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Carbon Leakage and a Post-Kyoto Framework

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CONTENTS

ABSTRACT

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In this paper, we use the concept of carbon leakage to evaluate the effectiveness of a Kyoto-type international framework as an international mitigation abatement framework. By using a dynamic computable general equilibrium model, we estimate the carbon leakage rate, and by using the decomposition method, we analyse the actual mechanism of carbon leakage.

The United States (USA) is estimated to be the biggest contributor to carbon leakage in 2020, but the contribution in 2020 (USA, 17.29%) is slightly lower than in 2010 (USA, 18.21%). On the other hand, China (CHN, 6.73% in 2010 and 7.90% in 2020) and other Asia (ASA, 5.69% in 2010 and 6.21% in 2020) increase their carbon leakage share. China is expected to continue with its high level of economic growth and China's economic and energy consumption share in the world will increase as well. As a result, carbon leakage to China will more readily occur.

We, therefore, need to change the way to control greenhouse gas emissions by moving from a reduction target to more fully embracing the polluter-pays-principle (PPP).

1. Introduction

Global atmospheric concentration of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years. The IPCC Fourth Assessment Report (FAR) concludes that most of the observed increase in globally averaged temperatures since the mid-20th century is ***very likely*** due to the observed increase in anthropogenic greenhouse concentration. This is an advance since the TAR's conclusion that "most of the observed warming over the last 50 years is ***likely*** to have been due to the increase in greenhouse gas concentrations" (IPCC, 2007).

To stabilise carbon concentration, the Kyoto Protocol on climate change was established as a framework and initial commitments period for 2008-2012, require a 5% reduction in collective industrialised country emissions from 1990.

The Kyoto Protocol is a innovative framework to control global carbon emissions by setting carbon reduction targets for each country. However, the United States which is the world's ***current*** biggest GHGs emitting country, has withdrawn from the Kyoto Protocol and China, which is the ***future*** biggest GHGs emitting country, will not join the carbon reduction group unless China achieves a medium level of economic growth. Without the participation of these giants, it is questionable whether a Kyoto-type international GHG reduction framework can contribute to global carbon emission reduction. Whilst the US and China refuse to participate in the framework, international debates on a post-Kyoto framework are being led by the EU. The EU is very keen to continue with a Kyoto-type international framework. Although the debates on a post-Kyoto framework are ongoing, the potential implications of any agreement on both national and international economies cannot be ignored. This is particularly important from a Japanese perspective since it was so badly caught out by the original Kyoto target.

In this paper, we use the concept of carbon leakage to evaluate the effectiveness of a Kyoto-type international framework as an international mitigation abatement framework. By using a dynamic computable general equilibrium model, we estimate the carbon leakage rate and by using a decomposition method, we analyse the actual mechanism of carbon leakage.

2. Methodology

To assess the effectiveness of the Kyoto-type international framework to control global carbon emission, we employ a computable general equilibrium model. The model is based on GTAP-E[1] model, which was originally developed by Dr. Truong, University of New South Wales. The GTAP-E model is a static CGE model and it can only calculate differences between one equilibrium and another equilibrium. The model cannot illustrate the transition from one equilibrium to another equilibrium. A static CGE model cannot forecast the future. For example, the world economic structure in 2010 will differ from that in 2020. However the static CGE model cannot reflect the differences between 2010 and 2020 and it assumes that economic structure are unchanging. Hence, a static CGE model is suitable for analysing short-term issues, but is not suitable for evaluating long-term issues, such as climate change. To overcome the weaknesses of static CGE model, we make the GTAP-E model dynamic.

[1] For in-detailed information, please refer to Burniaux, Jean-Marc and Truong Truong (2002).

2.1. Modification of the "Static "GTAP-E to a Dynamic GTAP-E model

This is our major contribution to the modification of the model. New variables and equations were added to GTAPE to simulate simple dynamic behaviour. These allowed us to run linked annual simulations for each year between 1997 and 2020. For each region, the new equations:

- linked net investment in each year to the change in the capital stock for that year.
- allowed employment to respond temporarily to changes in real wage rates.
- allowed rates of return to capital to respond temporarily to changes in demands for capital.

In the long run, all three dynamic equations reduce to simpler forms: investment moves in proportion to capital stock; and employment and rates of return converge to baseline trend levels.

2.1.1. Accumulation equation for Capital

There is no "gestation lag" - new investment increases capital in the same period.

	$\Delta K = Y - D.K^0$	Y = gross investment
so	$\Delta K = \Delta Y + Y^0 - D.K^0$	
but	$\Delta K = 0.01*K.k$ and $\Delta Y = 0.01*Y.y$	
so	$K.k = Y.y + 100*[Y^0 - D.K^0]\Delta T$	$\Delta T=1$
so	$k = [Y/K].y + 100*[Y^0/K - D.K^0/K]\Delta T$	$\Delta T=1$
or	$k = Accum1.y + 100*Accum2.\Delta T$	

where Accum1 is initially Y^0/K^0 and is updated by (y-k)
and Accum2 is initially $[Y^0/K^0 - D]$ and is updated by (-k)

2.1.2. Employment adjustment equation for Labour

Employment [relative to the base scenario] is allowed to increase temporarily in response to real wage increases [relative to base]. Let:

E = employment/(employment in base scenario)
W = CPI-deflated wage/(CPI-deflated wage in base scenario)

We set:

$$\Delta E = A2*\Delta W + A1*[1-E]]\Delta T \qquad \Delta T=1$$

A1 and A2 are adjustment speeds; we set the A1 to 0.8 and the A2 to 1. The A1 term acts to continually force E towards 1; The A2 term allows for real wage increase (relative to the base) to temporarily increase labour supply.

2.1.3. Rate of Return adjustment equation for Capital

We define R (gret) as a gross real rate of return: the unit capital rental deflated by the cost of a new unit of capital. Note that we can think of ΔR as the change in either the gross or the net rate of return. R [relative to the base scenario] is allowed to increase temporarily in response to an increase in demand for capital [relative to the base], but in the longer run capital stocks must adjust to restore base scenario rates of return. Let:

E = capital stocks/(capital stocks in base scenario)
W = R/(R in base scenario)

We set:

$$\Delta W = A2*\Delta E + A1*[1-W]]\Delta T \qquad \Delta T=1$$

A1 and A2 are adjustment speeds; we set the A1 to 1 and the A2 to 3. The A1 term acts to continually force W towards 1; The A2 term allows increased capital demands (relative to base) to temporarily increase rates of return.

2.1.4. Endogenous Technical Change

To make the "static" GTAP-E dynamic, the following two types of technical change are incorporated.

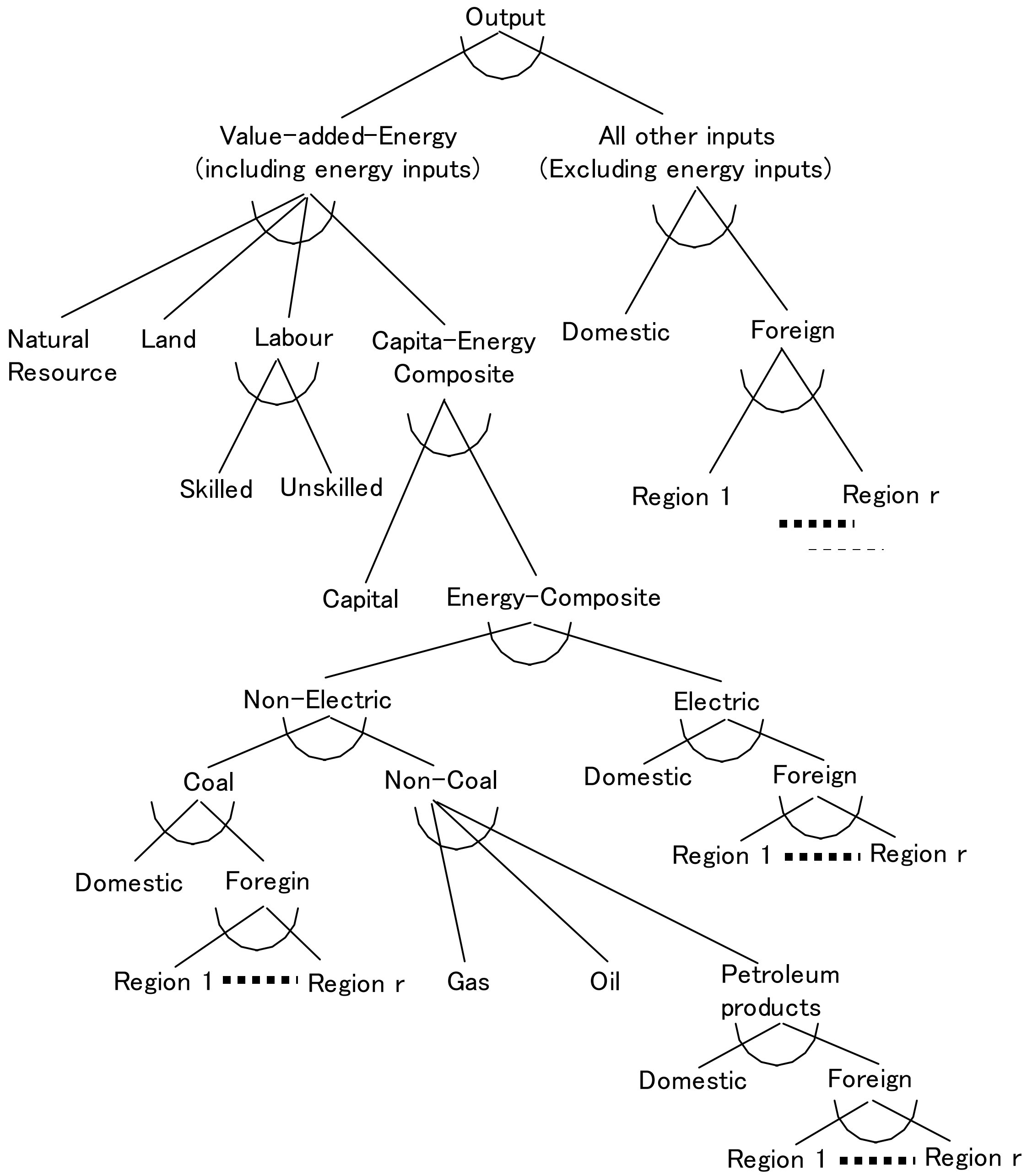
1) Factor-Substitution

The estimation of key elasticities unavoidably involves some combination of substitution possibilities available today and thus changes in relative prices lead to shifts in production that imply some new technology – and thus endogenous change. This will occur, for example, in the substitution between energy and non-energy or between carbon-intensive energy and less carbon intensive energy in response to rising relative fuels prices or carbon tax on energy usage. In the dynamic GTAP-E model, the following substitutions are incorporated as shown in Figure 1; 1) substitution between Value-added-Energy and All other inputs, 2) substitution among labour, land, natural resources and capital-energy composite, 3) substitution between skilled and unskilled labour, 4) substitution between capital and energy, 5) substitution between electricity and non-electric energy, 6) substitution between coal and non-coal fuel, 7) substitution among gas, oil and petroleum products.

2) Capital Accumulation

Capital accumulation tends to lower the cost of capital and thus to create substitution toward capital and away from energy.

Figure 1: GTAP-E Production Structure



Source: Burniaux and Truong (2002)

2.2. Database

In this study, we use 11 regions and 16 sectors database, which are based on the GTAP Database version 5. The GTAP Database is the global database produced by the Centre for Global Trade Analysis, Purdue University, the United States and is updated continually. GTAP Database Version 5 is the latest version and the main data file is a representation of the state of the world economy in 1997. It represents the world economy as a system of flows of goods and services, measured as money values, in millions of 1997 US$. These flows include both input-output flows within each region and bilateral international trade flows. Since most flows are measured at both tax-free and tax-paid prices, it also implicitly covers indirect taxation. The energy volume data file contains data on energy purchases by firms and by households and bilateral trade of energy products.

In the standard database, there are 66 regions and 57 traded commodities.

Figure 2: Categorisation of Regions/Countries

	Description
ANZ	Australia and New Zealand
CHN	China (include Hong Kong)
JPN	Japan
KTW	Korea and Taiwan
THA	Thailand
ASA	Other Asian Countries
USA	United States
CAN	Canada
EU	EU
FSU	Former Soviet Union
ROW	Rest of the World

Source: Fujitsu Research Institute (FRI)

Figure 3: Categorisation of Sectors

	Description
AGR	Agriculture
COL	Coal
OIL	Crude Oil
GAS	Gas
GDT	Gas Distribution
P_C	Petroleum Products
ELY	Electricity
MIN	Mineral
PPP	Paper, Pulp and Publishing
CRP	Chemical, Rubber and Plastic
I_S	Iron and Steel
MTL	Non-ferrous Metal
VEH	Motor Vehicle
OMN	Other Manufacturing
TRP	Transportation
SERV	Service

Source: Fujitsu Research Institute (FRI)

2.3. Baseline Scenario

In generating the baseline projection, we use forecasts for key supply-side macroeconomic variables and assumptions for changes in import protection and export taxes based on data provided by Terrie Walmsley, a researcher associated with the GTAP project. These forecasts are recent versions of those documented in Walmsley et al. (2000).

3. Kyoto Protocol and Carbon Leakage

The Kyoto Protocol, which defines GHGs emission targets for Annex countries, was made in 1997. The Kyoto Protocol requires Annex countries to meet pre-determined absolute emission targets for five years, ending in 2012. One option for a Post-Kyoto Framework is to continue the Kyoto Protocol beyond 2012 (Kyoto Forever Scenario), because consistency is very important, especially to tackle longer term issues like climate change. In this section, we evaluate the Kyoto Forever Scenario to clarify whether the Kyoto Protocol is a still useful tool or not as a climate change mitigation option and whether the Kyoto Protocol is a bad deal or not for Japan.

To conduct the analysis, we have used the dynamic CGE model. In undertaking the analysis we have to recognise that the US has decided to withdraw from the Kyoto Protocol and Australia followed the US lead. In addition, developing countries have no binding emission limit targets. Hence, we assume that the US, Australia and developing countries do not have any binding targets for GHG emissions and Japan, the EU and Canada will stabilise their emissions at the Kyoto target from 2008 until 2020.

To increase the efficiencies of GHG abatement strategies it is necessary to minimise the rate of carbon leakage. The leakage of GHG emissions out of the regulatory framework established by the Kyoto Protocol has the potential to undermine the credibility of the agreement if the leakages are of such significance that they are perceived to undermine international co-operation. In this section first of all, we explain the mechanisms of carbon leakage. Secondly, we outline a decomposition method of carbon leakage that we use to understand the causes of the potentially high carbon leakage rate under the Kyoto Protocol.

3.1. Mechanism of Carbon Leakage

As part of the United Nations Framework Convention on Climate Change (UNFCCC) the Kyoto Protocol was signed in 1997. The Protocol calls for industrialised countries, so called Annex countries to limit their greenhouse gas emissions during the first commitment period, from 2008 until 2012. Developing countries have not committed themselves to reduce their greenhouse emissions because it is recognised that in historical terms they have made minor contributions to global carbon dioxide concentrations. Whilst on grounds of equity and expediency the distinction between the industrialised countries that have signed up to the Kyoto Protocol and developing countries is sensible, there is, nevertheless, the potential for carbon leakage to occur between the two. This is where the unilateral carbon emissions abatement activities of industrialised countries might result in a movement of carbon emissions into regions with no carbon restrictions. This effect is called 'Carbon Leakage'.

There are two major paths for carbon leakage. The first one arises from change in demand on global fossil fuel markets. Here carbon abatement commitments decrease the demand for fossil fuels in the Annex countries. This may in turn lead to lower international prices for fossil fuels and hence increases in fossil-fuel demand and emissions in the non-Annex countries. The change in non-Annex countries energy demand (and their fuel mix) depends on fossil fuel prices and substitution possibilities. Different fossil fuels have a different carbon content per calorie. So, for example, the Kyoto agreement might cause a fall in the price of coal relative to the price of gas. Based on a new price ratio, non-Annex countries might substitute less carbon intensive gas for more carbon intensive coal. Thus, the change in fossil fuel demand in both developed and developing countries may lead to leakage. The magnitude of the leakage depends on the supply response by fossil fuels producer. Decisions about the rate of fossil fuel extraction is an important determinant of the international price, and, therefore, for carbon leakage.

The second major reason for leakage comes from the higher costs of energy intensive products in the Annex countries. Carbon abatement might cause a shift of production to the non-Annex countries due to a change in the competitiveness of energy intensive industries. This will lead to a positive carbon leakage. Also, changes in the terms of trade and regional income may cause positive or negative leakage. For example, Energy intensive industries in GHGs abating countries will lose their competitiveness against non-GHGs abating countries. As a result, outputs in non-abating countries increase and at the same time, abating countries decrease their output.

According to Paltsev (2000), current economic models have the following magnitudes to account for carbon leakage: 8% (G-Cubed), 9% (GTEM), 11% (Gemini-E3), 14% (WorldScan), 26% (MS-MRT), 34% (MERGE4). The simulations run through these models assume that all Annex countries reduce their emissions to meet the Kyoto target, but our simulation, which is more realistic, assumes that only Japan, Canada and the EU meet the Kyoto target, because the US and Australia decided to withdraw from the Kyoto Protocol. As a result, our figures for carbon leakage are even bigger than others[2], because carbon leakage occurs not only in non-Annex

[2] Carbon leakage rates are from 8% to 34% and the figure depends on which model we use. When we assume that all Annex countries meet their Kyoto target, carbon leakage rate is 19%. The figure

countries, but also in the US and Australia. In our simulation, carbon leakage rates are projected to be 51.51% in 2010 and 53.05% in 2020.

3.2. A Decomposition Method

Within the model the rates of carbon leakage are high. Here, we try to answer why carbon leakage rates are high. To conduct the leakage analysis, a method described by Harrison et al (1999) is used. This allows for the decomposition (i.e. of a change) in carbon emissions in the non-Annex regions due to restrictions in specific sectors of the Annex countries. We denote carbon emissions in a non-Annex region s as Z^s. The emissions might change because of the change in exogenous policy instruments, such as a carbon tax X in a sector i of the Annex region b. Based on certain values of the instrument variable, X_{ib}, the model gives a numerical value for Z^s, so it can be expressed as a function

$$Z^s = F(X_{ib})$$

A change in the carbon taxes X_{ib} leads to an aggregate change in the outcome for the non-Annex region's carbon emissions from Z^s to Z^{s*}. The objectives of the analysis is to create a consistent decomposition of the aggregate change $\Delta Z^s = Z^s - Z^{s*}$ into the changes due to a particular sector-specific carbon tax in a particular region, such that

$$\Delta Z^s = \sum_{ib} \Delta Z^s_{ib}$$

where ΔZ^s_{ib} is the change in carbon emissions in a region s due to change in the carbon tax X_{ib} in a sector i of a region b. When F is non-linear, the total change in Z^S is path-dependent, i.e., the decomposition is sensitive to the ordering of changes in the policy instruments X_{ib}. We assume that the policy instruments are introduced simultaneously. Therefore, the changes in the carbon tax X_{ib} can be represented as

$$\Delta X_{ib} = X^1_{ib} - X^0_{ib}$$

where X^1_{ib} is the final value and X^0_{ib} is the starting value of the policy instrument. The path between these two points can be constructed as follows.

$$X_{ib} = X^0_{ib} + t\Delta X_{ib}$$

where t is a scalar which parameterises the change in X_{ib}. When $t = 0$, X_{ib} is at its starting value. When $t = 1$, the carbon tax is at its final value.
For a given value of t we can write

$$\frac{\partial Z^s}{\partial t} = \sum_{ib} \frac{\partial F}{\partial X_{ib}} \frac{\partial X_{ib}}{\partial t} = \sum_{ib} \frac{\partial F}{\partial X_{ib}} \Delta X_{ib}$$

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is a intermediate value. Hence, 51.51% in 2010 and 53.05% in 2020 are not unrealistic.

Then the total change in Z^s is given by the following expression.

$$\Delta Z^s = \int_{t=0}^{t=1} \frac{\partial Z^s}{\partial t} dt = (\int_{t=0}^{t=1} \sum_{ib} \frac{\partial F}{\partial X_{ib}} \Delta X_{ib}) dt = \sum_{ib} \left[\Delta X_{ib} \int_{t=0}^{t=1} \frac{\partial F}{\partial X_{ib}} dt \right] = \sum_{ib} \Delta Z_{ib}^s$$

The above equation gives us the method of calculating the decomposition. That is, we start with calculating the partial derivatives $\partial F / \partial X_{ib}$ for a particular t, then integrate the derivatives over the whole range of t, then multiply the result by the change in the policy instrument ΔX_{ib}, and the sum over all policy instruments.

3.2.1. Carbon Leakage 2010

Figure 4 shows the regional decomposition of carbon leakage in 2010. The Figure shows the relationship between the abating countries, in this case, Japan, Canada and the EU, and non-abating country contributions to world carbon leakage. For example, the upper left corner of the Figure shows that Japanese (JPN) carbon abatement activities induce a carbon emission increase in Australia and New Zealand (ANZ) and the carbon leakage contributes 0.94% of the total 51.51% carbon leakage. Most of the increases in emissions are projected to happen in United States (USA, 18.21% of the total 51.51% leakage), followed by the rest of the world (ROW, 16.48%), China (CHN, 6.73%) and other Asia (ASA, 5.69%). The US withdrawal from the Kyoto Protocol worsens the efficiency of carbon abatement of the Kyoto Protocol. As the Figure illustrates Canadian (CAN) abatement activities are projected to induce carbon leakage in the US of 8.20% out of the total US leakage of 18.21%). The reason for this is that Canada is the biggest trade partner of the USA. Canada's exports to the US accounted for 72.56% of total Canada's exports in 1997 and the US's exports to Canada accounted for 15.85% in total of US exports in 1997. As a ratifying country of the Kyoto Protocol, Canada has to bear costs and lose international competitiveness (compared to the US for example). The US consumes US domestic products instead of Canadian products and as a result, carbon emissions increase in the US. A less marked example, but nevertheless one of significance, concerns Japan and China who are also big trade partners. As a result of Japanese abatement activities there is as a result an induced carbon emissions increase in China (CHN) of 3.25%.

Figure 4: Regional Decomposition of Carbon Leakage in 2010

(percentage)

	JPN	CAN	EU	Total Leakage
ANZ	0.94	0.17	0.67	1.78
CHN	3.25	0.73	2.75	6.73
KTW	0.95	0.31	1.08	2.34
THA	0.08	0.03	0.15	0.27
ASA	2.68	0.56	2.45	5.69
USA	2.83	8.20	7.18	18.21
ROW	2.73	1.28	12.47	16.48
Induced Leakage	13.46	11.27	26.77	51.51

Source: Fujitsu Research Institute (FRI)

3.2.2. Carbon Leakage 2020

Figure 5 shows the regional decomposition of carbon leakage in 2020. Overall, the proportion of GHG leakage increases compared to the projections for 2010. Most of the increases in the emissions are projected to happen in the United States (USA, 17.29% of the total 53.05% leakage), the rest of the world (ROW, 17.00%), followed by China (CHN, 7.90%) and other Asia (ASA, 6.21%).

Whilst the percentage of decomposition from Japan and Canada has decreased between 2010 and 2020, for the EU, the largest contributor, it has increased. The EU in 2020 is projected to have 29.37% induced carbon leakage.

With regard to leakage carbon, the most significant relationship is that between the EU (EU) and the Rest of the World (ROW). EU (EU) – United States (USA) is the second biggest contributor to carbon leakage. To increase the efficiency and effectiveness of abatement activities, we should stop these leakages.

Table 5: Regional Decomposition of Carbon Leakage in 2020

(percentage)

	JPN	CAN	EU	Total Leakage
ANZ	0.81	0.14	0.61	1.57
CHN	3.27	0.77	3.86	7.90
KTW	1.03	0.33	1.36	2.72
THA	0.10	0.04	0.23	0.37
ASA	2.70	0.59	2.92	6.21
USA	2.66	7.24	7.39	17.29
ROW	2.68	1.30	13.01	17.00
Induced Leakage	13.26	10.42	29.37	53.05

Source: Fujitsu Research Institute (FRI)

3.2.3. Comparison between 2010 and 2020

Figure 6 shows a comparison between 2010 and 2020 of induced carbon emissions in non-abating regions. Total induced carbon leakages are projected to increase from 51.51% in 2010 to 53.05% in 2020. The United States (USA) is still the biggest contributor to carbon leakage in 2020, but the contribution in 2020 (USA, 17.29%) is slightly lower than in 2010 (USA, 18.21%). On the other hand, China (CHN, 6.73% in 2010 and 7.90% in 2020) and other Asia (ASA, 5.69% in 2010 and 6.21% in 2020) increase their carbon leakage share. The relative change in the figures is because China is expected to continue with its high levels of economic growth and so China's economic and energy consumption share in the world will increase. As a result, leakage to China will occur more readily. In short term, we need to stop carbon leakage to the USA and in the medium and longer term, we should consider how to stop carbon leakage to China.

Figure 6: Carbon Leakage by Non-abating Regions

(percentage)

	2010	2020
ANZ	1.78	1.57
CHN	6.73	7.90
KTW	2.34	2.72
THA	0.27	0.37
ASA	5.69	6.21
USA	18.21	17.29
ROW	16.48	17.00
Induced Leakage	51.51	53.05

Source: Fujitsu Research Institute (FRI)

4. Conclusion

A carbon concentration stabilisation level of 550ppm is used as long-term target by countries, including the UK and Sweden. However, the Kyoto Forever scenario only decreases global carbon emissions by 5.86% below the baseline in 2020. Further emission reductions of 38.99% in 2020 are necessary to stabilise atmospheric concentration at 550ppm. There are two main reasons why the Kyoto Protocol cannot sufficiently contribute to the necessary reduction in global emissions: low coverage and high carbon leakage. The Kyoto Protocol covers only 19.89% in 2010 and 17.91% of global carbon emissions in 2020. On the other hand, China is projected to increase its share of GHG emissions from 19.15% in 2010 to 23.69% in 2020. Carbon leakage as a result of the Kyoto Protocol are projected to be 51.51% in 2010 and 53.05% in 2020, which means that more than 50% of carbon reduced in countries with reduction targets will be matched by an increase in countries without reduction targets.

The United States (USA) is still the biggest contributor to carbon leakage in 2020, but the contribution in 2020 (USA, 17.29%) is slightly lower than in 2010 (USA, 18.21%). On the other hand, China (CHN, 6.73% in 2010 and 7.90% in 2020) and other Asia (ASA, 5.69% in 2010 and 6.21% in 2020) increase their carbon leakage share.

To increase the efficiencies of GHG abatement strategies it is necessary to minimise the rate of carbon leakage. Our simulations and quantitative analysis show that the US withdrawal from the Kyoto Protocol and the non-participation of China increase carbon leakage. A post-Kyoto framework should include the participation of China and the US.

In January 2007, the European Commission proposed a comprehensive package of measures to establish a new Energy Policy for Europe. The Commission sought to combat climate change and boost the EU's energy security and competitiveness. The package of proposals set a series of ambitious targets on greenhouse gas emissions and renewable energy and aim to create a true internal market for energy and strengthen environmental and market regulations. The Commission announced that when international agreement is reached on the post-Kyoto Protocol framework this should lead to a 30% cut in emissions from developed countries by 2020. To further underline its commitment the Commission proposed that the European Union commit itself to cut greenhouse gas emissions by at least 20% by 2020. So, the Commission is still very keen to keep alive something akin to the Kyoto Protocol as an international commitment, which defines reduction rate targets for each country/region. However, only the EU, Japan and Canada will accept further reduction target. The US and China will not accept reduction rate targets, and since more than 50% of total greenhouse gas emission reduction targets can be achieved in the EU, Japan and Canada, GHG emissions will increase in other regions.

We, therefore, need to change the way to control greenhouse gas emissions by moving from a reduction target to more fully embracing the polluter-pays-principle (PPP), for example, through an auction type model for international emission trading. Saijo (2006) proposes an innovative international framework of Upstream Reimbursement Emission Trading System (URETS). The system sets up a GHG emission path from 2013 and beyond. For example, if the IPCC TAR 550ppm scenario should be accepted, then an international organisation could sell emissions permits determined by this path. Each country must buy permits that are equivalent to their level of GHG emissions. As URETS reimburses the revenue of emissions permits, each country receives a part of the revenue that has been collected by selling emission permits. In addition to reimbursement, each country receives (or loses) a fixed amount of the revenue. In the reimbursement mechanism, lower economic development economies receive more reimbursement. So, developing countries have clear incentives to participate in this scheme. The scheme is a redistributional one from rich country to poor country, as well as a GHG reduction scheme. There is as yet no quantitative analysis of a URETS type framework, but the framework should be one option to be considered as debate on the post-Kyoto framework gathers pace.

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