology. In addition, he also thought that the differentiation in products and their prices are influenced by their place of origin.

By relying on the differentiated products assumption of Anderson, another important theoretical contribution was made by Helpman and Krugman in 1985 and the contributions to this study came from Bergstrand in 1989 with the integration of monopolistic competition model used in new trade theory literature, into the gravity model theory. The backgrounds of previous theories are based on comparative advantages, differentiation in production technology and factor endowments. Nevertheless, according to this new approach, place of origin based on product differentiation assumption has started to be evaluated by using micro economic dynamics and this product differentiation is based on producing-firm characteristic. Moreover, it is assumed that there is increasing returns to scale in economy. This methodology has been used in order to define intra-industry trade flows within a specific industry branch for a specific good or service. In these studies, trade flows between trading partners are explained not only by distance but also by price levels and exchange rate level.

Other study influenced by Anderson has come from Deardorff. In 1998, Deardorff expressed his disagreement with previous studies. He built his theory mainly on homothetic preferences of Anderson and put the Heckscher-Ohlin approach into the core of his work. In his work, it is assumed that there are differences in factor endowment, markets are perfectly competitive and products are homogenous. Additionally, he assumed that there is no trade barrier or no transportation cost and due to these assumptions consumers are indifferent between places where the products are sold and bought. The most significant point of Deardorff's theorem is that, it does not include a distance variable since there is not any transportation cost. Moreover, if the factor price equalization process does not realize as a result of non-existence of trade barriers, each trading partner will start to gain expertise in goods or services which they have cost advantage relative to other trading countries.

The development in the gravity modelling had continued with Eaton and Kortum (2002). Their study used the basis of Deardorff but changed the assumptions. In this work, it is assumed that there is constant returns to scale and homothetic preferences, besides the acknowledgement of differentiation in product technology between countries. The prominent aspect of the study is about the interpretation of gravity model by stating that geographic distance between exporter country and importing country is deflated by price level to trade weighted average of all other trading partners.

Derivation of specification and determination of variables that are used in the model are the main concerns of the recent studies. In this respect, a considerable contribution is provided by Anderson and Van Wincoop (2003). They claim that having trade cost under control is required for specification of gravity model. Results of their study present the importance of multilateral resistance terms (MRT) in examination of bilateral trade. It is stated that there are several ways to observe these MRTs. Most preferable way is using proxy variables in the estimations. In general, trade costs are established as follows;

$$TC_{ij} = d_{ij}.\exp(\delta_1 border + \delta_2 lang + \delta_3 col + \delta_4 ccol + \delta_5 landlock + \delta_6 RTA)$$

where dij is the distance between partners i and j and others are dummy variables for common border, language, colony, common colonizer, landlockness and regional trade agreements.

Taking all of these studies into consideration, the theoretical and rational essentials of gravity modelling in international trade literature have been established and these studies have led to further developments which still continue in a more complex and comprehensive way. With this scope, several empirical studies which are related with this thesis, are reviewed and presented in next section.

6.2. Similar Studies of Gravity Model

Empirical studies support that gravity model is one of the most powerful and robust tool to explain trade relations (Leamer and Levinsohn, 1995). Commonly used variables have a high level of explanatory capability and the data for these variables can be reached and compiled easily. As a consequence, gravity model is used in enormous variety of researches and studies and thus there is considerable number of versions for gravity equation. Majority versions focus on total trade volume of countries. However, there are also lots of studies which deal with sector specific gravity models.

To illustrate this, the study about iron and steel industry of Vietnam can be given as an example. Impact of free trade agreements on iron and steel trade is investigated by gravity model by Thu and Hien (2014). It covers top trading partners for twelve years period. Authors prefer to include commonly used variables in their model such as common border, landlocked and also trade agreement dummies. Another sector specific study is done by Chan and Au (2007). Gravity model is again conducted to analyze the determinants of export of textile products Results of the study which is established for export of China provide that income, exchange rate, trade agreement and population variables are significant in explaining the relation while the distance variable is not.

In the literature, there are also some gravity model studies which point to specific problems and conditions such as environmental issues. One of them presents an analysis for export volume of China in the presence of environmental regulation in ASEAN countries (Wu, 2013). Study introduces the environmental effect in the model by using two proxy variables: energy consumption and carbon dioxide emissions. The author expects that these variables measure the level of environmental regulation in the partner country. Results indicate that pollution haven hypothesis can be confirmed for this case. There are many other studies that employ gravity model in environmental research.

Carbon leakage concept is also chosen as a main objective in the scope of some gravity model studies. In addition to the basic variables, commitment to Kyoto Protocol and carbon content of trade flows are considered to evaluate carbon leakage in the trade relations (Aichele and Felbermayr, 2015). Results conclude that protocol increases imports from non-committed countries which means leakage takes place for specific sectors. Moreover, the empirical study by Folfas et al. (2012) examines the carbon leakage risk on export specifically for cement and steel industries. Specific dummies and emission related variables are included in the gravity model. Results indicate that trade is increased in countries which have higher carbon dioxide emission levels than others.

6.3. Data

The empirical analysis includes all trading partners of Turkey for the period of 2001-2012. Within this aspect, study covers 118 countries[5] and bilateral export values of cement products for those countries are taken from United Nations Commodity Trade Statistics Database (UN Comtrade). However, these nominal values are divided by Consumer Price Index (CPI) to derive the real trade values. CPI values in U.S. dollars of 2005 are obtained from World Development Indicators (WDI) Database provided by World Bank. Economic sizes are included in the

[5] See Table A.1 in Appendix A for country list

model by using Gross Domestic Products (GDP) of each country which is also provided by WDI. Similarly, GDP's are also used in the model are in constant U.S. dollars.

Data for distance variable is taken from Centre d'Etudes Prospectives et d'Informations Internationales" (CEPII). Database of CEPII includes distances between capital to capital for each pair of countries and also other data on bilateral trade variables. Other variables which are used commonly as additional variables in gravity estimation are also taken from this database. In general these variables are colonial relationship, information on common borders, common languages and condition of landlockedness of each country. However, not all of these variables are appropriate for this study. Since only Turkish export flow is investigated in this study colonial background and common language are not considered as appropriate variables. For example, common language variable stands for direct communication between the countries which have the same official language. Nevertheless, Turkish is not used as an official language with the majority of its trading partners. Thus, using this variable in the model is not reasonable. But sharing a common border with trading partners and landlockedness information is very important for the model and the importance of these variables is explained in model estimation section.

The data on carbon dioxide emissions of cement production for each country is taken from the comprehensive database of The Carbon Dioxide Information Analysis Center (CDIAC). This center has served to U.S. Department of Energy in order to produce climate change data and analysis since 1982. Emission values are given as thousand metric tons of carbon. Therefore in order to convert the numbers to units of carbon dioxide emissions, they are simply multiplied by 3.667.

In addition to these, sector specific variables are also considered in the model. These variables are taken from World Statistical Review which is prepared by European Cement Association (CEMBUREAU, 2015). This data set covers the period of 2001-2012 and it provides information on cement production and cement consumption on a worldwide basis.

6.4. Model

Regarding the theoretical background and results of the empirical studies, basic gravity model for the thesis is established as shown below:

$$lnX_{tri} = \beta_0 + \beta_1 ln\left(GDP_{i,t} + GDP_{tr,t}\right) + \beta_2 lnDist_{tri,t} + u_{tri,t}$$

where;

$X_{tri} = Total\ export\ of\ cement\ products\ to\ country\ i\ in\ millions\ of\ US\ dollars$

$GDP_{i,t} = Gross\ Domestic\ Products\ of\ country\ i\ in\ millions\ of\ US\ dollars$

$GDP_{tr,t} = Gross\ Domestic\ Products\ of\ Turkey\ in\ millions\ of\ US\ dollars$

$Dist_{tri,t} = Distance\ between\ Turkey\ and\ country\ i\ in\ kilometers$

$u_{tri} = Disturbance\ term$

In the model, tr, i and t represent Turkey, trading partner of Turkey and time, respectively. Export volume of cement products between country i and Turkey is considered as a dependent variable. For explanatory variables; incomes of the country i and Turkey and distance between them are included. For the basic gravity model these variables are necessary to observe the bilateral trade flow. From previous studies, β1 and β2 are expected as positive and negative, respectively.

Table 10: Descriptions of Additional Variables

Abbreviations of Additional Variables	Descriptions
Dborder	Dummy variable for Common Border
Dlandlocked	Dummy variable for Landlockedness of country i
$\mathbf{Cement\_Cons_{tr(i)}}$	Cement Consumption of Turkey or country i
$\mathbf{Cement\_Prod_{tr(i)}}$	Cement Production of Turkey or country i
Dcarbonleakage	Dummy variable for Carbon Leakage[1]

1. See "Impact of Carbon Leakage" section for details.

According to the theoretical studies, variables of common border and landlockedness should be used in the estimation in order to include multilateral resistance terms in the model. Also variables related to the cement industry are introduced to the model to observe the sectoral supply and demand effects.

6.4.1. Univariate Characteristic of Data

In the first step, univariate characteristic of the data needs to be examined. In this context, panel unit root test is conducted to detect potential cointegration case between possible variables. Basically this test checks the stationarity condition of variables. It is significant to conduct unit root test because if variables are non-stationary traditional estimation methods cannot be used. In this respect, there are several panel unit root tests. Among these tests, Levin-Lin-Chu (LLC) and Fisher type panel unit root tests are conducted to investigate the existence of the unit root.
Difference between these two tests is that while Fisher test examine individual unit root, LLC test searches for common unit root in the series. The null hypotheses of both tests are given below;

(LLC Test) Ho: Panels contain unit roots
(Fisher-Type Tests) Ho: All panels contain unit roots

In this respect, results of these test are given in Table B.1 of Appendix B. Results provide that null hypothesis is rejected for all variables at least in one test which means variables are stationary. In other words, study does not require any cointegration test and it can perform common estimation methods.

6.4.2. Estimation

There are several ways to gather data sets for the econometric studies. In the literature, gravity model estimation is generally established with panel data which is a combination of time series and cross section data sets. Panel data can detect significant impacts of explanatory variables which cannot be observed within the model of cross section and time series. Besides, when model is estimated with panel data, degree of freedom increases. This provides a reduction in collinearity among explanatory variables (Baltagi, 1995). Because of these reasons, it is clearly stated that using panel data for econometric estimation improves the quality of model (Gujarati, 2003).

In this respect, analysis of panel data can be conducted with three different methods: pooled OLS model, fixed effect model and random effect model (Gujarati, 2003). This section presents those models and selection of the most appropriate one among them.

6.4.2.1. Pooled OLS Estimation and Extension of the Model

Estimation method of pooled model is very similar with basic OLS estimation. This estimation assumes common intercept for all cross sectional units. However main concern of this thesis is Turkish cement exports. For this reason, it is important to consider other specific variables in the model. Literature of gravity model also includes extensive research about including multilateral resistance variables in the gravity model (Anderson and Van Wincoop, 2003). Following these studies, basic gravity equation is extended. These additional variables present an opportunity to adapt gravity model into the specific case of bilateral trade.

6.4.2.2 Multicollineraity

For strong econometric results, diagnostic test results should be investigated for the above models. First, it should be examined for the possible existence of multicollinearity. This problem occurs when two or more explanatory variables in the model are correlated and this causes misleading regression results. An easy way to detect multicollinearity is checking the correlation between all pairs of variables.

In the table provided below, results of variance inflation factor (VIFs) values which enquire about this relationship between pairs are given. As a result of the conducted test, VIF values of most of the variables do not exceed the benchmark value which is ten that is the sign of multicollinearity (Neter et al., 1985). However, some of variables exceed the threshold level and it indicates that they cannot be included together in the same regression.

Table 2: Variance Inflation Factor Values

Variable	VIF	1/VIF
ln(GDP_tot)	1.98	0.504077
ln(Dist)	1.28	0.782652
ln(Cement_Cons$_{tr}$)	29.82	0.033537
ln(Cement_Cons$_{i)}$	9.74	0.102645
ln(Cement_Prod$_{tr}$)	29.79	0.033568
ln(Cement_Prod$_{i}$)	9.43	0.106037
Dborder	1.23	0.815428
Dlandlocked	1.10	0.907881
Mean VIF	10.54	

In general aspect, it is observed that multicollinearity is likely to be existed among variables of consumption and production of cement. Therefore, these variables are not considered together in this study. Additionally, the correlation matrix which is given in the Appendix B, highlights that income variable has a high correlation with cement consumption and production variables of partner countries. This correlation also leads to eliminate these variables to prevent any misleading estimation result.

6.4.2.3. Heteroscedasticity and Autocorrelation

In order to test whether regression leads to a heteroscedasticity problem, White test and Modified Wald test are applied. In this respect, it is tested whether the variances are constant. Analysis of variances indicates that models suffer from lack of homoscedasticity. Furthermore, to prevent biased standard errors and less efficient results, serial correlation in error term is also analyzed. For this purpose, Wooldridge test for autocorrelation is conducted where null hypothesis claims no first order autocorrelation. It is observed that the test rejects the null hypothesis and concludes that data have serial correlation problem. Both test results are provided in Table B.3 of Appendix B. In this respect, to overcome heteroscedasticity and autocorrelation problems, cluster-robust standard errors are preferred for estimations.

Furthermore, large panel data set with long time series may suffer from cross sectional dependence (Baltagi, 2008). Therefore, this case is not a significant problem in panel which has a short period of time. Still, cross-sectional dependence test is employed to test whether the residuals are correlated across entities. Test results which is given in Appendix B, do not reject the null hypothesis which means residuals are not correlated.

Regarding diagnostic test results, estimation results of basic gravity model is revised. By taking correlation between possible explanatory variables into consideration, baseline model of the study is established with cluster robust standard errors. These corrected and revised model results are given in Table 12. Moreover even thought, test claims that there is not cross sectional dependence, each model is also estimated with Driscoll-Kraay standard errors. These results which are stated in Table B.5 of Appendix B, gives standard errors which are robust to heteroscedasticity, autocorrelation and cross-sectional dependence.

6.4.3. Model Estimation with Fixed Effect

Despite the fact that Pooled OLS method is used in the estimations, in the literature recent studies are concerned about this estimation method which ignores the individual dimensions of panel data. Many researchers agrees that this estimation method may result in inefficient and biased estimators. In order to fix this biasness problem, studies in the literature suggest to apply fixed effect (FE) estimation that presents a specific result for each country. As a result it can provide an opportunity to include individual effects in the estimation. Also some studies[6] argue that using fixed effect is necessary to include multilateral price terms in the model estimation. Moreover, endogeneity concern due to omitted variables can be handled by employing fixed effect approach (Baier and Bergstrand, 2004).

In this estimation method, intercept of the model can vary for each country. However slope coefficients is still constant for all cross sections. This approach presents individual characteristics of each entity. According to the theoretical studies, fixed effect model specification is shown in the equation;

$$lnX_{ij,t} = \alpha_0 + \alpha_{ij} + \beta X_{ijt} + \varepsilon_{ijt}$$

where α_{ij} is the intercept term that indicates country specific impacts. In fact, this intercept term contains the impact of omitted variables which do not change over time. This means that fixed effect estimation method cannot present the effects of time invariant variables. For this reason, estimation method omitted all of the time invariant variables in its results. In this respect, Table 12 presents OLS and FE estimation results.

6 Baier and Bergstrand &(2004), Eaton and Kortum (2002) and Rose and van Wincoop (2001) applied fixed effect for MRTs

Table 12: Estimation Results of OLS and FE Model

Variables	Model 1	Model 2	Model 3	Model 4
GDP_tot_i	0.870***	0.697***	3.110***	7.028***
	(4.36)	(3.36)	(3.73)	(3.75)
$Dist_{tri}$	-0.379**	-0.067	- (1)	- (1)
	(-2.28)	(-0.37)		
Dborder	-	2.461***	-	- (1)
		(5.47)		
Dlandlock	-	-2.296***	-	- (1)
		(-7.48)		
$Cement\_Cons_{tr}$	-	3.098	-	-2.536**
		(0.62)		(-2.17)
Constant	-12.817**	-13.69**	-76.962***	-157.143***
	(-1.94)	(-2.05)	(-3.38)	(-3.99)
R^2	0.024	0.121	0.6874	0.6895
Number of Obs.	842	842	842	842
F test	-	-	13.94	13.47

* p<.1; ** p<.05; *** p<.01

(1) Variables are omitted due to the fixed effect estimation

(2) The dependent variable is the bilateral cement exports of Turkey to country i

(3) t values are provided in brackets

(4) All variables are used in natural logarithm except dummy variables

(5) Model 1: Pooled OLS Results of Basic Gravity Model
Model 2: Pooled OLS Results of Baseline Model
Model 3: Results of Basic Gravity Model with Country Fixed Effect
Model 4: Results of Baseline Model with Country Fixed Effect

In this respect, some researchers claim that country specific dummies are not appropriate, because of elimination of significant variables (Wei and Frankel, 1977). Their main concern is that effects of these variables are disregarded in the analysis. However, these statements do not have any econometric basis. On the contrary, these variables are easily estimated by two step regression (Zarzoso and Lehmann, 2003). In this regression, dependent variable is individual effect and explanatory variables are time invariant variables such as distance dummy, common border dummy etc. For this study an additional regression is established as shown in the equation below:

$$\alpha_{tri} = \alpha_1 + \alpha_2 lnDist_{tri} + \alpha_3 D\_Border_{tri} + \alpha_4 D\_Landlocked_{tri} + e_{tri}$$

where α_{tri} is individual effect, $\alpha 2$,$\alpha 3$ and $\alpha 4$ are coefficients. In this scope, Table B.4 in the Appendix B indicates the result of cross section regression of individual effects for Model 3 and 4.

Estimation results given in Table 12 also present F test result at the bottom. This F test is conducted to test the null hypothesis which states all dummy parameters are zero. It is an econometric way to test whether pooled OLS or fixed effect is a better estimation method. This test results reject the null hypothesis which means fixed effect models are much more preferable than pooled OLS models. Therefore, this study focuses on the fixed effect model results.

According to the regression which is estimated with fixed effects, income variable is statistically significant and it has a positive effect on Turkish cement trade. However, distance variable which is included as a proxy for transportation costs, cannot be provided with significant result. This means distance is not a sufficient variable to explain trade relation for Turkish cement exports. The reason behind this may be explained by the specific transportation requirements of the cement industry. As it is mentioned in Chapter 5, Turkish cement industry prefers sea transportation for exporting cement products. This sectoral detail indicates that distance is not an appropriate indicator for transportation cost. Because, land transportation is costly and difficult to the landlocked countries, even they are close to Turkey. For this reason, it is observed that while distance variable is insignificant, landlockedness dummy has a strong and negative impact on Turkey's cement export. This variable captures the effect of sectoral transportation detail. Moreover, common border variable seems to be important factor in trade relation. It has also a positive effect on cement export as expected. Besides, an additional variable is included in the basic model to improve the explanatory power of the regression. Domestic cement consumption variable which is included is statistically significant and it has an expected negative sign. One may conclude that if domestic consumption of cement increases, cement export decreases consequently.

6.4.4. Hausman Specification Test

There is also another model which is also preferred to examine the individual effects. In this model estimation, variation across countries is assumed to be random and uncorrelated with the predictor. Because of that, it is called the random effect model (RE). There is an econometric test which aims to check whether the FE model is more preferable than the RE model. It is called the Hausman specification test and it practically checks the correlation between variables and error terms. If the null hypothesis of the Hausman tests is rejected, fixed effect estimation will be consistent for the model.

According to the result of the test that is conducted for this study, null hypothesis is rejected. This means estimators of fixed effect model are more efficient. Details of the test results are also given in the Table B.3, Appendix B. As a consequence, Hausman test results leads study to use fixed effect model rather than random effect model.

In addition to these econometric results, in the literature it is stated that if observations of the model are not a random sample from a total dataset, fixed effects model is appropriate for the estimation (Dougherty, 2011). This study covers all trading partners and all export flows from Turkey to those partners for the related period. Therefore, the study concentrates on the consistent model that is using fixed effect estimation.

6.4.5. Two-way fixed effect

In this respect, studies bring different approaches to the fixed effect model estimation. Including set of dummies for individual (country) effect and also for time (year) effect in the estimation is proposed by Matyas (1997). Baltagi, Egger, and Pfaffermayr (2003) also state that estimations should include both fixed country-pair and fixed time effects. Studies find that estimation with time effects ensure unbiased coefficients for bilateral trade costs. (Eaton & Kortum (2002), Anderson & van Wincoop (2003), Bergstrand, Egger, & Larch (2008) Such dummies for time effect have become a requirement due to the fact that each country has different multilateral price term that varies over time. Moreover it is suggested that including dummies for country-pair effect handle the problem of unobserved heterogeneity in country pairs (Cheng and Wall, 2005)

In fact, this approach has formed a framework for estimating gravity model with panel data. Bergstrand, Egger, and Larch propose that individual effect models explain the variation in the data on bilateral trade around 60-80%. It is stated that those models include only cost variables of trade (distance, common border, common language etc.). On the other hand, applying time effects in addition to the individual effects increases the explanation ratio of variation to the 95-98% (Baltagi, Egger & Pfaffermayr, 2003). In the light of these statements, time specific dummies are also included in addition to country specific dummies.

6.4.6. Impact of Carbon Leakage

Several econometrical studies are examined to decide on the specific variable that will observe the carbon leakage effect in the model. Within this scope, Table 13 gives brief information about some of the variables used in the literature. Those variables are used in previous studies to find out the impact of climate change policies on trade volume.

Including prices of emission allowances and carbon tax values in the estimation is a good proxy to observe the implementation effect. However these methods are not applicable in all countries. Since the thesis covers Turkey's all trading partners, it is not possible to include these types of variables in the model.

Table 13: Variables That Are Used For Investigating Carbon Leakage

Variable	Description	Source
Price_CO_2	The average price of emissions allowances in the EU Emission Trading System.	O.Sartor,2012 ;Branger,2014
Difference_CO_2	Difference between CO_2 values of country i and country j	P.Folfas,2012
Tax_CO_2	Implicit carbon tax belongs to available countries	R.Aichel,2013
Dummy_KyotoProtocol	Dummy variable that takes value 1 if country has a binding emission cap and t ≥ year of Kyoto Protocol ratification and 0 otherwise.	R.Aichel,2011
Dummy_Leakage	Dummy variable that takes value 1 if the emission in country i is higher than in country j and 0 otherwise.	P.Folfas,2012

Other three variables are considered in the study but the results do not sound to be satisfactory because of several reasons. Difference between emission values of Turkey and other countries are not consistent because trade relation is just one-sided. Econometric results also indicate that this variable is insignificant in the model. Since all values for differences are used in absolute value, this variable cannot capture the actual effect in country specific studies.

Moreover, dummy variable for Kyoto Protocol does not have significant result in the estimation. However, dummy variable which is called Dummy_Leakage, suggests that it has a significant and positive effect on cement export. This case supports the idea of carbon leakage. Nevertheless, dummy variable has a limited structure in terms of coverage. Since Turkey is one of the leading countries in the cement production, there are very few countries that have higher emissions than Turkey. Therefore, the result is not sufficient to observe the actual impact. Results of these estimations

Instead of these variables, a sector specific dummy variable is established for the study. To achieve this aim, in the first step cement emission values are gathered for each country. Then, regarding the definition of carbon leakage, the steps below are followed. First, the dummy variable is established by considering the case of increasing cement emission of Turkey while decreasing cement emission of country i compared to previous year. In addition to this, to ensure the condition of emission reduction policies of carbon leakage definition, Kyoto Protocol dummy for Annex B countries is considered. The dummy variable which is used in the model, is the combination of these two variables. As a result, carbon leakage dummy is prepared and details of the variable are given in Table 14.

Dummy variable that is formed by the author is included in the baseline model to observe the carbon leakage effect on cement exports. Model is estimated with OLS, one way fixed effect and two ways fixed effect methods. Thus, the results of the model are given in Table 15. Similarly, cross section regression results of individual effects are provided separately in the Table B.4, Appendix B.

Table 14: Explanation of Carbon Leakage Dummy

Variable	Description
Dummy for Kyoto Protocol	Dummy variable that takes value 1 for the years 2008-2012 if the country has a binding emission target for first commitment period under Kyoto Protocol.
Dummy for the change in cement emission	Dummy variable that takes value 1 if the cement emission of Turkey is increasing while cement emission of country i is decreasing at year t compared to year t-1.
Dummy for Carbon Leakage	Dummy variable that takes value 1 if cement emission of Turkey is increasing while cement emission of country I which has an emission target under Kyoto Protocol, is decreasing at the year t compared to year t-1.

According to the results, all baseline model variables have expected signs. Carbon leakage dummy is significantly takes part in the model and it has a positive effect on the dependent variable. In other words, it is concluded that condition of cement emission in Turkey is increasing while there is a decrease in cement emission in countries which have emission target, cause an increase in the export of cement in Turkey. This result contributes to the carbon leakage evidence due to the asymmetric climate change policies in the cement industry among countries.

Table 15: Estimation Results with Carbon Leakage Dummy

Variables	Pooled OLS Model	One Way Fixed Effect Model	Two Way Fixed Effect Model
GDP_tot_i	0.684***	7.355***	8.125***
	(3.25)	(3.92)	(3.74)
$Dist_{tri}$	-.0592	-(1)	-(1)
	(-0.33)		
Dborder	2.461***	-(1)	-(1)
	(5.47)		
Dlandlock	-2.300***	-(1)	-(1)
	(-7.47)		
$Cement\_Cons_{tr}$	0.289	-2.828**	-(1)
	(0.58)	(-2.41)	
Dcarbonleakage	0.240	0.782**	0.723*
	(0.45)	(1.99)	(1.82)
Constant	-13.180**	-163.038***	-212.840***
	(-1.95)	(-4.13)	(-3.62)
Number of Obs.	842	842	842
R-square	0.1215	0.6911	0.7028
F test		13.55	13.79

* p<.1; ** p<.05; *** p<.01

(1) Variables are omitted due to the fixed effect estimation

(2) The dependent variable is the bilateral cement exports of Turkey to country i

(3) t values are provided in brackets

(4) All variables are used in natural logarithm except dummy variables

CHAPTER VI

CONCLUSION

The main objective of this thesis is to evaluate the effect of climate change policies on the exports of the cement industry in Turkey. To achieve this aim, bilateral cement export flow between Turkey and 118 countries is examined for the years 2001-2012. For this purpose, the gravity model approach which is counted as one of the most prominent models in the trade literature is implemented in order to explain export flows. In the first step, a baseline gravity model for cement export of Turkey is established by using relevant variables. Then, the impact of climate change policies is added to the baseline model.

In this scope, primary contribution of this thesis is to provide a model which explains the export behavior of the Turkish cement industry. According to the gravity literature, income and geographical distance variables are considered in the baseline model. In order to capture the effect of domestic demand for cement products, cement consumption is also included as an explanatory variable. Moreover, dummy variables for sharing common border and landlockedness status are inserted to the model in order to include multilateral resistance terms. Additionally, the carbon leakage is tested with the help of the gravity model. One of the novelties of the study is the carbon leakage dummy constructed specifically for this purpose.

Diagnostic test results are considered to determine the variables and estimation method. In this framework, fixed effect regression is selected as the appropriate approach among several estimation methods. As it is expected, estimation results indicate that, overall economic size of Turkey and her trading partners has a positive effect on export performance. Additionally, domestic cement consumption has expected results and affects cement export in a negative manner. Besides, common border dummy reflects that neighbor countries of Turkey have a positive impact on cement export. Also, the dummy variable for landlocked countries has a negative relationship with exports. These two variables introduce the transportation cost of cement products into the model. Moreover, when results are analyzed, although the sign of distance variable is negative, it is not statistically significant. The reason behind this result may be related with landlocked countries. Although these countries are geographically close, because of their landlocked status, they have relatively low accessibility to trade facilities.

In addition to the baseline model, extended model is estimated by adding a new dummy variable. In this scope, the dummy variable is built in order to find carbon leakage effect. This carbon leakage dummy variable considers specific countries that have emission reduction targets within the framework of Kyoto Protocol. Thus the condition of asymmetric climate change policies is reflected into the variable. Besides, dummy variable is established based on the definition of carbon leakage. It considers the decreasing pattern of cement emissions in these countries while there is an increasing trend in cement emissions of Turkey. In this sense, carbon leakage dummy variable is statistically significant and has a positive effect on cement exports. This result provides evidence that cement production is shifted from the countries that have emission reduction targets to Turkey via trade flows.

The results of this thesis confirm the existence of carbon leakage and it provides the effects of leakage on the Turkish cement industry with quantitative analysis. From the global aspect, this result shows that the climate change policies applied by only few countries are not functioning well. The countries which are committed to reduce their emissions prefer to shift their emission intensive sectors like cement industry and this attitude affects the total emissions globally. The key point to solve this problem is to prevent asymmetric climate policies. These kinds of policies should be adapted by all emerging and even least-developed countries in the following term. By this way, the global emissions will be effectively reduced.

From the perspective of Turkey, although it seems that larger export volume has a significant support for economic growth in the short term, this claim will may not be valid in the long term. In other words, if new climate change regime is established and Turkey undertakes possible pledges, then carbon leakage concept will gain importance and Turkey will face with difficulty in emission reduction in the future. Taking all of these points into consideration, all industries which may be exposed to carbon leakage risk should be evaluated for Turkey for further studies. This assessment will be very beneficial to take necessary measures in terms of climate and economic perspectives.

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APPENDIX A

Table: A.1 List of Emission Targets under Kyoto Protocol

Countries	Kyoto CP1 Target (in %)	Change of GHG emissions in 2008-2012 compared to the base-year (in %)
Austria	-13	3,2
Belgium	-7,5	-13,9
Denmark	-21	-17,3
Finland	0	-5,5
France	0	-10,5
Germany	-21	-24,3
Greece	25	11,5
Ireland	13	5,1
Italy	-6,5	-7,1
Luxembourg	-28	-9,3
Netherlands	-6	-6,2
Portugal	27	3,5
UK	-12,5	-23,4
Spain	15	20
Sweden	4	-18,3
EU-15	-8,1	-13,2
Australia	8	3,2
Japan	-6	-2,5
New Zeland	0	-2,7
Iceland	10	10
Liechtenstein	-8	2,5
Monaco	-8	-12,5
Norway	1	8,2
Switzerland	-8	-4
Bulgaria	-8	-53,5
Croatia	-5	-10,9
Czech Republic	-8	-30,6
Estonia	-8	-54,2
Hungary	-6	-43,7
Lithuania	-8	-57,9
Latvia	-8	-61,2
Poland	-6	-29,5
Romania	-8	-57
Russia	0	-36,4
Slovakia	-8	-37,5
Slovenia	-8	-9,7
Ukraine	0	-57,2
United States	-7	9,5
Canada	-6	18,5

Table: A.2 List of Countries

Afghanistan
Albania
Algeria
Angola
Argentina
Australia
Austria
Azerbaijan
Bahamas
Bahrain
Bangladesh
Belarus
Belgium
Benin
Bosnia and Herzegovina
Brazil
Bulgaria
Burundi
Cabo Verde
Cameroon
Canada
Central African Republic
Chad
China
Colombia
Comoros
Croatia
Cyprus
Czech Republic
Côte d'Ivoire
Democratic Rep. of Congo
Denmark
Djibouti
Dominican Republic
Ecuador
Egypt
Equatorial Guinea
Estonia
Ethiopia
Finland
France
Gabon
Gambia
Georgia
Germany
Ghana
Greece
Guinea
Haiti
Hungary
India
Iraq
Ireland
Iran
Israel
Italy
Japan
Jordan
Kazakhstan
Kenya
Kuwait
Kyrgyz Republic
Latvia
Lebanon
Liberia
Libya
Lithuania
Macedonia
Madagascar
Malawi
Mali
Malta
Mauritania
Mauritius
Moldova
Morocco
Mozambique
Netherlands
New Zealand
Nigeria
Norway
Oman
Pakistan
Paraguay
Peru
Poland
Portugal
Qatar
Rep. of Congo
Romania
Russia
Saudi Arabia
Senegal
Serbia and Montenegro
Sierra Leone
Slovak Republic
Slovenia
South Africa
Spain
Sudan
Sweden
Switzerland
Syria
Tajikistan
Tanzania
Togo
Tunisia
Turkmenistan
Uganda
Ukraine
United Arab Emirates
United Kingdom
United States
Uruguay
Uzbekistan
Venezuela
Yemen

APPENDIX B

Table: B.1 Results of Unit Root Test

Variable	Levin, Lin & Chu t*	ADF - Fisher Chi-square	PP - Fisher Chi-square
Export	-	55.5044*** (0.0000)	82.9027*** (0.0000)
GDP_tot	-12.5293*** (0.0000)	52.5599 (1.0000)	11.5100 1.0000
$Cement\_Cons_{tr}$	-10.3991*** (0.0000)	67.7594*** (0.0000)	45.5075*** (0.0000)
$Cement\_Cons_{i}$	-	25.1828*** (0.0000)	13.0836*** (0.0001)
$Cement\_Prod_{tr}$	-18.4698*** (0.0000)	28.6438 (1.0000)	19.8758 (0.9787)
$Cement\_Prod_{i}$	-	33.1760*** (0.0000)	39.7734*** (0.0000)

Table: B.2 Results of Correlation Matrix

Cement_Prod$_i$	Cement _Prod$_{tr}$	Cement _Cons$_i$	Cement _Cons$_{tr}$	GDP_tot	Export	
0.1525	0.0382	0.1856	0.0241	0.1265	1.000	**Export**
0.6108	0.1635	**0.6443**	0.1701	1.000		**GDP_tot**
0.0093	**0.9830**	0.0273	1.000			**Cement _Cons$_{tr}$**
0.9425	0.0207	1.000				**Cement _Cons$_i$**
0.0177	1.000					**Cement _Prod$_{tr}$**
1.000						**Cement _Prod$_i$**

Table: B.3 Diagnostic Test Results

	Null Hypothesis	Test Stat	P-values
Wooldridge Test For Autocorrelation	H0: no first order autocorrelation	F= 19.613	0.0000
White Test for Heteroscedasticity	H0: homoscedasticy	Chi-square = 74.39	0.0000
Modified Wald Test for Heteroscedasticity	H0: $sigma_i^2 = sigma^2$ for all i.	Chi-square=3063.76	0.0000
Hausman Test	H0: difference in coefficients not systematic	Chi-square=15.04	0.0005
Breusch-Pagan LM test of independence	H0: cross sectional dependence	Chi-square=22.571	0.1260

Table: B.4 Results of Cross Section Regression of Individual Effects

Variable	$Dist_{tri}$	Dborder	Dlandlock
Model 1	-28.218** (-1.96)	-	-
Model 3	-0.331 (-0.23)	5.473** (1.85)	-2.755** (2.04)

t values are provided in brackets, * p<.1; ** p<.05; *** p<.01

Variable	$Dist_{tri}$	Dborder	Dlandlock
One Way Fixed Effect Model	-0.396 (-0.28)	5.374* (1.82)	-2.757** (-2.04)
Two Way Fixed Effect Model	-0.488 (-0.34)	5.241* (1.78)	-2.737** (-2.04)

t values are provided in brackets, * p<.1; ** p<.05; *** p<.01

Table: B.5 Results of fixed effect model estimations with Driscoll-Kraay standard errors

Variables	Model 1	Model 3	One Way Fixed Effect Model
GDP_tot_i	3.110*** (5.03)	7.028*** (7.69)	7.355*** (11.11)
$Dist_{tri}$	-	-(1)	-(1)
Dborder	-	-(1)	-(1)
Dlandlock	-	-(1)	-(1)
$Cement\_Cons_{tr}$	-	-2.536** (-3.70)	-2.828*** (-4.79)
Dcarbonleakage	-	-	0.782*** (3.57)

* p<.1; ** p<.05; *** p<.01

(1) Variables are omitted due to the fixed effect estimation

(2) The dependent variable is the bilateral cement exports of Turkey to country i

(3) t values are provided in brackets

(4) All variables are used in natural logarithm except dummy variables

Table: B.6 Result Table for Kyoto Protocol Dummy Variable

Variables	Pooled OLS Model	One Way Fixed Effect Model	Two Way Fixed Effect Model
GDP_tot_i	0.843***	7.669***	6.568***
	(4.17)	(3.87)	(2.74)
$Dist_{tri}$	-.0162	-(1)	-(1)
	(-0.90)		
Dborder	2.393***	-(1)	-(1)
	(5.31)		
Dlandlock	-2.298***	-(1)	-(1)
	(-7.69)		
$Cement\_Cons_{tr}$	0.716	-3.069***	-(1)
	(1.41)	(-2.38)	
Dkyoto	-1.027***	0.300	-0.315
	(-3.15)	(0.98)	(-0.88)
Constant	-21.048***	-169.05***	-170.77***
	(-3.02)	(-4.10)	(-2.64)
Number of Obs.	842	842	842
R-square	0.1308	0.6899	0.7019
F test		14.41	5.62

* p<.1; ** p<.05; *** p<.01

(1) Variables are omitted due to the fixed effect estimation

(2) The dependent variable is the bilateral cement exports of Turkey to country i

(3) t values are provided in brackets

(4) All variables are used in natural logarithm except dummy variables

Table: B.7 Result Table for Cement Emission Difference Variable

Variables	Pooled OLS Model	One Way Fixed Effect Model	Two Way Fixed Effect Model
GDP_tot_i	0.836***	7.916***	9.300***
	(3.76)	(3.54)	(3.37)
$Dist_{tri}$	-0.011	-	-
	(-0.06)		
Dborder	2.337***	-	-
	(4.68)		
Dlandlock	-2.083***	-	-
	(-5.50)		
$Cement\_Cons_{tr}$	0.798	-1.757	-
	(1.29)	(-1.26)	
CementEmissionDiff	-0.142	-0.545**	-0.738***
	(-1.04)	(-2.50)	(-3.29)
Constant	-21.810***	-184.91***	-238.68***
	(-2.71)	(-3.93)	(-3.21)
Number of Obs.	667	667	667
R-square	0.1166	0.7084	0.7223
F test		11.85	12.14

* p<.1; ** p<.05; *** p<.01

(1) Variables are omitted due to the fixed effect estimation

(2) The dependent variable is the bilateral cement exports of Turkey to country i

(3) t values are provided in brackets

(4) All variables are used in natural logarithm except dummy variables

Table: B.8 Result Table for Leakage Dummy Variable

Variables	Pooled OLS Model	One Way Fixed Effect Model	Two Way Fixed Effect Model
GDP_tot_i	0.547***	7.333***	8.046***
	(2.71)	(3.93)	(3.73)
$Dist_{tri}$	-0.004	-	-
	(-0.03)		
Dborder	2.482***	-	-
	(5.49)		
Dlandlock	-2.257***	-	-
	(-6.85)		
$Cement\_Cons_{tr}$	0.290	-2.799**	-
	(0.62)	(-2.41)	
Dleakage	2.478***	1.751***	1.235**
	(3.22)	(3.25)	(2.20)
Constant	-9.940	-162.73***	-210.68***
	(-1.49)	(-4.15)	(-3.62)
Number of Obs.	842	842	842
R-square	0.1321	0.6940	0.7036
F test		17.81	5.96

* p<.1; ** p<.05; *** p<.01

(1) Variables are omitted due to the fixed effect estimation

(2) The dependent variable is the bilateral cement exports of Turkey to country i

(3) t values are provided in brackets

(4) All variables are used in natural logarithm except dummy variables

APPENDIX C: TURKISH SUMMARY

Uluslararası dış ticaret teorilerinin temellerini oluşturan karşılaştırmalı üstünlük teorisine göre; ülkeler belirli ürünlerin üretiminde diğer ülkelere göre daha düşük bir maliyete katlanıyorlarsa, o ürünlerde karşılaştırmalı üstünlüğe sahiplerdir. Bir başka deyişle, belirli bir ürün için daha yüksek verimliliğe sahip ülkeler, bahse konu ürünün ticaretinde avantaj kazanmaktadırlar.

Bu çerçevede, 20. yüzyılın ortaları itibarıyla dış ticaretin çevreyle olan ilişkisi dikkat çekici bir alan olarak kendisini göstermeye başlamıştır. Bu alanda yapılan çalışmaları temel dış ticaret teorilerinden ayıran önemli bir farklılık bulunmaktadır. Ricardo'nun karşılaştırmalı üstünlükler teoremi ile Hecksher ve Ohlin'in faktör donatımı teorilerinde ve dolayısıyla bu teorilerin yönlendirdiği dış ticaret literatüründe, ülkelerin sahip olduğu kaynak ve emtiaların fiyatları hep sabit olarak kabul edilmiştir. Bir diğer ifadeyle, çevreyi korumaya yönelik herhangi bir politikanın bahse konu kaynakların fiyatlarını değiştirmesi göz ardı edilmiştir. Bu yeni yaklaşımla beraber daha esnek çevre politikaları uygulayan ülkelerin karşılaştırmalı üstünlük kazandığı şeklinde yeni bulgular edinilmeye başlanmıştır.

Çalışmalar arttıkça dış ticaret teorilerinde dikkat çekici bulgular ortaya çıkmıştır. Bu çalışmalar ışığında ortak bir bulgu olarak, çevresel düzenlemelerin çevreyi kirletici özelliğe sahip ürünlerde karşılaştırmalı üstünlüğün kaybedilmesine neden olduğu ortaya konulmuştur. Dikkat çekici bir diğer sonuç ise ülkelerin uyguladığı çevre politikalarının karşılaştırmalı üstünlük hususundan ötürü kirletici ürünlerin üretiminin yapıldığı tesislerin konumlarının değiştirilmesine neden olmasıdır. Bu etkinin yalnızca tek bir kirletici ürün bağlamında görülmekle kalmadığı, daha esnek düzenlemelere sahip ülkelerin kirletici ürün üretimi gerçekleştiren sektörünün tamamının karşılaştırmalı olarak bir üstünlük kazandığı bulgusuna ise başka bir çalışmanın sonucunda varılmıştır. Başka bir çalışmada ise çevresel düzenlemelerin ve bu düzenlemelerin gerekliliklerini oluşturan teknoloji kullanımının sanayi kesiminin rekabetçiliğini olumsuz şekilde etkilediği ortaya konulmuş, bu etkinin giderilmesi için devlet eliyle sübvansiyon nitelikli müdahalelerde bulunulması gerektiği ifade edilmiştir.

Çevre ve ticareti bir arada ele almakta olan teoriler arttıkça çevre ve ticaret temasına bakış da değişmiştir. Gerçekleştirilen çalışmalarda çevre politikalarının ticaret akımlarına etkileri incelenmiş olsa da genellikle bu politikaların çevre üzerindeki olumlu etkilerinin göz ardı edilmemesi gerektiği ortaya konulmuştur. Bu çerçevede yapılan araştırmalarda ticaretin üzerindeki olumsuz etki doğrulanmış olsa da çevre politikalarıyla çevresel zararın tersine çevrildiği sonucuna ulaşılmıştır.

Bahsedildiği üzere çevre politikalarının uygulandığı ülkelerde kirletici bazı sanayi dalları bu politikalardan olumsuz etkilenmektedir. Bunun neticesinde ise daha esnek politikalara sahip ülkelere bahse konu kirletici sanayi kolları açısından doğrudan yatırımlar yapılması ve bu ürünlerin üretilmesi konusunda bu ülkelere bir kayma yaşanması üzerine yeni bir hipotezin oluşmuştur. Bu konu literatürde Kirlilik Sığınağı Hipotezi olarak bilinmektedir. Çalışmalarda daha esnek politikalara genellikle gelişmekte olan ülkelerin sahip olduğu ifade edilmektedir. Bunun yanında bir takım araştırmalarda ise bu hipotezin gelişmiş ülkelerden gelişmekte olan ülkelere doğru gerçekleştirildiği bulgusuna erişilmiştir.

Tüm bu çalışmalar çevresel politikalara duyulan gereksinimin, ülke ekonomilerine olan etkilerini gözlemleyebilmek amacıyla ortaya çıkmıştır. Bu açıdan değerlendirildiğinde, insan tarihinin karşılaştığı en ciddi ve en geniş çaplı çevre problemlerinden biri olan küresel iklim değişikliğine yönelik uygulanan çevre politikaları bu konuyla ilişkili olarak tezin ana çerçevesini oluşturmaktadır. Bu tezde, Kirlilik Sığınağı Hipotezine benzer olan ve iklim değişikliğine önlem almak için uygulanan iklim politikaları sonucu ortaya çıkan karbon sızıntısı kavramı tartışılmıştır.

İklim değişikliği; doğal iklim değişkenliklerine ek olarak insan faaliyetlerinin küresel atmosferin bileşimini bozması sonucunda karşılaştırılabilir zaman dilimlerinde ortaya çıkan değişiklik olarak tanımlanmaktadır. Tanımdan anlaşılacağı üzere iklim değişikliği insan faaliyetlerinin sonucu olarak ortaya çıkmaktadır. Zira bu değişime neden olan faaliyetlerde sera gazı emisyonları ortaya çıkmakta ve bu emisyonlar atmosfere salınmaktadır. Söz konusu sera gazları atmosferde birikerek küresel sıcaklık artışını tetikleyip iklim değişikliğine neden olmaktadır. Bu kapsamda yürütülen bilimsel çalışmalar sera gazı emisyonlarına neden olan ana faktörlerin enerji ve sanayi sektörleri olduğunu ifade etmektedir. Bundan ötürü bu sektörlere ve sektörlere ait faaliyetlerin iklim değişikliği açısından gözden geçirilmesine ilişkin küresel çaplı çalışmalar başlatılmıştır.

İklim değişikliğinin insan kaynaklı faaliyetlerin bir sonucu olarak ortaya çıkan küresel bir çevre sorunu olduğunun bilimsel olarak kanıtlanmasının ardından, bu soruna küresel ve geniş çaplı bir çözüm bulmak amacıyla birçok ülke bir araya gelmiştir. Bu kapsamda uluslararası bir çözüm olarak Birleşmiş Milletler İklim Değişikliği Çerçeve Sözleşmesi (BMİDÇS) ortaya çıkmıştır. Sözleşmenin ortaya çıkmasının asıl amacı iklim değişikliğine neden olan sıcaklık artışını kısıtlamak için oluşturulacak seçeneklerin işbirliği içerisinde belirlenmesidir. Ancak ilerleyen yıllarda sözleşmenin yükümlülükleri iklim değişikliğiyle mücadelede istenilen sonuçlara ulaşmada yetersiz bulunulmuş olup yeni bir anlaşmanın ortaya çıkması öngörülmüştür. Böylece, 1997 yılında 192 ülkenin taraf olduğu Kyoto Protokolü (KP) imzalanmıştır. Bu Protokol, BMİDÇS ile aynı amaca yönelik hazırlanmış olup söz konusu Protokol ile atmosferdeki sera gazı emisyon miktarlarının azaltılması ve iklim değişiklinin önüne geçilmesi hedeflenmiştir. Ancak Protokol kapsamında BMİDÇS içeriğinin aksine KP'ye taraf olan ülkelerin sorumlulukları açıkça belirtilmiştir. Bu kapsamda, genel bakış açısı olarak ortak fakat farklılaştırılmış sorumluluklar ilkesi göz önünde bulundurulmuştur. Kyoto Protokolü, gelişmiş ülkelerin tarihi sorumluluklarına uygun olacak şekilde sera gazı emisyonlarını azaltmasına yönelik maddeler içermektedir. Bu açıdan, iklim değişikliğine karşı sera gazı emisyonlarına kısıtlama getiren ilk ve en geniş kapsamlı uluslararası anlaşma olarak tarihe geçmiştir.

Ancak, Protokol geniş kapsamlı olarak tasarlanmış olsa da ülkelerin sınıflandırılması için sunulan ekler yöntemi iklim değişikliğine yönelik çözüm amaçlı planlanan eylemlerin yürütüleceği ülke sayısını kısıtlamıştır. Zira, KP'nin yalnızca Ek-B listesinde yer almakta olan ülkeler emisyonlarını sayısal bir hedef ile kısıtlama taahhüdü vermekle yükümlü tutulmuşken, Ek-B listesi dışındaki ülkeler için bu tür bir yükümlülük getirilmemiştir. Bu kapsamda, 37 gelişmiş ve gelişmekte olan ülke Ek-B listesini oluşturmuştur. KP'nin yürürlüğe girmesi ile söz konusu ülkeler, ilk taahhüt dönemi olan 2008 ve 2012 yılları arasında sera gazı emisyonlarına ilişkin hedeflerini bildirmiştir. Bu hedeflerin toplamı ülkelerin 1990 yılında saldıkları toplam sera gazı emisyonlarının yaklaşık yüzde 5 azaltımına eşdeğer olarak hesaplanmıştır.

Bahse konu bu azaltımı gerçekleştirmek amacıyla yükümlülük sahibi olan ülkeler taahhütlerine ulaşabilmek için KP'de yer almakta olan maddelerde de belirtildiği üzere bazı politika araçlarına ve önlemlerine başvurmuşlardır. Ancak Protokol bu açıdan ülkeleri kısıtlamayarak esnek bir yaklaşım sergilemiştir. Bu esnek yaklaşım sayesinde ülkeler ulusal ve kendilerine özgü iklim politikalarını oluşturabilmiştir. Bu şekilde her ülke emisyon azaltımını sağlayabileceği en etkin yolu bulabilmiştir.

Bu çerçevede, iklim değişikliği problemine yönelik bazı ekonomik araçlar mevcuttur. Ek B ülkeleri de ilk taahhüt döneminde emisyon azaltımı sağlamak amacıyla bu ekonomik araçlardan faydalanmıştır. Avrupa Birliğinde yer alan 28 ülkenin uygulamakta olduğu emisyon ticaret sistemi bu araçlara örnek gösterilebilir. Avrupa Birliğine üye ülkelerine ait toplam sera gazı emisyonlarının yüzde 45'ini kapsama almakta olan AB Emisyon Ticaret Sistemi, Birliğin iklim değişikliği problemine karşı kullanmakta olduğu başlıca politika araçlarından biridir. Bu sistemin temel amacı, enerji ve sanayi sektörlerine ait toplam sera gazı emisyonlarına üst limit koyarak bu emisyonları kısıtlamaktır. Emisyon ticaret sistemlerinin yanı sıra AB ülkelerinde ve diğer Ek B ülkelerinde azaltım hedeflerine ulaşmak için karbon vergisi uygulamalarına başvurulduğu da gözlenmiştir. Örneğin, Avustralya'da emisyonları kısıtlamak amacıyla oluşturulmuş olan karbon vergisi bu duruma örnek gösterilebilmektedir. Sera gazı emisyonlarını azaltmak amacıyla kullanılan bu araçların yanı sıra bazı ülkeler, standartlar ve sınır değerlerden oluşan komuta ve kontrol mekanizmalarına da başvurmuştur. Örneğin Rusya, Kyoto Protokolü'nün ilk taahhüt dönemi için enerji verimliliğine ve emisyon azaltımına yönelik yeni ulusal standartlar tanımlamıştır.

Tüm bu ekonomik araçlar ve önlemler Ek-B ülkeleri tarafından KP'de yer alan hedeflerini gerçekleştirmek için tercih edilmiştir. Ancak Ek-B dışında kalan ülkeler herhangi bir emisyon hedefleri olmadığından bu tür politikaları kullanmaya ihtiyaç duymamıştır. Bu durum, uluslararası düzeyde farklı iklim politikalarının tercih edilmesiyle sonuçlanmıştır. Bu nedenle araştırmacılar, Kyoto Protokolü'nün Ek sistemiyle ülkeleri sınıflandırmasının asimetrik iklim politikalarına sebep olduğunu öne sürmektedir. Bu çerçevede, rekabetçiliğe yönelik gerçekleştirilen araştırmalar söz konusu asimetrik iklim politikalarının bazı dış ticaret politikalarıyla doğrudan ilintili bir takım riskler ortaya çıkardığını dile getirmektedir.

Bu risklerden biri de karbon sızıntısı riskidir. Tanım itibariyle karbon sızıntısı tek taraflı iklim politikalarının sonucu olarak belli ürünlerin üretimlerinin, politikaların uygulandığı ülkelerden diğer ülkelere kaydırması sonucu bu ülkelerde emisyonlarının artması olarak ifade edilmektedir. Bu konu üzerinde yapılan çalışmalar karbon sızıntısının iki temel göstergeye sahip olduğunu belirtmektedir. Bu göstergeler, rekabetçilik ve fosil yakıt fiyatlarıdır. Bu kapsamda, bu göstergelerden rekabetçilik konusu bu tezin ana fikrini oluşturmaktadır. Rekabetçilik konusu açısından bakıldığında ülkelerde uygulanan iklim politikaları üretim maliyetlerini artırarak bu politikaları uygulamayan ülkelerin karşılaştırmalı üstünlük sağlamalarına sebep olmaktadır. Bu durum, uzun vadede belirli sektörlerde yatırım davranışlarını değiştirirken kısa vadede sektörlerin dış ticaret akışlarını etkilemektedir. Bu akışlarda genellikle yerel piyasada karbon içerikli ürünlerin ithalatının azaldığı, söz konusu ürünlerin ihracatının ise arttığı gözlenebilir. Özellikle bu ürünlerin ihracatının sera gazı emisyon kısıtlamasına yönelik iklim politikası uygulamayan ve gelişmekte olan ülkelerden yapılması bu ülkelerin emisyon miktarlarını arttırmakta olup karbon sızıntısı yaşanmasına neden olmaktadır.

Anlaşılacağı üzere karbon sızıntısının önemli sebeplerinden biri iklim politikaları yüzünden artan maliyetler sonucu bozulan rekabetçiliktir. Bu kapsamda, her sektör aynı karbon sızıntısı riski ile karşı karşıya kalmayabilir. Araştırmalar sektörlerin iklim politikaları altında rekabetçilik düzeyini belirleyen bazı faktörlerin olduğuna işaret etmektedir.

Bu faktörlerden ilki sektöre ilişkin emisyon ve enerji yoğunluğu düzeyidir. Bu yoğunluk düzeyini belirlemek, sektörün iklim politikaları karşısında üretim maliyetlerinin ne kadar etkileneceğine dair bir gösterge olarak kullanılır. Bu kapsamda, sanayi sektörünün önemli aktörleri büyük oranda enerji ve emisyon yoğunluklu faaliyetler içermektedir. İstatistiklere göre demir çelik, çimento, kağıt, birincil alüminyum ve cam üretim faaliyetleri tüm sanayi üretiminde kullanılan toplam enerjinin yaklaşık yüzde yetmişine denk gelmektedir. Bu açıdan bakıldığında bu faaliyetlere ilişkin sektörlerin herhangi bir iklim politikası karşısında ilave maliyetler ile karşılaşacağı aşikârdır.

Bu maliyetler ise sektörlerin enerji tüketim yapısıyla doğru orantılı olarak değişebilir. Örneğin enerji ihtiyacını büyük oranda fosil yakıtlardan sağlayan bir sektör diğerlerine kıyasla ek maliyetlerle karşılaşacaktır. Enerji kullanım miktarlarına ek olarak, sektörlere ait sera gazı emisyon salım miktarları da sektöre ilişkin kırılganlığı ölçmek için incelenebilir. Yukarıda belirtilen sektörler fosil yakıtların yakılması sonucu ortaya çıkardıkları emisyonlara ek olarak üretimler esnasında endüstriyel emisyonların salınımına da neden olmaktadır. Bu açıdan sektörlerin emisyon yoğunlukları sektörün karşılaşacağı maliyeti ve rekabetçiliğinin etkilenmesini belirlemek açısından önem kazanmaktadır. Bunun sebebi; emisyon azaltım politikalarının, üretim esnasında ortaya çıkan emisyon miktarları ile doğru orantılı olarak üretim maliyetlerini artırmasıdır

Ancak sektörlerin enerji tüketimlerini ve emisyon yoğunluklarını incelemek iklim politikalarının sektörler üzerindeki etkisini ölçmek için yeterli değildir. Rekabetçilik düzeyini belirleyen diğer bir faktör olan maliyetlerin yansıtılabilme özelliği göz önünde bulundurulmalıdır. Bu özellik ilave maliyetlerin tüketiciye fiyat üzerinden yansıtılmasıyle ilişkilidir. Bir önceki belirleyici faktörde olduğu gibi bu faktörde sektörden sektöre farklılık gösterir. Bazı sektörlerde maliyetlerin tüketiciye fiyat üzerinden yansıtılması daha olası iken bazı sektörlerde bu maliyetlerin absorbe edilmesi gerekir. Bu farklılık sektörlerin talep esnekliği ile ilgilidir. Eğer sektör inelastik ürünler üretiyorsa ek maliyetlerin fiyata yansıtılması durumunda ürüne olan talep değişmez. Ancak, üretilen ürünler elastik ise tüketicilerin talebi ikame ürünlere veya sektörlere kayabilir.

Bu noktada, karbon sızıntısı riskine maruz kalabilecek sektörler arasında çimento sektörü bazı özellikleri itibariyle dikkat çekmektedir. Öncelikle, bahsedilen faktörler çimento sektörü için incelendiğinde çimento sanayinin iklim politikaları karşısında kırılgan bir yapıya sahip olduğu belirlenmiştir. İlk faktör açısından bakıldığında söz konusu sanayinin enerji yoğunluklu yapıya sahip olduğu ve bu enerjinin yaklaşık yarısının kömür, petro kok ve kok gibi emisyon yoğunluklu yakıtlardan oluştuğu gözlemlenmiştir. Bu durum çimento sanayinin emisyon yoğunluğunun fazla olduğunun bir kanıtı olarak sunulmuştur. Ayrıca sektöre ait maliyetlerin alt kırılımları incelendiğinden en büyük paya sahip olan kalemin enerji maliyetleri olduğu sektör raporları tarafından doğrulanmıştır.

Yukarıda bahsi geçen faktörlere aynı zamanda Avrupa Komisyonunun 2011 yılında resmi olarak yayımladığı karbon sızıntısı hakkındaki rehber doküman içerisinde dolaylı olarak sektörlerin karbon sızıntısı riskini belirlemek için yer verilmiştir. Söz konusu dokümanda karbon sızıntısı riski iki unsura bağlıdır: toplam maliyet ve dış ticaret yoğunluğu. Her iki unsur olası sektörler için sayısallaştırılmıştır. Sektörlere ait sonuçlar incelendiğinde iklim politikaları karşısındaki toplam maliyet açısından çimento sanayi diğer sektörlerden gözle görülür bir şekilde ayrışmaktadır. Bu durum çimento sektörünün emisyon ve enerji yoğunluğu yapısından ötürü ortaya çıkmaktadır.

Bunun yanı sıra, söz konusu rehber dokümanda karbon sızıntısı riskini değerlendirmek için incelenen dış ticaret yoğunluğu çimento sanayisi için çok düşük değere sahiptir. Dış ticaret yoğunluğu yukarıda bahsedilen iki faktörden biri olan maliyetleri yansıtabilme özelliğini değerlendirmek için incelenmiştir.

Ancak, araştırmalar dış ticaret yoğunluğunun bu tür bir faktörü yansıtması açısından uygun bulmamaktadır. Söz konusu araştırmalar, dış ticaret yoğunluğunun dinamik bir parametre olmasından kaynaklı olarak sektörlerin yapısına göre değişkenlik gösterdiğini ve herhangi bir kısıt veya teşvik karşısında yapısını değiştirebileceğini öne sürmektedir. Bundan ötürü bu unsur karbon sızıntısını incelemek için yeterli bir değerlendirme sunmamaktadır. Bunun yerine çimento ürünler için talebin esnekliği incelenmelidir. İlgili literatür çalışmaları incelendiğinde çimento ürünlerinin göreceli olarak esnek bir talebe sahip olduğu gözlemlenmiştir. Bu durum artan ürün fiyatlarının talep üzerinde azaltıcı bir etkisi olduğu anlamına gelmektedir. Bundan ötürü, çimento ürünleri için ilave maliyetler tüketici fiyatlarına yansıtılamamaktadır. Çimento sanayinin bu açıdan sınırlanması karbon sızıntısı riskini büyük oranda artırmaktadır.

İki faktör incelendiğinde çimento sanayinin iklim politikaları karşısında kırılgan bir yapıya sahip olduğu ve yüksek oranda karbon sızıntısı riskine sahip olduğu görülmektedir. Bu riski değerlendirmek amacıyla sanayiye ait yıllara göre değişen karbondioksit emisyonları incelenmiştir. Grafikteki eğilimler değerlendirildiğinde çimento sanayiye ait toplam emisyonlar artış sergilerken Ek B ülkelerine ait emisyonlar 2008 yılından sonra azalmaya başlamıştır. Bu eğilimler karbon sızıntısı durumunu destekler niteliktedir.

Karbondioksit emisyonlarının yanı sıra çimento üretimlerine ilişkin bilgiler de karbon sızıntısı açısından değerlendirilmiştir. 2001 yılına kıyasla iki katına çıkmakta olan toplam çimento üretimleri yıllık ortalama yüzde yedi büyüme sergilemiştir. Ülkeler bazında incelendiğinde 2005 yılında ilk on çimento üreticisi ülkeler içerisinde yer almakta olan Ek B ülkeleri zaman içerisinde bu sıralamadaki pozisyonlarını kaybetmişlerdir. İlgi çeken durum ise bu incelemelerin yapıldığı dönemin KP dönemine denk gelmesidir. Aynı listelerde Türkiye'nin 2005 yılına göre büyük bir gelişme sergilemesi ve 2013 yılında en büyük beşinci çimento üreticisi olması ise ayrıca dikkat çeken unsurlardan biridir.

Bu kapsamda, özellikle Kyoto Protokolü dönemlerinde Türkiye'nin çimento üretiminde büyük bir artış göstermesi, karbon sızıntısına hedef olduğu şüpheleri doğurmuş olup tez konusunun özellikle bu ülkeyi incelenmesine sebebiyet vermiştir. Bu açıdan Türkiye'ye ait ihracat verileri incelenmiş olup yine aynı dönemde söz konusu ülkenin dünyada en çok çimento ürünleri ihracatı yapan ülke konumuna geldiği gözlemlenmiştir. Ayrıca Ek B ülkelerinin yaptığı çimento ithalatında Türkiye'nin KP'nin ilk taahhüt dönemi yıllarına denk gelen yıllarda büyük bir paya sahip olduğu dış ticaret verilerinden hesaplanmıştır.

Bu tez kapsamında Türkiye'nin Ek B ülkeleri tarafından çimento sektöründe karbon sızıntısına hedef olduğu şüphelerini doğrulamak için Türkiye'ye ait çimento ihracatını ekonometrik yöntemler ile açıklamak istenmiştir. Bunun için son yıllarda dış ticaret çalışmalarında sıklıkla kullanılan çekim modeli tercih edilmiştir. Çalışmaya ait modelin tercih edilmesi sırasında çekim modelinin ampirik çalışmalarda yüksek derecede açıklama kabiliyetnin olması göz önünde bulundurulmuştur. Buna ek olarak, her ülke için kolaylıkla ulaşılabilen veriler ile kurulmasıda tercih edilme sebeplerinden biri olmuştur.

Çekim modeli, ampirik çalışmaların yanı sıra arkaplanda dış ticaret teorileri tarafıncada desteklenmiştir. Temel olarak modelde yer alan ekonomik büyüme ve ülkeler arası uzaklık değişkenlerine ek olarak modele bazı farklı değişkenlerde eklenmektedir. Literatür çalışmalarında bu değişkenlerin dış ticaret maliyetininin göstergesi olarak modele eklenmesi uygun görülmektedir.Ülkeler arasındaki ortak sınır, ortak dil, ortak koloni ve dış ticaret antlaşmaları bu değişkenlere örnek verilebilir.

Literatür incelenmesi sonucunda ulaşılmaya çalışılan sonuçlara yönelik çalışmaların varlığı tespit edilmiştir. Bu kapsamda, ülkelere ait bütün ürünlerin ihracat ve ithalat akışlarının açıklanmasında kullanılan çekim modeli yöntemi aynı zamanda spesifik sektörlere ait ürünlerin dış ticaret davranışlarını açıklamak içinde kullanılmaktadır. Örneğin demir ve çelik sektörüne veya tekstik sektörüne ait ürünlerin ihracat akışlarının çekim modeli ile incelendiği çalışmalar mevcuttur.Bunlara ek olarak, çevre problemlerini konu almakta olan çalışmalarda yöntem olarak çekim modeline başvurmaktadır. Örneğin söz konusu çalışmalardan bir tanesinde çevre uygulamalarının ihracat hacmine olan etkisi üzerinde durulmaktadır.

Tez çalışmasını yürütmek amacıyla, ekonometrik test sonuçlarıda göz önünde bulundurularak ekonomik büyüme ve ülkeler arası uzaklık değişkenleri ile ortak sınır ve kara ile çevrili olma kukla değişkenleri modele açıklayıcı değişkenler olarak konulmuştur. Bunlara ek olarak sektöre özel olarak Türkiye'nin çimento tüketim miktarlarıda modele eklenmiştir.

Temel olarak oluşturulmuş model tahmin sonuçları sabit etkiler çerçevesinde değerlendirildiğinde toplam ekonomik büyümenin Türkiye'nin çimento ihracatına pozitif bir etkisi olduğu görülmüştür. Çekim modelinin diğer vazgeçilmez değişkeni olan iki ülke arasındaki mesafenin ise anlamsız çıktığı gözlenmiştir. Bunun sebebinin Türkiye'de çimento sektörünün taşımacılık olarak deniz taşımacılığını tercih etmesinden kaynaklandığı öne sürülebilir. Çimentonun ağır bir mal olduğundan ötürü kara yolu ile taşınmasının maliyetli olması, sektörü deniz taşımacılığına kaydırmıştır. Bu noktada, mesafe olarak yakın ülkelerin denize kıyısı olmadığı durumlarda çimento ihracatı maliyetli olmaktadır. Bu durum, mesafe değişkeninin anlamsız çıkmasına sebebiyet verebilir.

Bunların yanı sıra, ortak sınır ve kara ile çevrili olma durumları için modele eklenen kukla değişkenlerinin anlamlı sonuçlar verdiği raporlanmıştır. Beklenildiği üzere, Türkiye ile ortak sınırı olan ülkelerin çimento ihracatını arttırdığı gözlemlenmiştir. Ayrıca denize kıyısı olmayan ülkelerin ise Türkiye'nin ihracatına negatif etki ettiği görülmüştür. Sektörel bir değişken olan Türkiye'nin çimento tüketimi ise yerel talebin karşılanmasını destekleyeceği beklentisiyle modelin tahmin sonuçlarında anlamlı çıkmış ve çimento ihracatını azaltan bir katsayı sonucu vermiştir.

Karbon sızıntısının incelenmesi için ise eklenen kukla değişken ilk kez kullanılmış olup yazar tarafından karbon sızıntısının anlamından yola çıkarak kurulmuştur. Söz konusu kukla değişken iki değişkenin birleştirilmesiyle oluşturulmuştur. İlk adımda KP'de emisyon kısıtlama taahhüdü olan ülkelere 2008-2012 yıllarını kapsayan bir kukla değişken kurulmuştur. Diğer adımda ise çimento emisyon miktarlarındaki değişimler göz önünde bulundurulmuş olup yeni bir kukla değişken yaratılmıştır. Ülkelerin bir önceki yıla göre azalan çimento üretiminden kaynaklı emisyonlar aynı yıllar için Türkiye'de artış gösteriyor ise söz konusu kukla değişken 1 değerini almaktadır. Son adımda bu iki değişken çarpılarak yeni bir karbon sızıntısı kukla değişkeni yaratılmıştır.

Oluşturulan kukla değişken temel olarak kurulmuş modele eklendiğinde anlamlı çıktığı ve pozitif katsayı verdiği gözlemlenmiştir. Bu çerçevede, KP altında emisyon kısıtlaması hedefi olan ülkelerin 2008-2012 yılları arasında çimento üretiminden kaynaklı emisyonlarının azaldığı ve söz konusu emisyonların Türkiye'de arttığı yıllardaki durumunda Türkiye'nin çimento ihracatının arttığı raporlanmıştır.

Sonuç olarak, tez bulguları Kyoto Protokolü'nün ilk taahhüt dönemini göz önünde bulundurarak Türkiye'nin çimento sektörü üzerinde karbon sızıntısı etkisinin olduğunu ispatlamaktadır. Bu bulgular çimento sektörüne ait ihracat akışlarını açıklayan ekonometrik bir analiz ile sunulmaktadır. Sonuçlar genel olarak incelendiğinde emisyon yoğunluklu sektörlerin bu duruma maruz kalabileceği sonucuna varılmaktadır. Bu durum karşısında iklim değişikliğine karşı uygulanan tek taraflı iklim politikalarının gerçekte yetersiz olabileceği ve asıl amaca hizmet etmediği sonucu çıkarılabilinir. Bu sorunu çözmek için ise bir takım iklim politikaları uyumlaştırma çalışmaları yapılabilir. Söz konusu politikaların gelişmiş ülkelerin yanı sıra gelişmekte olan ülkeleri de kapsaması önem arz etmektedir. Ancak bu şekilde karbon sızıntısının önüne geçilip iklim değişikliğine yönelik gerçekçi adımlar atılabilinir.

APPENDIX D : TEZ FOTOKOPİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü

Sosyal Bilimler Enstitüsü

Uygulamalı Matematik Enstitüsü

Enformatik Enstitüsü

Deniz Bilimleri Enstitüsü

YAZARIN

Soyadı : DOĞAN
Adı : DAMLA
Bölümü : İKTİSAT

TEZİN ADI (İngilizce) : IMPACT OF CARBON LEAKAGE ON TURKISH CEMENT EXPORT: A GRAVITY MODEL APPROACH

TEZİN TÜRÜ : Yüksek Lisans Doktora

1. Tezimin tamamı dünya çapında erişime açılsın ve kaynak gösterilmek şartıyla tezimin bir kısmı veya tamamının fotokopisi alınsın.

2. Tezimin tamamı yalnızca Orta Doğu Teknik Üniversitesi kullancılarının erişimine açılsın. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.)

3. Tezim bir (1) yıl süreyle erişime kapalı olsun. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.)

Yazarın imzası .... Tarih ....