The Impact of Trade and Factor Market Liberalization on Carbon Abatement Policies in the Enlargement of the European Union

Levent Aydın[*]

Abstract

This paper aims to analyze the macroeconomic impact of eastward European Union enlargement, in two contexts: first, that of reduced carbon abatement targets; and second via liberalized trade and labor mobility. The European Union, being one of the Annex-1 parties to the Kyoto Protocol, has expanded to incorporate first wave countries (Czech Republic, Estonia, Hungary, Poland, Slovenia, Malta, Cyprus) and second wave countries (Bulgaria, Latvia, Lithuania, Romania, Slovakia), from Central and Eastern European Countries, since 2004. The EU-15 bubble target would remain the same, but will adjust itself to the new burden sharing 8% target for the enlarged bubble, by using emission transfers. While the marginal abatement cost of EU-15 has been estimated above 35 USD per ton of carbon, the same cost in accession countries has been estimated to be very low. This paper examines the costs of implementing the Kyoto Protocol (with and without flexibility mechanisms), in terms of the utility for the representative household and terms of trade(tot) in two liberalization scenarios; one, the liberalization of trade, and the other, labor mobility in the enlargement process. The adjusted GTAP-E model, which is a comparative-static general equilibrium model, is used to examine impacts under different liberalization scenarios.

Keywords: EU Enlargement; Carbon Abatement Policies; Computable General Equilibrium

[*] Deputy Director of the General Directorate of Petroleum Affairs, Ministry of Natural Resources and Energy, Eskisehir Yolu 7.km. No. 166 06520 Ankara, Turkey Tel.: +90 312 2198120; fax: +90 312 2860105; e-mail: laydin@pigm.gov.tr.

1. Introduction

The EU has changed significantly both in scope and membership from the European Economic Community (AEC), founded with six members and created by the Treaty of Rome in 1957. Five successful rounds of enlargement of the original Community have taken place so far: i) Denmark, Ireland and the United Kingdom in 1973; ii) Greece in 1981; iii) Spain and Portugal in 1986; iv) Austria, Finland, and Sweden in 1995; and v) ten Central and Eastern European Countries (Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovakia and Slovenia), in 2004, and two more members (Bulgaria and Romania) in 2007. So, the EU's membership has grown to twenty-seven with the most recent and largest enlargement in its history (Bandyopadhyay, Lahiri and Roy, 2008).

There is a large body of literature providing quantitative researches on the economic effects of full integration of the Central and Eastern European countries to the EU, and further researches on the economic effects of the Kyoto Protocol. However, the literature lacks quantitative researches on the links between trade and environment in the context of the EU (Löschel and Mraz, 2001). Some studies on the enlargement of the EU (Baldwin et al., 1997; Frandsen and Jensen, 2001; Brockmeier et al., 2001; Salvatore, 2001; Breuss, 2002) have paid more attention to economic welfare than to the interaction between trade and environment. Therefore, further work is needed to model the interaction between trade and factor mobility liberalization under environmental constraints, in the light of the EU enlargement (Zhu and Ierland, 2006).

The successive enlargements of the EU, and the accompanying liberalization of trade and increased factor mobility, have affected trade, economic welfare, and environment. In order to analyze the interactions of different carbon abatement policies with each other under the Kyoto Protocol during the process of enlargement, we divide the EU enlargement process into two periods; the pre-enlargement period, before the incorporation of EEC (or EU-12) into the EU (or E-15), and the post-enlargement enlargement period, following the incorporation of the EU-12 into the EU. According to the sixth version of the GTAP database, the enlarged EU has 481 million inhabitants, 18% of total world trade, and 28% of world GDP.

Since EU countries have agreed to reduce their greenhouse gas emissions to the levels set by the Kyoto Protocol, by 2010, the EU must maintain its own bubble target, as mentioned in Article 4.4. Both EU-15 countries and some of EU-12 countries[1] have already committed themselves to reduce emission levels by 8% compared to 1990 level in the post-enlargement period. However the EU-12

---

[1] Other EU-12 countries which are Croatia, Hungary and Poland have different target set in Kyoto protocol have commitment to reduce by 5%, 6% and 6% respectively in post-enlargement. Also Cyprus and Malta do not have any commitment.

countries do not have any commitment to reduce greenhouse gas emission set by the Kyoto Protocol in the pre-enlargement of the EU (Michaelowa and Betz, 2001).

In order to pave the way for the accession of the EU-12 into the EU-15, in 2004, trade between the EU-15 and the EU-12, and among the EU-12 itself, was liberalized gradually between 1991 and 2004. It is believed that this process has affected trade between the EU-15 and the EU-12, among the EU-12 itself, and within the EU-15, by inducing increased trade between the EU-15 and the EU-12 (trade creation), and decreased trade between the EU-15 and EU-12 and the rest of the world (trade diversion). The trade provisions of the European Agreements (EAs) created a free trade area (FTA) including the EU-15 and the EU-12, from 1 January 2001. That is, most goods were to be traded without tariffs or quantitative restrictions, and technical standards in the EU-12 were adjusted to meet EU standards. However, agricultural products were not traded freely and rules of origin were applied. When the EU-15 was enlarged on 1 May 2004, the new member states have introduced EU-15 Common External Tariffs (CET), and agricultural products are now traded without tariffs (Wilhelmsson, 2006).

In order to assess the effects of trade liberalization on the Kyoto Protocol's carbon abatement policies, during the EU enlargement, it is essential to analyze how trade between EU-15 and EU-12 members has been affected in terms of welfare and terms of trade. It is additionally necessary to determine to what extent trade creation and trade diversion have changed carbon prices and emission trading market of the EU-15 and EU-12. In addition to trade liberalization, EU membership involves the free movement of labor within the enlarged EU. While barriers to trade between EU-15 and accession countries were completely abolished in May 2004, there are still restrictions impeding labor mobility. Transitional arrangements regarding the free movement of labor between old and new member states in the EU-25 mainly arose from the fear of mass immigration from Eastern European countries (Niebuhr and Stiller, 2004). The Accession Treaty allows for the introduction of 'transitional measures.' Commonly referred to in EU circles as the '2+3+2-year arrangement', this scheme obliges the member states to declare themselves in May 2006, and again in May 2009, as to whether they will open up their labor markets for workers from the EU-8 (Poland, Lithuania, Latvia, Estonia, the Czech Republic, Slovakia, Hungary and Slovenia) or keep restrictions in place. The restrictions will definitely end on 30 April 2011. A similar '2+3+2' scheme is in place with respect to workers from Romania and Bulgaria, which joined the EU on 1 January 2007. The policies relating to the free movement of workers from the EU-8 within the EU-15 countries can be classified into three categories: i) keeping the restrictions in place for at least three more years (until 2009), as in Austria and Germany; ii) lifting the restrictions gradually, (until 2009), as in Belgium, Denmark, France, Luxembourg,

and the Netherlands; iii) keeping labor markets open or removing restrictions, as in Finland, Greece, Ireland, Italy, Portugal, Spain, Sweden, and the United Kingdom.[2]

This paper intends to develop a framework for analyzing the interaction between production factors, and the trade and environment, through general equilibrium modeling in the context of EU enlargement and the Kyoto Protocol. For illustrative purposes, we modified GTAP-E, which is the environmental and energy version of the standard GTAP model, and adjusted it to the sixth version of the GTAP database.

This paper is organized as follows. While the first section constitutes introduction, the second section discusses the modification of the database and model. This is followed by experimental design describing the scenarios in the third section and the forth section gives the interpretation of results and finally the fifth section comprises discussion and the conclusion.

2.2 Modification of the model and database

Before proceeding with the model simulations, we must first adjust the standard GTAP-E model and the database, originally developed by Burniaux and Truong (2002). We take the standard GTAP-E model and introduce some changes to make it consistent with factor mobility and trade liberalization. We first show that the structure of the GTAP-E model allows for analysis of the links between trade and the carbon mitigation policies. We then modify the standard model and database by incorporating labor factor mobility.

2.1 Modifying the standard GTAP-E Model

The GTAP-E model is an extended version of the standard GTAP model.[3] Both are multiregional and static CGE models. Their production technologies are CRTS in competitive environment. In order to analyze the impact of trade liberalization, it is important to capture pro-competitive effects of this policy. However, we assume that the EU Single Market Program (SMP) fostered competition, and that economic integration reduced firm market power (Botasso and Sembenelli, 1998).

On the other hand, the standard GTAP or GTAP-E model allows for the bilateral exchange of goods and services being not only demanded by domestic users, but also foreign users in accordance with the Armington (1969) assumptions. It is assumed that production factors (land, natural resources, capital, and labor) are fixed, in the standard GTAP-E model. So, it does not seem to be possible to analyze regional integration processes, such as the EU integration. This means that a border

---

[2] Free movement of labor in the EU-27, http://www.euractiv.com/en/enlargement/free-movement-labour-eu-27/article-129648 , Published: Thursday 23 September 2004 Accession: 14/04/2009
[3] The framework of Standard GTAP model is well documented in chapter 2 of GTAP book (Hertel, 1997) and available on the internet (http:// www.gtap.agecon.purdue.edu).

opening for a production factor, e.g. labor, cannot be considered simultaneously with a trade liberalizing event. Thus, the resulting economic impact cannot be observed.

In order to examine labor mobility, or migration between the EU-15 and EU-12, the standard GTAP-E model was modified using the Global Migration Model (GMig2) developed by Walmsley and Winter (2005), so that the adjusted model allows for bilateral movement of labor. Unlike in the standard GTAP-E model, the labor factor is now able to cross borders and take part in the production processes of foreign firms in different regions, similar to production commodities. This migration, or mobility of labor, generates an endogenous labor inflow and outflow according to each different region's labor demand and supply, and interregional wage differentials (Mansoor, A., and Quilin, B., 2006)

Some important features of the GMig2 model were incorporated for the implementation of the modified GTAP-E model. Labor forces, made up of domestic and foreign labor, are treated as perfect substitutes. Labor supply is allocated across sectors to equate the changes in wages. Migrant income depends on wages but it is decreased by remittances, and migrants do not have income from ownership of capital or land, but do pay taxes. Remittances are constant share of income being added to income of home region. Real income changes of migrants take into account differences in purchasing power indexes (PPP) between home and host regions. Non-movers' income depends on income from factors, taxes and remittances received (Walmsley, Winters, Ahmed, 2007)

For liberalizing labor mobility, we use standard GTAP_E model, by taking into account EU-15, and EU-12 labor flows. The labor force in the EU-12 (labor export) region can be transferred to the EU-15 (labor import) region, using an exogenous variable of the labor force in the EU-15, which will increase the labor force there.

2.2 Adjusting Database

CEES countries, named as EU-12, are included into annex countries in the EU enlargement process. 87 industries are included in the GTAP version 6 database, based on the 2001 version (Dimaranan and McDougall, 2005), and these are aggregated to the seven sectors, predominantly determined by energy sectors. Since each sector produces only one single commodity, there are seven commodities in the database. Five commodities of them are energy commodities, which release carbon into atmosphere when they are burned. Also these commodities have different emission factors (see Appendix Table A1).

This same database divides the world into 57 regions. These regions are further aggregated to seven regions. The EU-15 and EU-12 regions are determined separately, to examine the effects of the pre-enlargement and post enlargement processes of the EU. The "former Soviet Union" is determined as a hot air region. The other regions are composed of "rest of Annex countries" and "rest of the world" (see Appendix A2).

By changing the production structure, production factors are divided into two groups; the first, non-labor endowments including land, natural resources, and capital; the second, labor endowments including skilled and unskilled labors. Also, it is assumed that both land and natural resource factors are sluggish factors, while capital and labor are mobile factors.

For the purposes of this paper, the adjusted database used with the Bilateral Labor Migration Model (GMig2) is based on the GTAP 6.2 Database (Dimaranan, 2006), and it extends to the bilateral migration, skill, and remittance data.

Both the European Commission's report (February 2006) and the figures in Table-1 show that the labor mobility flows from EU-15 to EU-10 and within EU-10 are generally negligible. Therefore, we assume that labor mobility flows only from the labor-exporting EU-12 to the labor-importing EU-15 in the model.

The figures in Table-1 suggest relatively little impact of EU enlargement on immigration into the two Scandinavian countries (Sweden and Denmark) considered, especially as compared to the two English-speaking countries shown (Ireland and UK). Ireland, in particular, has experienced a large change as 1.5 percent of the total population coming from EU-12 countries. By far the most popular destination for selected EU-12 emigrants to the selected EU-15 seems to be the UK, but relative to population size, the impact appears much smaller than for Ireland (Barrell, FitzGerald and Riley, 2007)

Table-1: Change in selected EU-12 population resident in selected EU-15 countries following EU enlargement May 2004

Thousands

	Denmark	Ireland	Sweden	UK	Austria	Germany	Italy	% of Total Population
Czech Rep.	0,2	2,5	0,1	13,5	0,3	6,1	2,2	0,24
Estonia	0,2	1,1	-0,1	3	0	0,8	0,3	0,39
Hungary	0,3	1,9	-0,3	8	0,3	6	2,2	0,18
Latvia	0,3	4,8	0,3	15,7	0	1,4	0,5	1,01
Lithuania	1	9,6	1,3	29,7	0,1	2	0,8	1,3
Poland	3,2	37,9	6,3	167,5	6	62	30,9	0,82
Slovakia	0,1	5,1	0,2	27,5	1,6	3,2	1,2	0,72
Slovenia	0	0	0,1	0,3	1,1	1,2	0,4	0,16
Total	5,3	62,9	7,9	265,2	9,4	82,7	38,5	
% Total of Population	0,1	1,49	0,09	0,45	0,11	0,1	0,07	

Source: R. Barrell, J. FitzGerald and R. Riley, (2007)

EU-12 countries are assumed to be the home region, defined as the country of origin, of the person in this database. EU-15 countries are assumed to be the host region, where the person resides.

According to the migration modeling approach of Walmsley and Ahmed and Parsons (2005), the firm now chooses from a pool of workers from both the home region and the host region. That's why the labor force of skill i, located in region r ($LF_{i,r}$), is defined as the sum across home regions c of all workers located in the *host* region r,

$$LF_{i,r} = \sum_c LF_{i,c,r}$$

Similarly for population,

$$POP_{i,r} = \sum_c POP_{i,c,r}$$

It is assumed that no employment migrant workers move with their families and foreign and domestic labor are perfect substitutes. Supply of labor is redistributed across sectors until changes in wages are equal.

Wages are defined as;

$$W_{migrants} = W_{home} + \beta(W_{host} - W_{home})$$

β is fixed proportion and foreign workers have different wages and productivities to domestic workers.

Although the GMig2 model allows for the alternative closure[4], we want to use the closure that increases in quotas of labor for the importing region. In this closure, labor force of the labor importing (EU-15 countries) increases by the amount of the shock being supplied by the labor exporting region (EU-12 countries)
After adjusting both the model and the database, we intend to analyze:
i-) the impact of trade and factor market liberalization on emissions in two separate experiments; first trade, then factor labor markets,

ii-) the impact of combining EU targets between the East and the West; two different experiments: one is starting from pre-enlargement and implementing Kyoto Protocol and the other is starting from post-enlargement and pooled commitments.

2. Experimental Design

The set of experiments analyzes the two above impacts by implementing the flexibility mechanism of Kyoto Protocol along different dimensions of liberalization, which are laid out in the following.

---

[4] See more information, Walmsley, Winters and Ahmed (2007).

First of all, all of the experiments are designed in accordance with the enlargement scenario. We consider that the enlargement scenario is to entail the integration of Central and Eastern European (EU-12) countries into the EU in 2004. In principle, the enlargement of EU implies that all tariffs between EU-15 and EU-12 are abolished. At the same time all sectors in the EU-12 are given the same level of protection against third-party countries, through Common External Tariffs (CET). The enlargement scenario also includes free movement of labor by removing labor quotas on the border between these two regions.

2.1 Pre-enlargement and Implementing Kyoto Protocol:

Experiment 1: No emission trading (Domestic)

A first step in analyzing the impact of Kyoto protocol both in pre-enlargement or post-enlargement of EU is to consider cases where EU-15 meet their commitments individually. An experiment in which the flexibility mechanism plays no role is a useful starting point for determining domestic emission and comparing marginal abatement costs with emissions reductions.

The EU-15 countries in Annex-I represent the developed countries. The EU-15 countries form the bubble under the Protocol and have an internal burden sharing agreement. They have agreed to reduce their aggregate emission of carbon by 8 percent to their 1990 level of emission. However, EU-12 developing countries, not included in Annex-I, do not have any binding commitment.

Experiment 2: Emission trading among Annex-I countries

The entire Annex-I countries are allowed to trade emission with their carbon allowances. Although EU-15 countries have binding commitment to reduce emission of carbon by 8 percent, to their 1990 level, in the period from 2008-2012, it is possible for EU-15 countries, within the Emission Trading System (ETS) or cap and trade, to buy emission credits from EU-12, which emits less than quota.

2.2 Post-enlargement with Liberalization and Pooled Commitments

The enlargement process of EU with CEES countries has been finalized by the Kyoto Protocol ratification. The EU would then enlarge the EU-15 bubble by the new member states. However it would take into account the rule of article 4.4 of the Protocol which would mean that the target of the EU (-8%) would remain the same. Therefore, EU-12 countries mostly have the same target (-8%) of EU-15.

Liberalization takes place in both goods and factors markets, as part of the process of enlargement; first, the trade tariffs are abolished and the same common external tariffs, as exists in EU-15 countries, are applied to the new members in goods markets. Second, barriers to labor migration from the central and the Eastern

European countries (EU-12) are lifted in the factor markets. The labor migration to EU-15 will be only temporary (Senn, 1999).

Labor mobility can occur as an exogenous change in the supply and/or demand for migrant workers (that is, changes in quotas) and it is represented as the change in the number of migrants, in the model. In this paper, mobility in factor labor only occurs exogenously through changes in quotas imposed by the host economies (EU-15), and this labor force is supplied by designated home countries (EU-12) according to the share of migrant labor forces from the home country in the labor pool of the host economy.

Experiment 3: No Emission trading and liberalization (Domestic)
Both EU-15 and EU-12 countries comply with their commitments individually without relying on the use of the flexibility mechanism under both liberalization of trade and labor mobility. First, the tariff trade barriers are abolished between the EU-15 and EU-12 (import and export tariff and CET). Then, we incorporate labor flows into GTAP-E model to examine the impact of liberalizing the temporary movement of the labor mobility. Quotas on both skilled and unskilled temporary labor in the EU-15 (host region) are increased by percentage of their labor forces. This additional labor is supplied by EU-12 (home region) countries. The labor-importing region is the EU-15 and the labor types are skilled and unskilled labor, then we can shock the variable of labor force in terms of people.

Experiment 4: Emission trading among Annex-I countries and liberalization
Annex countries are allowed to trade emission in an environment of trade liberalization and labor mobility in the process of EU enlargement. This experiment may be compared to the second experiment to indicate the implications of interaction of liberalization with emissions.

4. Results

This section reports on the above simulation results for each experiment and gives their interpretations. The model was solved for these scenarios using the RunGEM of GEMPACK software packages.

We discuss the results for experiments 1-4, to indicate the impacts of trade liberalization and labor mobility under the implementation of the Kyoto Protocol.

4.1 No Flexibility Mechanism in the Pre-Enlargement of EU: Results of Experiment-1.

The first and second columns of Table-1 show the emissions reduction of the Annex block relative to the reference year levels and corresponding marginal abatement costs in the absence of the flexibility mechanism. The EU-15, in Annex-I, have reduced their emission by 22.4% to meet the target in the commitment period of 2008-2012, and the corresponding marginal abatement cost is 35.4 USD per ton of carbon. However there is not any marginal abatement cost for EU-12, due to the absence of any commitment or target. When we compare, the ratios of the required

marginal abatement costs to reduce emission by 1% for Annex countries like the USA, EU-15, Japan, and RoA1 respectively, were 1, 1.6, 2.8 and 1.2 USD per ton of carbon. We see that the lowest cost belongs to the USA while the highest cost is for Japan, due to coal usage.

The costs of the Kyoto Protocol for Annex-1 countries are implemented in terms of welfare (utility of representative household) and terms of trade. The implementations of the Kyoto Protocol, with no flexibility mechanism, have a largely negative effect on energy product prices and output producing energy sectors among Annex-1 countries (see figure A1 in appendix B). The lower prices of oil give rise to degraded terms of trade with oil-exporting countries and improved terms of trade with oil-importing countries. According to the results of Table-1, the lowered oil price leads to the improvement of terms of trade because both EU-15 and EU-12 countries are oil-importing countries. While the energy importing value for EU-15 region falls, it loses 0.4 of its welfare because of the reduced oil consumption. In contrast to the EU-15, the EU-12 region gains 0.2 % of its welfare because it has no carbon constraint to meet. Lower oil prices are likely to lead to increased oil consumption (see figure A2 in appendix B).

Table-2: Impacts of implementing of Kyoto Protocol without flexibility mechanism

Regions	Emission Reduction %	MAC USD/Ton	Welfare	Terms of Trade %
EU15	-22,4	35,39	-0,41	0,18
EU12	2,37	0	0,13	0,13
USA	-35,6	33,76	-0,37	0,26
FSU	0,97	0	-0,5	-0,86
Japan	-31,8	90,51	-0,71	0,89
RoA1	-35,7	41,87	-0,91	-0,28
RoW	1,05	0	-0,11	-0,4

4.2 Making Use of Flexibility Mechanism in the Pre-Enlargement of EU: Results of Experiment-2

In order to reduce the marginal abatement costs of the Kyoto Protocol, among the Annex-1 countries, the Protocol allows for the use of three different flexibility

mechanisms.[5] One of the flexibility mechanisms is to allow for emissions trading among Annex-I countries. Table-2 reports that emissions trading could reduce the marginal abatement costs of meeting the Kyoto targets by more than half, when we compare them with previous experiment. According to the third column of this table, if the EU-15 purchases 184 million tons of emissions permits from EU-12 and FSU, the marginal abatement cost of the EU-15 decreases from the 35.4 USD to 22.6 USD per ton of carbon. In this experiment, the EU-12 sells 156 million tons of carbon per year (the value of this trading equals to the 3.5 billion US dollars) to the other Annex-1 countries.

Table-3: Impacts of flexibility mechanism with emission trading of Kyoto Protocol

Region	Emission Reduction %	MAC USD/Ton	Emission Trading (Million tons of carbon)	Emission Trading (M USD)	Welfare %	Terms of Trade %
EU15	-16,7	22,62	-184	-4.162	-0,27	0,14
EU12	-31,8	22,42	156	3.498	0,46	0,48
USA	-27,6	22,61	-483	-10.921	-0,32	0,22
FSU	-21,9	21,89	925	20.248	2,88	-0,28
Japan	-13,7	22,63	-189	-4.277	-0,23	0,52
RoA1	-24,9	22,65	-194	-4.394	-0,69	-0,29
RoW	0,9	0		0	-0,09	-0,33

4.3.1 No Flexibility Mechanism in the Post-Enlargement of EU: Results of Experiment-3

The accession of the EU-12 to the EU-15 may affect impediments to and incentives for trade and labor migration. The principle of a single market program guarantees the freedom of trade and factor mobility to all members of EU.

The aim of this experiment is to analyze likely the impact of free trade and labor migration on the implementation of the Kyoto Protocol. Before interpreting the results of the experiment, we first indicate some important macroeconomic data for both EU-15 and EU-12, in order to compare two economies. We need the data for the GDP,

---

[5] Joint Implementation (JI) and Clean Development Mechanism (CDM) are known as the others of flexibility mechanisms of Kyoto Protocol.

capital stock, labor force, and carbon emission. In accordance with the Table-4, the EU-15 is capital intensive and EU-12 is labor intensive since the capital/labor ratios are 5.4 for EU-15 and 1.1 for EU-12.

Table-4: Macroeconomic data for EU-15 and EU-12 in base year of 2001

	GDP (M USD)	Capital Stock (M USD)	Labor Force (Million)	CO2 (Mt)	Population (Million)
EU-15	7.930	915	168	3.218	376
EU-12	415	56	52	670	105

Source: GTAP-E V.6 database

On the other hand, when the EU-12(CEEC) countries enter the EU-15 bubble and take part in European burden sharing, all the new members ratified the Protocol and agreed to reduce their greenhouse gas emissions in 2010. It is important to consider the emission reduction rate in 1990 and target emission in 2010, as the first commitment period. Table-5 gives the emission reduction and target reduction rates for both EU-15 and EU-12 countries that have ratified the Protocol during enlargement processes since 2002. Therefore the target emission reduction rate of the EU-12 has changed from hot air to -15.4% in the post-enlargement of EU.

Table-5: Emission reduction for EU in nominal and target level

	Pre-enlargement		Post-enlargement	
	Nominal	Target	Nominal	Target
EU-15	-8	-22.4	-8	-22.4
EU-12	0	0	-7	-15.4

Source: Dominique M., (1998) and own calculations[6]

The analysis in this experiment focuses on two dimensions of the EU enlargement process: i) free trade in the goods market; ii) labor mobility in the factor market

The first step of the enlargement is to abolish bilateral trade barriers such as import tariffs and common external tariffs for the EU-12 with domestic emissions reduction policies. Therefore trade liberalization is modeled as an abolishment of existing

---

[6] Let x represent the target reduction in the year of 2010, with respect to the level of emissions in 1990 and g is average growth in emissions in the baseline scenario. The percentage reduction in emissions in 2010, with respect to the baseline (or BaU) level of emissions is given by formula, E1BaU $=(1+g)20E0$ and $E1^*=(1-x)E0$ target were calculated by the ratio of $E1^*/E1BaU-1$

tariffs on importing and exporting goods between EU-15 and EU-12 countries, as well as CET policy for EU-12. It is assumed that trading conditions with other regions remain unchanged.

Table-6 shows that CEEC enlargement of the EU, with and without trade liberalization, leads to decreased industry output (qo) of all sectors for the EU-15 and EU-12, in a range of 0.2 and 53.8 percent, with the exception of energy intensive sectors in the EU-12. The increase in output of energy intensive sectors of EU-12 is 1.3% with no trade liberalization, and 7.0% with free trade. This might be explained as a consequence of increase in the imports of the EU-15, due to the increased competitiveness of energy intensive industries in the EU-12

Table-6: Impact of liberalizing trade between the EU-15 and EU-12 and implementing the Kyoto Protocol: Change in output, export, and import

	No Trade Liberalization			Trade Liberalization		
	Output qo	Export qxw	Import qim	Output Qo	Export qxw	Import qim
Agriculture						
EU-15	-0,5	-1	0,1	-0,5	0	0,6
EU-12	-0,2	1	-0,8	-0,4	18,6	11,75
Coal						
EU-15	-42,5	-5,7	-31	-42,5	-5,7	-31
EU-12	-23,7	-25,5	12,3	-24	-24,8	12,5
Oil						
EU-15	-7,7	-11,2	-5,4	-7,6	-11,2	-5,3
EU-12	-5,8	-19,6	-2,2	-5,8	-17,9	-3,7
Gas						
EU-15	-14	181,9	9	-14	182	9
EU-12	-53,4	4,3	7,8	-53,8	15,4	7,5
Oil Products						
EU-15	-5,3	-7,1	-8,1	-5,2	-6,8	-8
EU-12	-2,6	-8	-4	-3,9	-10	1,7
Electricity						
EU-15	-7,3	-11,1	-6,5	-7,3	-11,2	-6,5
EU-12	-3	3	-5,1	-2,8	3,3	-4,9
Energy Intensive						
EU-15	-2,3	-3,4	-0,3	-2,9	-4	0,1
EU-12	1,3	3,8	-0,7	7	24,4	4
Other Industry						
EU-15	-0,4	-0,8	-0,2	-0,4	-0,7	-0,1
EU-12	-0,2	-0,5	-0,3	-0,4	3,6	3,9

According to Table-7, the increase in labor supply for the EU-15, due to the increasing 2% labor quota, reduces the real wages of unskilled and skilled labor, -1.25% and -1.29% respectively. But, the real wages of unskilled labor increases 3.0%, skilled 7% for the EU-12. Although the reduction of real wages for EU-15 leads to the degradation of terms of trade, imposing carbon constraint improves the terms of trade by decreasing international oil prices. The greatest trade gains occur for labor-exporting and net-energy importing countries.

Table-7: Impact of labor mobility: change in welfare, term of trade and wages

	Welfare	Terms of Trade	Real Wages	
			Skilled	Unskilled
EU-15	-2,04	0,07	-1,25	-1,29
EU-12	7,43	0,97	6,97	3,04

The second dimension of the enlargement process involves incorporating the mobility of labor into the model. It is assumed that 2% percent of the labor force in the EU-12 migrates from a labor exporting or supplying region to the EU-15, which is a labor importing region. In the results of this experiment, factor labor is mobile and free trade, under constraint production derived from the Kyoto Protocol, is presented in the last columns of Table-8. Here, we compare environmental constraints to the Kyoto target of carbon emissions with and without free trade and labor mobility.

Increases in production, due to the supply of labor and changes in production patterns in the direction of using more energy commodities, result in increased marginal abatement costs of only 1.4 USD per ton of carbon for the EU-15. In addition to the marginal abatement cost, the reduction in real wages by increasing the supply of labor and means losses in terms of trade (TOT) from 0.18 to 0.1. Despite free trade, the labor mobility causes the cost of implementing of Kyoto to increase from 0.41 to 2.0 percent in terms of household utility (u). The marginal abatement cost decreasing from 7.15 to 6.87 USD per ton of carbon results in decreasing production for the labor exporting EU-12 countries. The net energy importing and labor exporting of the EU-12 gain 7.1% welfare, due to the increases in real wage and improvements in terms of trade.

Table-8: Impacts of liberalization trade and labor mobility on the implementing Kyoto Protocol without flexibility mechanism (domestic abatement policies)

Region	Emission Reduc. %	No Liberalization			Trade Liberalization			Labor Mobility & Trade Lib.		
		MAC $/Ton	u %	Terms of Trade %	MAC $/Ton	u %	Terms of Trade %	MAC $/Ton	u %	Terms of Trade %
EU15	-22,4	35,5	-0,41	0,18	35,5	-0,4	0,21	36,87	-2,01	0,1
EU12	-15,4	7,15	-0,03	0,18	7,59	-0,35	-0,35	6,87	7,14	0,44
USA	-35,6	33,77	-0,37	0,26	33,8	-0,37	0,25	33,76	-0,36	0,28
Russia	1,08	0	-0,5	-0,87	0	-0,46	-0,78	0	-0,45	-0,77
Japan	-31,8	90,52	-0,71	0,89	90,5	-0,71	0,89	90,49	-0,71	0,9
RoA1	-35,7	41,93	-0,91	-0,27	41,9	-0,91	-0,28	41,94	-0,9	-0,24
RoW	1,1	0	-0,11	-0,4	0	-0,11	-0,4	0	-0,1	-0,37

Table-9 presents changes in production patterns of both EU-15 and EU-12 under free trade, with labor mobility scenarios. The shares of production for agriculture and energy commodities increase for the EU-15. Compared to the absence of liberalization, with trade liberalization and labor mobility, the share of production for agriculture, coal, oil, electricity, energy intensive industries, and other industries and services, increases for the EU-15, while the share of production for agriculture, gas, energy intensive industries, and other industries and services, decreases for the EU-12. Therefore, the marginal abatement cost curve for the EU-15 will be steeper and shifted towards upward, because production increases and also the EU-15 countries are more carbon intensive. However, the marginal abatement cost curve for the EU-12 shifts towards downward because of the decreasing labor supply, which decreases production, and the EU-12 countries are becoming less carbon intensive, as shown in figure A3 in appendix C.

Table-9: Impact of liberalization on production pattern change: change in share of firms demand for intermediate input

	Agriculture	Coal	Oil	Gas	Oil Products	Electricity	Energy Intensive Industries	Other Industries and Services
No liberalization								
EU-15	14,6	8,8	5,1	6,9	33,3	19,7	16,1	24,2
EU-12	4,6	5,2	0,5	0,7	2	2,6	2,6	1,9
Others	80,8	86	94,4	92,4	64,7	77,7	81,3	73,9
Liberalization Trade and labor Mobility								
EU-15	15	9,7	5,2	3,6	33,1	19,9	16,3	24,5
EU-12	4,2	5,2	0,5	0,1	2	2,6	2,5	1,7
Others	80,8	85,1	94,3	97,3	64,9	78,5	81,2	73,6

Source: Own calculations from adjusted GTAP-E database V.6

4.3.2 Emission Trading in the Post-Enlargement of EU: Results of Experiment-4

In this experiment, the Annex-1 countries are allowed to trade with their carbon allowances; first with trade liberalization, in terms of removing tariffs, and then labor mobility from the EU-12 to EU-15, in terms of reduced labor quotas at the border. The results of the experiment are presented in Table-10.

The Table-10 shows that the flexibility of meeting the Kyoto targets allows the price of the permit to be lower than in the case with no trading. The impact of enlargement or integration to the EU, without the flexibility mechanism of the Protocol on marginal abatement cost, and the costs of implementing in terms of welfare and terms of trade, are not substantial. If the emission trading among Annex-1 countries are compared with the domestic emission reduction policies, the usage of energy goods having different emission factors changes due to the change in relative prices. When we compare the result of this experiment with that of experiment-3, we see that emissions trading reduces the burden of emission reduction in all Annex-1 countries. In addition, it lowers the losses of reduction of emission in energy exporting countries because of the coal substituted for oil in hot air countries like the EU-12 and FSU. The smaller decline in oil prices leads to more loss in terms of trade in energy importing countries and more gain in terms of trade in energy exporting countries.

Table-10: Impacts of liberalization trade and labor mobility on the implementing of Kyoto Protocol with flexibility mechanism (emission trading)

Region	Emission Reduc. %	No Liberalization			Trade Liberalization			Trade Liberalization & Labor Mobility		
		MAC $/Ton	u %	Terms of Trade %	MAC $/Ton	u %	Terms of Trade %	MAC $/Ton	u %	Terms of Trade %
EU15	-22,4	23,03	-0,3	0,14	23,1	-0,26	0,17	23,2	-1,87	0,06
EU12	-15,4	23,04	0,2	0,49	23,1	-0,11	-0,06	23	7,44	0,76
USA	-35,6	22,84	-0,3	0,22	23,1	-0,32	0,22	23,2	-0,32	0,25
FSU	18	22,29	2,96	-0,28	22,3	3	-0,19	22,4	3,04	-0,17
Japan	-31,8	23,06	-0,2	0,53	23,1	-0,23	0,53	23,2	-0,23	0,54
RoA1	-35,7	23,07	-0,7	-0,3	23,1	-0,7	-0,3	23,2	-0,69	-0,26
RoW	0,96	0	-0,1	-0,33	0	-0,09	-0,33	0	-0,08	-0,3

Since emission trading among Annex-1 countries reduces carbon prices, it leads to losses of the comparative advantage for energy intensive sectors in the EU-12. Furthermore trade liberalization between the EU-12 and EU-15 shows very slight impacts on the cost of implementing Kyoto through emissions trading, in terms of marginal abatement costs and the utility of households. Although abolishing tariffs and increasing labor supply give rise to the increased production, reducing emissions constraints reduce production whereas emissions trading lower the reduction of production for the EU-15 in post-enlargement. The net effect of liberalization on production for energy intensive, agriculture, and other industries and services is positive, which means production in these industries increases. However, the EU-15 countries lose welfare by means of decreased real wages, with respect to the improvement in terms of trade. However, increased real wages resulting from the decreased labor supply leads to the increased welfare for the EU-12.

According to Table-11, the EU-12 and the FSU countries are the suppliers of the emission permits on the world market. The EU-15 and other Annex-1 countries reduce marginal abatement costs by using emissions trading flexibility mechanisms of Kyoto Protocol. Since the enlargement process affects meeting the Kyoto targets, the supply of EU-12 emissions permits decreases from 152 to 114 million tons of carbon in the process of the EU's post enlargement. If we consider free trade with the labor mobility scenario, the supply of emissions permits for EU-12 increases from 114 to 127 million tons of carbon, because of the change in both quantity and pattern

of production or consumption. The loss of 13 million tons of carbon emission permits regain due to the liberalization of the enlargement of the EU. On the other hand, the EU-15 countries have to purchase 183 million tons of carbon from EU-12 and FSU in pre-enlargement. The required emissions permit of the EU-15 to meet the targets of the Protocol under the free trade and the labor mobility increases by 24 million tons of carbon. Even if the EU-15 countries want to buy all of the emission permits of EU-12, it has to purchase an additional 80 million tons carbon from FSU.

Table 11: Impact of liberalization on carbon trading (million tons of carbon)

| Region | Pre-enlargement | Post-enlargement | | | |
	No Lib.	No Lib.	Trade Lib.	Labor Mobility	Trade Lib. & Labor Mobility
EU-15	-183	-180	-180	-205	-207
EU-12	152	114	114	125	127
USA	-481	-469	-469	-461	-463
FSU	924	948	947	949	957
Japan	-186	-187	-187	-195	-188
RoA1	-193	-191	-191	-189	-190

Of course, due to Article 4.4 of the Protocol, the EU-15 has to stick to its own bubble. However, nothing prevents it from forming an implicit EU bubble, including Central and Eastern countries by including them to form a bubble of their own and transfer the surplus to the EU-15. Similarly, EU-12 countries should form a bubble of their own to co-ordinate emission permit transfers to the EU. This would reduce the trading emission permits by about 60%.

5. Discussion and Conclusion

The aim of this paper is to analyze the impact of free trade and factor labor mobility on environmental policies under the Kyoto Protocol, between the EU-15 and the EU-12 in the process of EU enlargement. The environmental policies are only domestic carbon abatement policies and emissions trading, or cap and trade, within Annex-1 countries in this paper. The other flexibility mechanisms derived from the Kyoto Protocol known as the Clean Development Mechanism (CDM) and Joint Implementation (JI) are not used.

Different environmental policies, based on the Kyoto Protocol, may be examined by using the standard GTAP-E model. However we intend to examine these environmental policies together with the process of fifth round of EU enlargement. On one hand, CEEC countries (EU-12) had to ratify the Kyoto Protocol while they were incorporated into the EU-15, meanwhile, the accession of twelve Central and

Eastern European countries (CEEC) to the European Union in 2004 have brought about some important economic policies. The old and new members removed barriers to trade. By 2011, the migration of labor will also be free. Many other issues related to the enlargement of the EU, such as capital mobility, procompetitive effects, and financial aids, have not been discussed in this paper.

There are also many elements which are not part of GTAP-E, but are important parts of the greenhouse warming issue. For example non CO_2 greenhouse gases, such as Nitrous Oxide, Ozone and Methane are not included in the database.

It is demonstrated that the standard GTAP-E model and database may be adjusted to address trade liberalization and factor mobility policy questions of EU enlargement. Both model structure and several illustrative policy experiments are described, in order to show the effects of free trade, the mobility of factors on production and international trade in the light of the enlargement of the EU under the constraint of production, as well as the comparison of the impacts of abatement cost and welfare between the pre-enlargement and post-enlargement of the EU.

In contrast to the pre-enlargement, the EU-12 countries have to meet the commitment of the Kyoto Protocol in the process of EU enlargement. The enlargement process increases the costs of implementing Protocol for EU-12, in terms of the utility of representative households, due to the reduction of energy consumption. EU-12 countries, like EU-15 countries, are net energy importing countries. Therefore, under free trade, the reduction of the cost of implementing for EU-12 countries increases because of the degradation of terms of trade by the mitigation in reduction of energy prices, particularly oil prices.

Depending on the increase in production due to the increased supply of labor, the marginal abatement cost increases in the no-trade case for the EU-15, under free trade with the factor labor mobility scenario. However, EU-12 experiences the opposite effects in this scenario. The net energy and labor importing countries, the EU-15 countries, have high costs for implementing the Kyoto Protocol in terms of utility of representative household, due to the reduced real wage and degradation of terms of trade. The net energy importing and labor exporting countries, the EU-12 countries, have low cost of implementing Kyoto. The impact of factor labor mobility is stronger than the impact of trade liberalization in the Kyoto Protocol.

If we use emission trading among Annex-1 as flexibility mechanisms of the Protocol, the carbon price or marginal abatement cost of both EU-12 and EU-15 decreases by 60% with respect to the no-flexibility or no-trade case. Such low carbon prices give rise to shifting the burden of reduction from oil towards coal and also they cause to mitigate the fall of oil prices in favor of oil exporting countries. The liberalization of trade insignificantly affects the cost of implementing Kyoto with emissions trading. However, the liberalization of trade together with the labor mobility increases the

production and carbon emission and decreases the real wage due to the increased supply of labor for EU-15 and opposite effects occur for the EU-12.

Acknowledgements

References

Armington, P.S., 1969. A Theory of Demand for Products Distinguished by Place of Production, IMF Staff Papers 16, 159-178.

Baldwin, R.E., J.F., Francois, R., Portes, 1997. The costs and benefits of eastern enlargement: the impacts on the EU and Central Europe. Economic Policy 24, 127–176.

Bandyopadhyay, S., S., Lahiri and S. Roy, 2008. Enlargement and Common External Tariff in a political-economic model of customs union. Working Paper 2008-022A, Research Division, Federal Reserve Bank of St Louis.

Barrell R., J., FitzGerald and R., Riley 2007. EU enlargement and migration: Assessing the macroeconomic impacts. National Institute of Economic and Social Research, London Economic and Social Research Institute, Dublin NIESR Discussion Paper No. 292

Bottasso, A., and A., Sembenelli, 1998. Market power, productivity and the EU Single Market Program: An Ex-Post assessment on Italian firm level data. FEEM Working Paper ETA 17.98.

Burniaux, J. and T. Truong 2002. GTAP-E: An Energy-Environmental version of the GTAP Model. GTAP Technical Paper No. 16, Center for Global Trade Analysis, Purdue University, West Lafayette, IN.

Breuss, F., 2002. Benefits and dangers of EU enlargement. Empirica 29, 245–274.

Brockmeier, M., C.A., Herok, P.B., Salamon, 2001. Technical and institutional changes in an enlarged EU: Welfare effects for old and new members with a focus on the agri-food chain, Conference Paper at the Fourth Annual Conference on Global Economic Analysis, West Lafayette.

Dimaranan, B.V., and R.A., McDougall, 2005. Global trade, assistance, and production: The GTAP 6 Data Base, Center for Global Trade Analysis, Purdue University.

Dominique V.M., 1998. A (Preliminary) Analysis of the Kyoto Protocol: Using the OECD GREEN Model, OECD Development Centre.

European Commission, 2006. Report on the functioning of the transitional arrangements set out in the 2003 Accession Treaty (period 1 May 2004–30 April 2006), European Commission, and Brussels.

Hertel, T. W. (editor) 1997. Global Trade Analysis: Modeling and Applications, Cambridge University Press.

Löschel, A., and M., Mraz 2001. EU enlargement policy. ZEW Discussion Paper No. 01-52, Mannheim.

Mansoor, A., Quilin, B., 2006. Migration and remittances: Eastern European and the Former Soviet Union, Worldbank publication.

Michaelowa, A., and B.Regina, 2001. Implications of EU enlargement on the EU greenhouse gas bubble and internal burden sharing. International Environmental Agreements: Politics, Law and Economics 1: 267–279.

Niebuhr, A., and Stiller, S., 2004. Integration and labor markets in European border regions. HWWA Discussion paper, 284, Hamburgisches Welt-Wirtschafts-Archiv (HWWA), Hamburg Institute of International Economics.

OECD, 1999. Action against Climate Change: The Kyoto Protocol and Beyond.

Sinn, H. 1999. EU enlargement, migration and lessons from German Unification, CEPR Discussion Paper 2174.

Walmsley, T.L., S. A., Ahmed and Christopher R. P. 2006. The GMig2 data base: A Data base of bilateral labor migration, wages and remittances. GTAP Research Memorandum, 6, Center for Global Trade Analysis, Purdue University, IN, USA.

Walmsley, T.L., L. Alan Winters, and S. Amer Ahmed 2007. Measuring the impact of the movement of labor using a model of bilateral migration flows, GTAP Technical Paper No. 28, Center for Global Trade Analysis, Purdue University, West Lafayette, IN, USA.

Walmsley, T.L. and L.A. Winters 2005. Relaxing the restrictions on the temporary movement of natural persons: A Simulation analysis, Journal of Economic Integration, December, 20(4).

Wilhelmsson, F., 2006. Trade creation, diversion and displacement of the EU enlargement process. Unpublished manuscript. Department of Economics Lund University.

Walmsley, T., S.A., Ahmed and C., Parsons, 2005. The Impact of liberalizing labor mobility in the Pacific Region. GTAP Working Paper No.31 revised 2009.

Xueqin, Z., E.Ierland, 2006. The enlargement of the European Union: Effects on trade and emissions of greenhouse gasses. Ecological Economics 57, 1-14
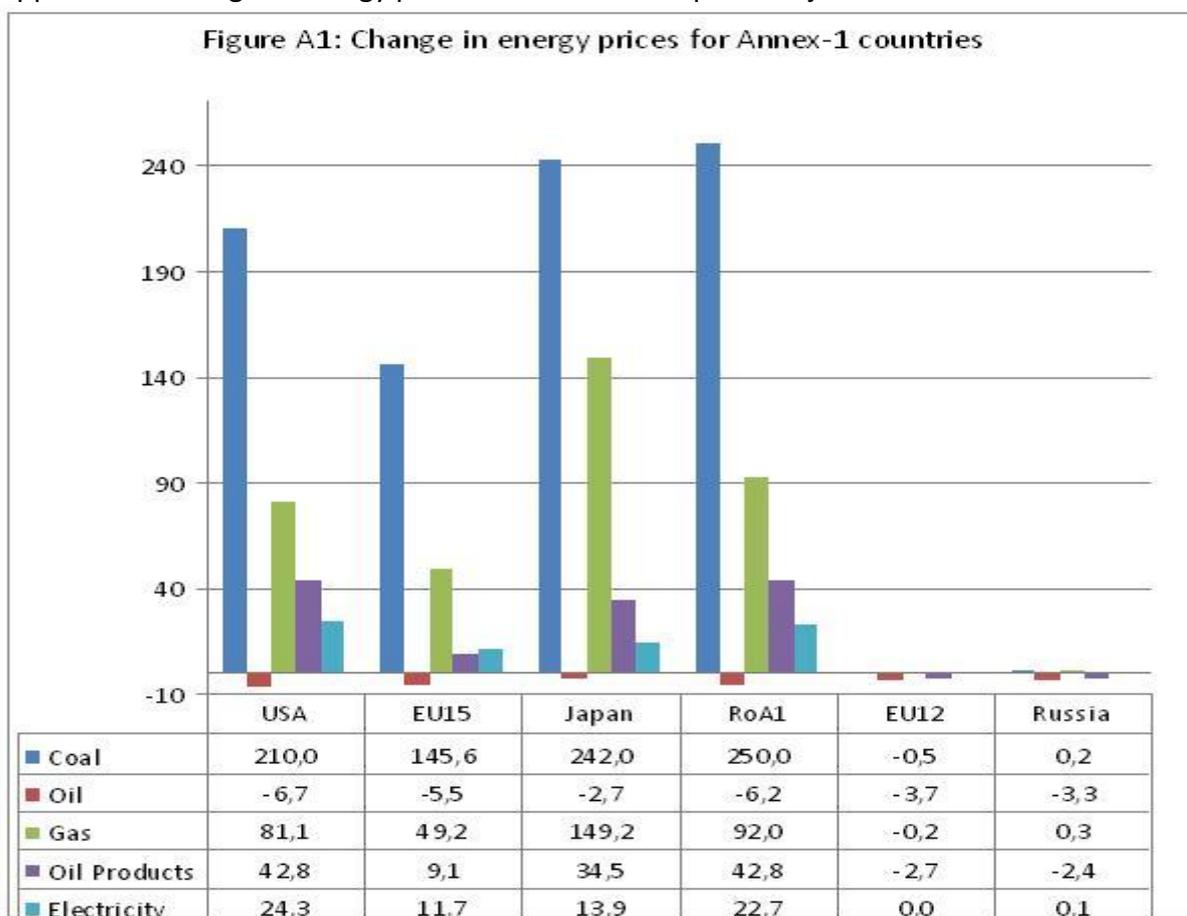
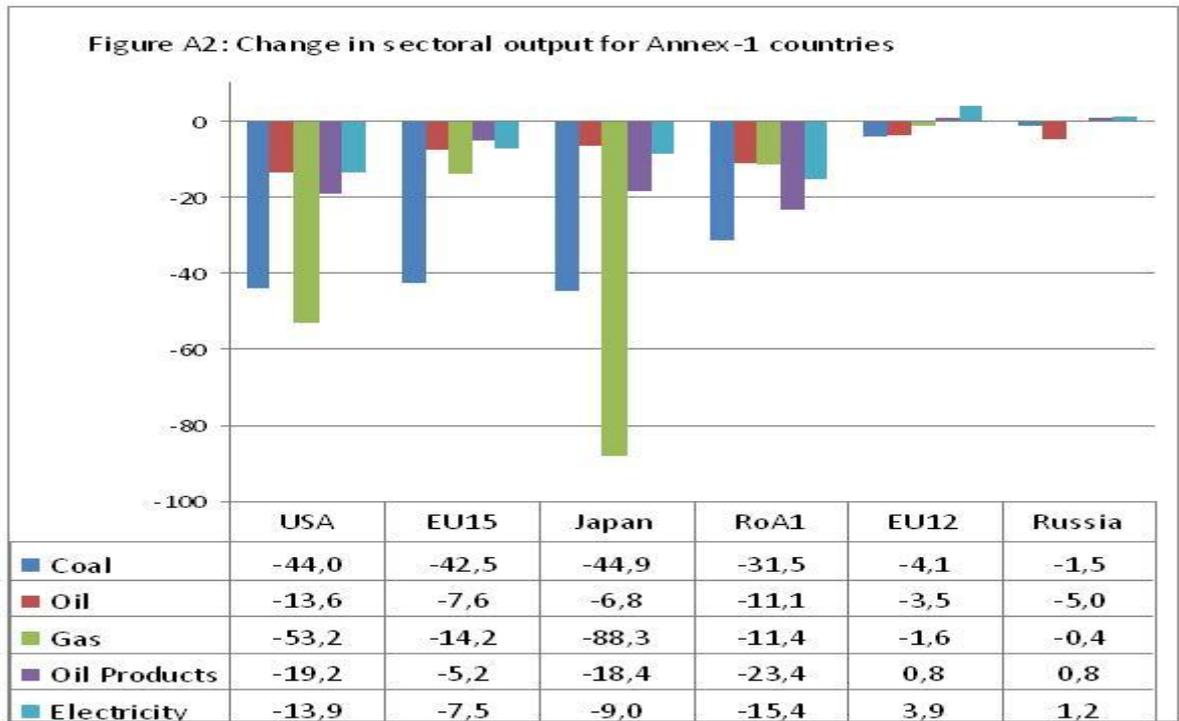Appendix A: Aggregation of regions and sectors

Table A1: Sectoral aggregation

No	New Code	Sectoral Description	Name of Sectors
1	Agriculture	paddy rice; wheat; cereal grains nec; vegetables, fruit, nuts; oil seeds; sugar cane, sugar beet; plant-based fibers; crops nec; bovine cattle, sheep and goats; animal products nec; raw milk; wool, silk-worm cocoons; forestry; fishing.	Agriculture
2	Coal	Coal Mining	Coal Mining
3	Oil	Crude oil Extraction	crude oil Extraction
4	Gas	Gas manufacture, distribution.	Natural gas extraction
5	Oil_Pcts	petroleum, coal products.	Refined oil products
6	Electricity	Electricity	Electricity
7	En_Int_ind	minerals nec; chemical, rubber, plastic prod; mineral products nec; ferrous metals; metals nec.	Energy intensive industries
8	Oth_ind_ser	bovine cattle, sheep and goat ; meat products; vegetable oils and fats; dairy products; processed rice; sugar; food products nec; beverages and tobacco products; textiles; wearing apparel; leather products; wood products; paper products, publishing; metal products; motor vehicles and parts; transport equipment nec; electronic equipment; machinery and equipment nec; manufactures nec; water; construction; trade; transport nec; water transport; air transport; communication; financial services nec; insurance; business services nec; recreational and other service; public admin. and defense, education; ownership of dwellings.	Other industries and services

Table A2: Regional aggregation

No	Code	Regional Description
1	USA	USA
2	EU-15	Austria, Belgium, Denmark, Finland, France, Germany, United Kingdom, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden
3	EU-12	Czech Republic, Estonia, Hungary, Poland, Slovenia, Malta, Cyprus, Bulgaria, Latvia, Lithuania, Romania, Slovakia
4	Japan	Japan
5	FSU	Former Soviet union
6	RoA1	Australia, Canada, New Zealand, Switzerland, reset of the ETFA
7	Row	Rest Of the World

Appendix B: Change in energy prices and sectoral output in adjusted GTAP-E model

Figure A1: Change in energy prices for Annex-1 countries

	USA	EU15	Japan	RoA1	EU12	Russia
Coal	210,0	145,6	242,0	250,0	-0,5	0,2
Oil	-6,7	-5,5	-2,7	-6,2	-3,7	-3,3
Gas	81,1	49,2	149,2	92,0	-0,2	0,3
Oil Products	42,8	9,1	34,5	42,8	-2,7	-2,4
Electricity	24,3	11,7	13,9	22,7	0,0	0,1

Figure A2: Change in sectoral output for Annex-1 countries

	USA	EU15	Japan	RoA1	EU12	Russia
■ Coal	-44,0	-42,5	-44,9	-31,5	-4,1	-1,5
■ Oil	-13,6	-7,6	-6,8	-11,1	-3,5	-5,0
■ Gas	-53,2	-14,2	-88,3	-11,4	-1,6	-0,4
■ Oil Products	-19,2	-5,2	-18,4	-23,4	0,8	0,8
■ Electricity	-13,9	-7,5	-9,0	-15,4	3,9	1,2

Appendix C: MAC curve for EU-15 and EU-12

Figure A3: MAC curve for EU-15 and EU-12