Designing Post-Kyoto Institutions: From the Reduction Rate to the Emissions Amount

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ABSTRACT

In this study, we propose the United Nations Emissions Trading Scheme (UNETS) and employed computable general equilibrium (CGE) analysis for the estimation. In this scheme, each country purchases emission credits from the United Nations by auctioning and the revenue from selling emission credits is recycled more to developing countries and less to developed countries. In addition to the UNETS, we take the Global Emission Trading Scheme (GETS) as an alternative framework of the Kyoto Protocol and compare between UNETS and GETS as a international GHG mitigation framework. In both cases, major reduction will be achieved in China and other Asia, including India and emission reductions in the EU and Japan will not be significant. These results bear out the importance of major GHG emitting developing countries participation, because there are huge low cost carbon reduction opportunities in the countries. In addition, the participation automatically solves competitiveness and leakage problems. There are no significant differences of simulation results between UNETS and GETS.

Key Words: Post-Kyoto, Global Climate Change, Emission Trading

Introduction

In February, 2007, the United Nations' Intergovernmental Panel on Climate Change (IPCC) observed that average global temperature has climbed 0.74 degrees Celsius in the ten years from 1996 and 2005, and basically concludes that global warming is escalating due to human activity. If countermeasures are not taken, the panel warns that the temperature could climb a maximum of 6.4 degrees Celsius by the end of this century compared to the end of the 20th century. With this in mind, discussion regarding the post-Kyoto Protocol, an international framework concerning the reduction of greenhouse gases after 2013, has become animated. In January 2007, the EU independently declared that it would reduce greenhouse gases by at least 20% by 2020 (compared to the level in 1990). In May 2007, looking ahead towards to the G8 summit held in Germany in June, Prime Minister Abe and the Japanese government proposed the strategy of "Cool Earth 50" strategy[1]. Regarding the post-Kyoto framework, Former Prime Minister Abe proposed that all of the major emitting countries including the US, China and India aim to create a framework that will accomplish a 50% global reduction by 2050. The specifics of this plan, however, have not been produced, and what comes after the promised term of the Kyoto Protocol ends; in other words the specific institutional design of the global framework after 2013 remains unclear. The major issue at the G8 summit to be held at Lake Toya (Hokkaido) in 2008 will be discussion regarding the international framework to replace the Kyoto Protocol after 2013, but the reality is Japan has not yet proposed a clear system.

In this report, we compare two alternatives, United Nations Emission Trading Scheme (UNETS) and Global Emission Trading Scheme (GETS) by using CGE (Computable General Equilibrium Model).

Issues Surrounding the Kyoto Protocol

For a framework proposal for post-Kyoto, let us first look at the issues surrounding the protocol with simple numerical examples. Assume the amount of greenhouse gas emitted by country A in one year is ten units, and two units for country B. Using this year as the base year, let us say that the protocol decided on a 10% reduction for country A and a 0% reduction for country B. Let us say that at the end of the protocol term, country A had produced eight units and country B had produced three units of emission. Country A has realized the 20% reduction, while country B's emissions have increased by 50%. The major factors in country A's reduction

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[1] The entire speech can be found at: http://www.kantei.go.jp/jp/abespeech/2007/05/24speech.html

are the end of subsidies for coal, and a change to natural gas for fuel and the outflow to other countries of major industries. On the other hand, let us suppose that country B is clearly still in the developing stages and its emissions increase was from the export of products to country A and so on. Hypothetically, if country A were to sell one unit of emission to country B, both countries would have accomplished the goals of the protocol. If country A's emissions decline is almost entirely a natural reduction, then it would enjoy greater economic profits by ratifying the protocol than not. Conversely, B would suffer the partial loss. If A is a country that has released massive amounts of greenhouse gas through the 20th century, could A and its 20% reduction be called a more environmentally advanced country than B and its 50% increase? Hypothetically, let us change the above numerical figures to emissions per capita. Under the protocol promise, A would have the right to emit nine units and B would claim two units. Though it has achieved a 20% decline, why would A's emissions limit be 4.5 times than of B's? What is the problem that lies within this logic-defying framework? The answer is the style of negotiation that focuses on the reduction percentage since the base year. What is really important in the discussion of stopping global warming, however, is not the reduction percentage from the base year, but rather how much is being emitted relative to the rest of the world. At the completion of the promised period, A's emission is eight units while B stands at three units. Should not the post-Kyoto principle be that each country takes responsibility for their respective emissions? In other words, it is necessary that the post-Kyoto framework not be based on reduction percentages, but rather it should center on taking responsibility for the actual quantity of emissions.

Hamasaki (2007) points out low coverage (the percentage of emissions of the countries bound to reduce emissions is low among total global emissions) and low efficiency (carbon leakage from the transfer of industries from countries engaged in reduction activities to countries that are not[2]) as problems with the Kyoto Protocol, and emphasizes the importance of a framework where major greenhouse gas emitting countries such as the US, China and India would participate in reduction programs. With the major emitting countries involved, it would be possible to resolve the problems of coverage and poor efficiency. Participation from these countries in a post-Kyoto framework would require that the framework be flexible and consider the situation of each individual country.

[2] Carbon leakage refers to, under the Kyoto Protocol, an increase in greenhouse gas emission from countries without reduction goals as a result of countries with reduction goals engaging in reduction activities. Carbon leakage occurs because of the following two reasons. 1. In countries with reduction goals, companies bear added expenses from energy reduction measures and etc. As a result, the production of primarily heavily consuming industries is shifted to countries where there are no reduction goals. 2. Greenhouse gas reduction in countries with reduction goals leads to a decrease in the global demand for energy and a subsequent drop in the price of fossil fuels. This leads to stagnation of energy reduction measures in countries with no reduction goals, and a shift to a high energy consuming economic structure. According to Hamasaki and Okagawa (2005), the carbon leakage rate of the US and Europe pulling out of the Kyoto Protocol is 56.3% (2010). In other words, this shows that roughly half of the emission reduction in countries with reduction obligations is increased in countries with no such obligations.

Proposals for the Post-Kyoto Framework

United Nations Emission Trading Scheme (UNETS)

We propose the United Nations Emission Trading Scheme (UNETS)[3] as a framework that will make it easier for major emitting countries to participate by having each country pay expenses appropriate to their stage of economic growth, as well as bear a burden commensurate to emission amounts. Under the UNETS framework, decision-making will be conducted at COP/MOP regarding what kind of international emissions path to take to stabilize the climate. Research regarding an emissions path at IPCC will be helpful to have in this process.

Next, following this path the UN and etc. would sell emission rights to countries. While the total amount of global emission is decided for a certain period, there is no limit on total emission for individual countries. Each country must purchase emission rights corresponding to the amount they emit from UNETS using an auction system. In practice, the purchasers of emission rights would be upstream energy companies. These companies would purchase emission rights commensurate to amount of greenhouse gas produced from the energy they sell in a particular country, and could not sell energy exceeding the amount of emission rights held. There is a necessity to reduce total global greenhouse gas emissions to stabilize the climate, and as a result the supply of emission rights will decrease and purchasing these rights will come at a premium. Upstream energy companies will pass on the expenses incurred from buying the emission rights to the selling price of energy, and therefore companies buying energy will have pay an even higher energy cost that reflects the price of emission rights. As a result, switching from coal to gas (in other words to energy with less carbon content), utilizing renewable energy such as wind and solar power, and investing in energy saving will be actively pursued, and a reduction in greenhouse gas emissions will be realized. In addition, this will lead to a mid to long-term cost decrease in technology that will dramatically reduce greenhouse gas emissions of renewable energy, as well as jump-start research and development investment into innovative low-carbon technology.

UNETS would sell emission rights using an auction system and would receive the sales proceeds. As graph 1 illustrates, the proceeds would be reallocated to each country.

3 Here we place the UN in charge of the credit sales as an example. As long as it is an appropriate third-party organization, however, it does not necessary have to be the UN.

Reallocation would involve two methods. The first is to refund a certain portion of the sales proceeds, for example half, and reimburse each country in proportion to the sales amount. To do this, countries would be divided into, for example, three categories: developed, semi-developed, and developing countries. Each country would receive a certain coefficient × amount of emission rights sales × the average sales price of emission rights. Regarding the certain coefficient (emission rights purchasing return rate), the rate of return decreases in proportion with the country's level of development. The remaining half would, for example, be returned in proportion to something with no direct relationship with emissions, such as GDP. Here again, the more undeveloped the country the higher the rate of return.

This would ensure that semi-developed and developing countries would not lose by participating in this system. In other words, by using the refunded capital it would become possible to contribute to investment in global warming and poverty countermeasures. On the other hand, developed countries would have to bear an appropriate level of burden. This could be called a system where developed countries such as Japan would bear a portion of the burden of greenhouse gas reduction activities and expenses towards adapting to climate change in developing countries. It would also be consistent with the United Nations' Framework Convention on Climate Change's basic principle of "shared but different responsibilities", as well as the principle of "a flexible and diverse framework that considers each country's individual situation" proposed by Prime Minister Abe in his "Cool Earth 50". The level of refunding by each country would be a point of contention in international negotiation, but if developing countries were given adequate refunding it would be possible for countries such as China and India to join the framework. The returned money would be put towards subsidies for areas such as research and development of technology to combat global warming and the introduction of wind power generation. It is also conceivable to have a portion returned to energy purchasers with the goal of reducing the burden on energy users.

The fluctuating part of the refund is as follows.

$$V(r) = \alpha(r) \times C(r) \qquad (1)$$

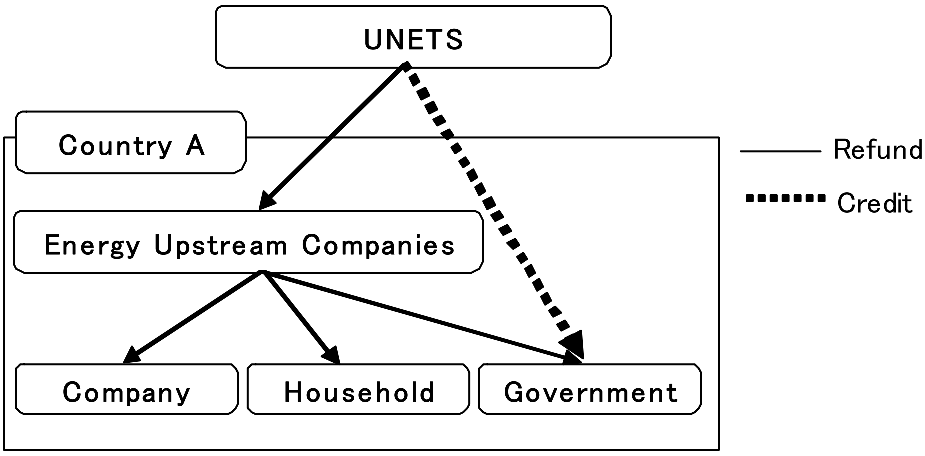
$V(r)$: Amount refunded to country r (fluctuating part)
$\alpha(r)$: Fluctuating refund rate to country r
$C(r)$: Credit purchase amount paid by country r

The fixed part of the refund is as follows.

$$F(r) = \beta(r) \times GDP(r) \quad (2)$$

$FRCO2TAX(r)$: Amount refunded to country r (fixed part)
$\beta(r)$: Fixed refund rate to country r
$GDP(r)$: GDP in country r

Fig.1 . Outline of the United Nations Emission Trading Scheme (UNETS)



Global Emission Trading Scheme (GETS)

Another framework which we deal with in this research is the Global Emission Trading Scheme. The GETS is proposed by Nishimura and Yasumoto (2007). The GETS is international emission trading scheme based upon equal per capita emissions permits. Under the GETS, every single person is allocated same amount of emission allowances and each party must buy permits which are the same as the GHG emission of the party. International emission trading is allowed to equalize and minimize GHG abatement cost all over the world.

Overview of Model

Our research was developed using GTAP-E, a general equilibrium model used widely in research related to global warming, as a base. GTAP-E refers to a GTAP[4] model expanded to conduct analysis of global environmental issues, and is greatly contributing to the impact assessment of global environmental policy, beginning with the Kyoto Protocol. Moreover, the databases and models have been made public, a point that is praised for making it possible for third parties to verify the results.

The GTAP-E model uses the GTAP-E database, which is the GTAP database with the inclusion of energy data. This model handles energy as a good that creates added value instead of an intermediate input good, and one of its major characteristic is that a substitutive relationship among energies has been added[5]. Under the GTAP-E model, industry, households and the government, both regional and national, are the principle actors. Industry engages in production by using factors of production. Households and the government, which are the principle actors in consumption, are treated as principle trading actors known as regional households in a broad sense of the term. Households receive factor income by supplying production factors to industry, and the government collects tax revenue from households and industry. The factor income of households and the government's tax revenue will become the income of regional households, and so the expenditure of regional households will be the sum of private consumption expenditure and government consumption expenditure. It is assumed that there will be perfect competition in the goods market and production factor market. This research assumes that the movement of labor and capital is free only among industries, and not free internationally. Moreover, labor and capital are used perfectly. The production structure of the GTAP-E model is illustrated in Figure 2. Each industry, with production amount as a given, decides on demand for intermediate input goods and production factors based on minimized costs, and engages in production. The GTAP-E model uses a multistage CES-style function as its production function. Factors of production are capital, labor, land and natural resources, and production factors and intermediate input (including energy) are linked with the CES-style production function. The top added value and intermediate input goods are linked by the fixed coefficient type production function. Capital and the production of energy composite goods have a small multistage structure, and energy composite goods are comprised of fossil fuels such as coal, crude oil, gas, oil products, as well as electricity.

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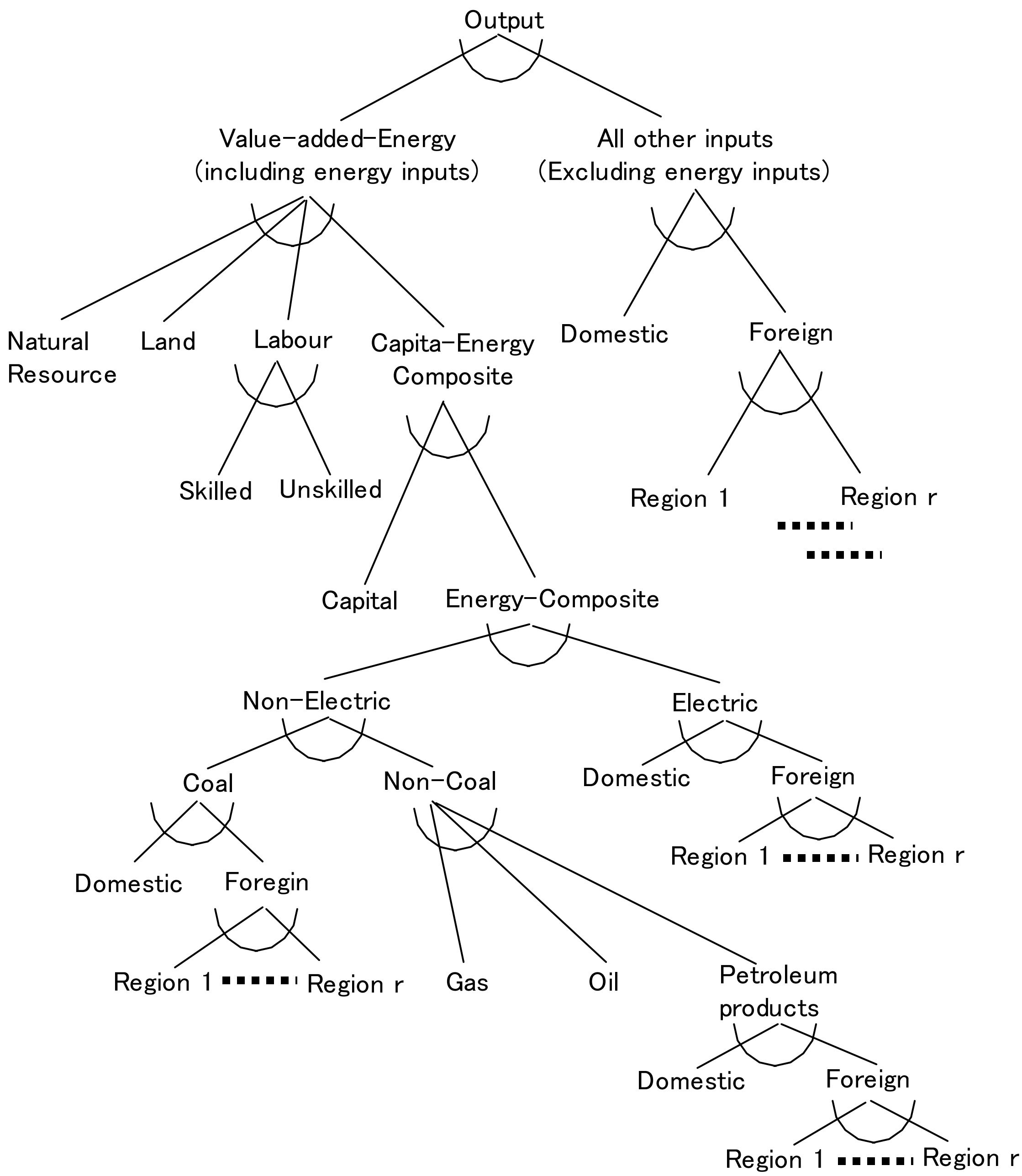
4 For more information on GTAP, refer to Hertel ed (1997).

5 For more detailed information on GTAP-E model, refer to Burniaux and Truong (2002).

Fig.2. Production Structure of the GTAP-E Model



In this research GTAP databases Version 5[6] are used, and as shown in Tables 1 and 2, analysis is conducted based on separating by country and region as well as industry.

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6 Databases using 1997 as a basis.

Table 1. Countries and Regions

Code	Remarks
ANZ	Australia, New Zealand
CHN	China, Hong Kong
JPN	Japan
KTW	Korea, Taiwan
THA	Thailand
ASA	Indonesia, Malaysia, Philippines, Singapore, Vietnam, Bangladesh, India, Sri Lanka, South Asia
USA	USA
CAN	Canada
EU	European Union 15
FSU	Russia, other former republics of the Soviet Union
ROW	Other

Table 2. Industries

Code	Remarks
AGR	Agricultural crops, dairy, forestry, fishery
COL	Coal
OIL	Oil
GAS	Gas
GDT	Gas supply
P_C	Petroleum products, coal products
ELY	Electricity
MIN	Minerals
PPP	Paper, pulp, publishing
CRP	Chemicals, rubber, plastics.
I_S	Iron and steel
MTL	Metals, metal products
VEH	Automobiles, automobile parts, transport machinery
OMN	Other manufacturing
TRP	Land, air, water, and other transport
SERV	Water works, construction, distribution, transmission, financial, insurance, business services, leisure/entertainment, public services, housing

Settings and Design of the Simulation Scenarios

In this research, we hypothesize that total global carbon dioxide emissions will be reduced by 10% from the current level. The simulation was conducted with the following two types of conditions.

In UNETS simulation, returns are made using the fluctuating return rate and fixed return rate shown in Table 4. Regarding the fluctuating return rate, as illustrated in Table 3 the more undeveloped the country the higher the rate of return. The fixed return rate is also proportionally higher for developing countries. We assume that the returns made to each country would be done through lump-sum returns to the entire region. The fluctuating return rate and fixed return rate in table 4 are set under the principle that for developing countries an amount greater than expenses to purchase emissions rights would be returned, while for developed countries an amount lower than expenses to purchase emissions rights would be returned.

In GETS simulation, it is assumed that every single person receives same emission allowances. Each party must have the permits that are the same as the GHG emission of the party. International emission trading is allowed to meet their targets.

Table 3. Return Rate by Country/Region

	Fluctuating return rate α	Fixed return rate β
Australia, New Zealand	0.3	0.5
China	0.7	0.7
Japan	0.3	0.25
Korea, Taiwan	0.5	0.5
Thailand	0.5	0.7
Asia (excluding China)	0.7	0.7
USA	0.3	0.45
Canada	0.3	0.45
EU	0.3	0.3
Russia and etc.	0.7	1.2
Other	0.7	0.7

Simulation Results

First of all, we show the simulation results of UNETS. The simulation is done under the premise that 10% of the current emissions amount would be reduced, and the price of emission rights would be US$24.5/carbon ton. Table 4 illustrates the net amount, emissions rate compared to the current level, and impact on the GDP. As noted previously, UNETS returns an amount greater than the expenses to purchase emissions rights to developing countries, and an amount lower than expenses to purchase emissions rights to developed countries. The net return amount to Japan is minus US$458 million, while the return amount to China is plus US$176 million. The country reducing emissions the most is China (33% reduction), following by "other Asia" (22.1%). On the other hand, the reductions are marginal in developed countries such as Japan (3.3% reduction) and the EU (2.7% reduction). The reasons behind China's large-scale reductions are energy prices are held down at an unreasonable level by the government, and awareness among Chinese companies towards energy-saving is low (Magari, 2007). As a result, while the price for emission rights is consistent throughout the world, the room for China, which has low energy prices, to raise energy prices is large compared to other countries, and as such energy-saving would be pursued actively. The fact that China's energy structure is centered on coal with a high carbon-containing rate should also accelerate energy-saving activities.

Regarding the impact on GDP, while the return amount to Japan is minus US$458 million, the impact on the GDP is marginal at 0.01%. On the other hand, the impact on China's GDP is at -0.47%, a figure which is comparatively large compared to developed countries such as Japan, the EU and the US. The reason for this is, as previously mentioned, energy prices are held down at a low rate in China, and consequently the rise in energy prices will be more pronounced in China compared to other countries. An increase in production prices hurts international competitiveness, and a hike in overall prices can lead to stagnant consumption.

Table 4. UNETS: Results

	Net Return Amount[7] (US$ million)	Emissions rate compared to current （%）	Impact on GDP （%）
Australia, NZ	-476	92.2	-0.07
China	176	66.5	-0.47
Japan	-458	96.7	-0.01

[7] The net amount of return is the difference after taking amount of return received from the relevant country's amount of payment for emissions credit.

Korea, Taiwan	-428	95.1	-0.05
Thailand	-137	94.3	-0.06
Other Asia	1,189	87.9	-0.14
USA	-1,491	92.6	-0.01
Canada	-650	95.0	-0.11
EU	-3,396	97.3	+0.07
Russia and etc.	-1,520	92.7	-0.21
Other	7,192	93.9	-0.08

Secondary, we examine the simulation results of another proposed approach, GETS. Table 5 shows BAU emissions, allocated credits and required reductions from BAU. Under GETS, high per capita emission countries, in general, developed countries, receive less credit than their BAU emissions and low per capita emission countries, in general, developing countries, receive more credit than their BAU emissions. The US is the highest per capita emission country and as a result, the US has to reduce the emission by 82.3%. On the other hand, China receives 43.3% more credits than BAU emission.

Table 5 Credit Allocations

	BAU Emissions (million tonne of carbon)	Allocated Credits (million tonne of carbon)	Required Reduction
Australia and NZ	95.2	22.3	-76.5%
China	865.2	1,239.5	43.3%
Japan	348.5	134.7	-61.3%
Korea and Taiwan	191.5	68.6	-64.2%
Thailand	46.3	60.4	30.5%
Other Asia	439.0	1,644.7	274.6%
US	1,535.6	271.7	-82.3%
Canada	143.7	30.2	-79.0%
ＥＵ	937.8	396.6	-57.7%
Former Soviet	584.1	314.0	-46.2%
Rest of the World	1,127.6	1,500.2	33.0%

Table 6 shows comparisons of simulation results between UNETS and GETS. Under both UNETS and GETS, economic impacts are minor and there are no significant differences of results between UNETS and GETS. Major reduction GHG emissions are achieved in China and other Asia and very minor reductions are achieved in EU and Japan.

Table 6. Comparison between UNETS and GETS

	GHG Emissions in comparison to BAU（%）		GDP Change （%）		Credit Price （US$/tonne of carbon）	
	UNETS	GETS	UNETS	GETS	UNETS	GETS
Australia and New Zealand	92.2	91.7	-0.07	-0.10		
China	66.5	68.0	-0.47	-0.48		
Japan	96.7	96.8	-0.01	-0.01		
Korea and Taiwan	95.1	94.5	-0.05	-0.06		
Thailand	94.3	94.2	-0.06	-0.04		
Other Asia	87.9	88.7	-0.14	-0.09	24.5	27.5
US	92.6	91.7	-0.01	0.03		
Canada	95.0	98.2	-0.11	-0.31		
EU	97.3	97.3	0.07	0.05		
Former Soviet Union	92.7	92.2	-0.21	-0.38		
Rest of the World	93.9	93.7	-0.08	-0.08		

Under the GETS, many credits are allocated to developing countries and very small number of credits is allocated to developed countries, which means that developed countries have to buy credit from developing countries' hot-air and developing countries make huge profits. However, economic impacts are very minor. These studies shows that how to allocate credits to countries has minor impacts on carbon reductions and economic impacts, but coverage rate of countries which have carbon abatement commitment has huge impacts on carbon reduction and economic impacts.

Conclusion

In this report, we conduct an assessment of the effectiveness of the United Nations Energy Trading Scheme (UNETS) and Global Emission Trading Scheme (GETS) as a post-Kyoto Protocol framework using a general equilibrium model and compare these two frameworks.

In both cases, major reduction will be achieved in China and other Asia, including India and emission reductions in the EU and Japan will not be significant. These results bear out the importance of major GHG emitting developing countries participation, because there are huge low cost carbon reduction opportunities in the countries. In addition, the participation automatically solves competitiveness and leakage problems.

There are no significant differences of simulation results between UNETS and GETS, for example, carbon prices of UNETS and GETS are 24.5 and 27.5 US$/tonne of carbon.

Regarding international frameworks for global warming countermeasures after 2013, there have been many proposals such as a sector-based approach (Japan Federation of Economic Organizations, 2007) and a Hybrid Policy (McKibbin and Wilcoxen, 2002). A comparison of the United Nations Emission Trading Scheme with these and other systems is an issue for the future.

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