Full Paper Prepared for the 11th Global Conference on Environmental Taxation

Opportunities and Barriers of Implementing Carbon Tax Policy in Northeast Asia: A Comparative Analysis

Xianbing Liu *, Kazunori Ogisu **, Yusuke Matsuo and Tomohiro Shishime

Kansai Research Centre, Institute for Global Environmental Strategies (KRC/IGES)

* Corresponding author: Xianbing Liu

** Presenter: Kazunori Ogisu

Post address: Hitomirai Building 4F, 1-5-2 Wakinohama Kaigan Dori Chuo-ku, Kobe 651-0073, Japan

Tel: +81-78-262-6634

Fax: +81-78-262-6635

E-mail: liu@iges.or.jp

[Abstract] This paper gives a glance of carbon emission status, the latest efforts and policy progress in Japan, China and Korea, and provides an integrative summary of previous discussions of carbon tax policy based on a comprehensive literature overview. By using the information collected from these countries, a comparative analysis is conducted to identify opportunities and barriers of implementing carbon tax policy in this region from a multiplier viewpoint.

The overview indicates the great importance of the design of carbon tax scheme, including the scope, tax level, collection and utilization of the tax, which requests much more discussions for convincing the decision-makers. Existing macro analysis at national level by using dynamic computable general equilibrium (CGE) model confirms the primary negative impact of carbon tax on the economy, especially on the energy and trade intensive sectors. However, the impact may be alleviated via properly relieving the heavily affected sectors. The double dividend may arise by using revenues from carbon tax to finance reductions in pre-existing irrational taxes. Our comparison identifies the problems of target countries in implementing carbon tax policy due to political resistance and energy structure characteristics. In Japan, against from industrial lobbies is the most crucial factor blocked the practice of carbon tax. The centralized administrative system of China may shorten the period for the introduction of this policy partly due to the consideration of country profile fighting against climate change. The general attitude towards the carbon tax in Korea is rather positive among the environmental specialists. As the taxation of carbon causes a shift from coal to other low carbon energy, the energy tax would be a more stable approach for Japan and Korea which highly rely on energy import from abroad. Keeping energy security and a variety of energy sources would be their first policy priority.

As the way forward, discussions of acceptability to carbon tax from the perspective of individual companies are useful. Their reactions to optional tax scenarios and corresponding behavioral changes, especially on technological innovations and the choice of greener technologies, bear in-depth analysis.

Key words: Carbon tax policy, Northeast Asia, comparative analysis

1. Introduction

Under the assumption of rationality and market efficiency, carbon reduction cost of the society is the same for carbon tax policy and cap and emission trading scheme (Mankiw, 2007). The difference is only the result of redistribution. Carbon tax is in several aspects superior to emission trading system. Carbon tax may address carbon emissions from every sector while the Emissions Trading is solely applicable for large polluters because it requires accurate monitoring of carbon emissions. Fair allocation is almost impossible for emission trading and there will be many innocent losers. Uncertain carbon price in the case of emission trading makes the companies myopic and discourages their reduction efforts, while fixed carbon tax rate would be clear for them to make appropriate decisions in medium and long term. In fact, emissions trading has dilemma, if many firms reduce their emissions in order to make money by selling reduction credits, carbon price would go down and they would be penalized by doing a good thing. Lastly but not at the least, by using carbon tax revenue, it is easier to reduce the number of losers, either by reducing other taxes or by lowering tax rate of energy-intensive businesses. In more recent, several famous economists argue that the international carbon tax is systematically better and easier to arrive at an agreement than global cap and trade as a Post-Kyoto Scheme (e.g., Mankiw, 2007).

Carbon tax was first introduced in Finland from 1990 and then levied in certain other European countries like Sweden, Norway, Netherlands and Denmark. Cansier and Krumm (1997) once gave an overview of the existing carbon tax schemes in Europe and found some obvious differences between them. As examples, in terms of the levy manner, Finland and Netherlands have no tax relief measure for the production sectors while Sweden, Norway and Denmark have tax reliefs especially for energy-intensive sectors. Regarding the use of tax, Sweden, Norway, Finland and Netherlands assign all the revenue to the general public budget while Denmark uses the tax paid by a sector to subsidize its labor input or energy-saving investment. In overall, the implementation of carbon tax in these countries has shown broadly positive effects in reducing the demand of fossil energy and CO_2 emissions and increasing the employment but very small negative impacts to economic growth (Anderson and Ekins, 2009).

However, the policy progress for appropriately pricing carbon emissions, either by taxation or emission trading, in Asian countries is much slower. Besides India from South Asia, another three large economies, Japan, China and Korea based in Northeast Asia, are on the list of top 10 CO_2 emitters in the world. Although all the three countries have declared their own reduction targets of CO_2 emissions under post-Kyoto regime, their policy countermeasures against climate change remain sparse, in particular, regarding the adoption of market-based approaches like carbon tax and emission trading scheme.

With aims to close the existing policy gap, this study provides a comparative analysis of emerging discussions of carbon tax in Japan, China and Korea. The remaining of this paper is therefore arranged as follows. Section 2 gives a glance of carbon emission status and ongoing efforts for understanding policy insufficiencies in the three countries. The academic analyses of carbon tax policy at macro-level with relevance to the target countries are summarized in section 3. Section 4 overviews the progress of carbon tax policy in the three countries by using available information. Section 5 further identifies the opportunities and barriers of implementing carbon tax policy in each country from a multiplier viewpoint. Section 6 concludes the findings of this study and suggests the way forward for the development and actual implementation of this policy.

2. The latest climate policies in the three countries

2.1 Status of carbon emissions in the three countries

CO_2 emissions of the three target countries in Northeast Asia are indicated in Table 1 with the data of India and the U.S. listed as references. China has surpassed the U.S. and became the largest carbon emitter in the world. The total amount of CO_2 emissions of China increased by 152.8% in 2006 compared with the number of 1990. The annual growth in average was 5.1% during this period. CO_2 emissions of Korea also increased quite fast with the overall change rate being 96.7% and annual average growth rate being 4.2% during 1990-2006. Comparatively, CO_2 emissions of Japan were much stable but still shown an increasing trend with the average growth rate being 0.6% in the same period. As an Annex B country with 6% mitigation target by 2012 under the Kyoto protocol, Japan is facing great challenge to reverse the growth of CO_2 emissions. From another viewpoint, the per capita CO_2 emissions of China were quite low in 2006, around half of the number of Japan and Korea and 1/4 of that of the U.S. On the contrary, CO_2 emission intensity by GDP (Gross Domestic Product) in China was over 3 times of Japan and twice of the U.S.

Table 1: CO_2 emissions data in the three countries (1990-2006)

Items	Japan		China		Korea		India		U.S.	
	1990	2006	1990	2006	1990	2006	1990	2006	1990	2006
CO_2 emissions (Mill. tons)	1171.4	1292.5	2412.9	6099.1	241.5	474.9	690.1	1509.3	4861.4	5748.1
Per capita CO_2 emissions (tons)	9.5	10.1	2.1	4.7	5.6	9.8	0.8	1.4	19.5	19.3
Per GDP CO_2 emissions (kg/2005 PPP $)	0.4	0.3	1.9	1	0.5	0.4	0.7	0.6	0.6	0.5

Source: 2010 World Development Indicators, World Bank.

Regarding CO_2 emissions by economy sectors, it is difficult to know how sectors contribute to national total emissions in China as China has not officially released its GHG (Greenhouse Gas) inventory since 1994. According to the estimations of IEA (International Energy Agency), about 68% of China's 2005 GHG emissions came from fuel combustion; 5% evaporated as methane from energy related systems; 10% came from industrial processes; 14% came from agriculture; waste and miscellaneous sources accounted for the remaining 4%.

The breakdown of CO_2 emissions in Japan during 1990-2008 is listed in Table 2. Energy use of industrial sector is the largest source of CO_2 emissions in Japan with a decreasing share from 42.2% in 1990 to 34.5% in 2008. At the same time, shares of CO_2 emissions from transport sector, commercial and residential sources were increasing. In 2008, residential sector accounted for 14.1% of the total emissions and transport and commercial sector each equally shared 18.9%.

Table 2: Breakdown of CO_2 emissions in Japan (1990-2008, in Mill. t-CO_2)

Year	Industrial	Transport	Commercial	Residential	Energy sector	Industrial processes	Waste	Total
1990	482	217	164	127	68	62	22	1143
1995	471	258	185	148	73	64	27	1226
2000	467	265	206	158	71	57	31	1254
2005	459	254	236	174	79	54	30	1286
2008	419	235	235	171	78	50	26	1214

Source: Ministry of Environment, Japan; Data after reallocation to the end-use sector.

Total GHG emissions of Korea in 2007 reached 620 million tons of CO_2. The energy accounted for 84.7% of the total. As indicated in Figure 1, industries were the largest contributor and represented 66% of CO_2 emissions in Korea. Residential sector accounted for 10% in 2007 and had decreased by 16% compared to the 1990 level due to the energy substitution from coal to clean energy as natural gas and electricity in 1990s. The Korean economy has expanded rapidly mainly driven by heavy industrial sectors like steel, shipbuilding, automobiles and chemicals during the 1980s and 1990s, which leaded to the rapid CO_2 emissions growth. Korea heavily relied on fossil energy with coal and oil sharing 43.6% and 24.3% respectively in 2006. The dependence on imports for energy was around 97% in the same year (Source: Website of Green growth committee, Korea: http://www.greengrowth.go.kr).

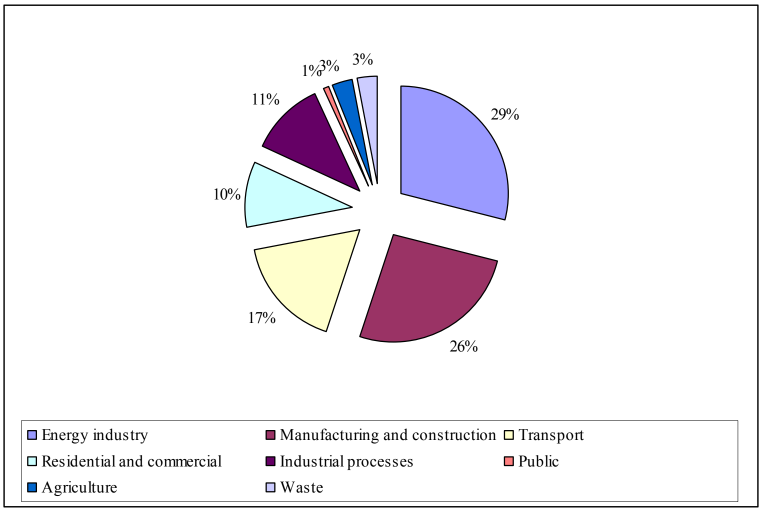

Figure 1: Breakdown of CO_2 emissions in Korea (in 2007, with a total of 620 Mt-CO_2).

2.2 The latest climate policies in the three countries

2.2.1 The latest climate policies in Japan

Under the Kyoto protocol, Japan committed to reduce its 1990 GHG emissions by 6% from 2008 to 2012. As the medium target, Japan has pledged to reduce GHG emissions by 25% from 1990 levels by 2020. However, this commitment is based on the premise that the agreement of aggressive reduction targets shall be achieved with the participation of all major CO_2 emitting countries. Japan also announced its long-term target to reduce GHG emissions by 80% from 1990 levels by 2050.

As major countermeasures of climate change of industrial sectors at national level in Japan, energy efficiency-related policy and the shift to low carbon energy have been planned and implemented. CCS (Carbon Capture and Storage) for large-scale source of GHG emission will be introduced after 2020 (MOE, 2010). Keidanren (The nationwide business association of Japan) Voluntary Action Plan, Trial of emissions trading scheme, Carbon offset scheme and Carbon financing have been under implementation. GHG emissions Calculation, Reporting and Disclosure System based on 'the Law Concerning the Promotion of the Measures to Cope with Global Warming' has been implemented since 2006. This system requires the companies with large amount of GHG emissions to calculate out their emission amount and report to the government. Based on the information received from firms, MOE (Ministry of Environment) discloses the firm's GHG emission-related information to the public. MOE promotes the improvement of reliability of the environmental information disclosed in firm's environmental report. In Addition, 'the Basic Act on Global Warming Countermeasures' is under consideration. Various measures are listed in the draft act for achieving the medium and long-term reduction targets. Domestic emission trading scheme and carbon tax are being discussed for the introduction in the future.

2.2.2 The latest climate policies in China

China's climate policy is based on its own assessment of national interest as outlined both in its 2007 'National Climate Change Program' and 2008 'Climate Change White Paper'. China's climate policy meshes with concerns about energy security, pollution abatement and the cost of energy, as well as the impacts of climate change and China's international reputation. While China has traditionally avoided policies that explicitly target carbon emissions, its energy and forestry programs have provided the basic frame for 'National Climate Change Program'. In seeking to control the increase in energy consumption, the government set two key policy targets in 2006. One is to reduce national energy intensity by 20% by the end of 2010 and to increase renewable energy in the national energy mix to 15% by 2020. Both goals, contributing to controlling carbon emissions, are ambitious for a developing country. The Chinese Cabinet further pledged in November of 2009 to cut CO_2 emissions per unit of GDP by 40-45% by 2020 compared with 2005 levels. However, this is a voluntary action based on its own country conditions and is a major contribution to the global effort in tackling climate change issues.

China has enacted specific policies to put it on track to satisfy above goals. China's climate policy is diverse and includes targets and quotas, industrial and equipment standards, energy taxes and financial incentives and penalties. China has gained some experience in carbon markets through the CDM (Clean Development Mechanism) projects. Given China's institutional strength, the country will likely use a variety of tools as its climate policies. These policies may drive carbon intensity reductions while suiting to the current development of China's financial markets and enforcement infrastructure.

At energy supply side, improving energy efficiency and reducing carbon intensity of the power sector have been major tasks for the Chinese government. NDRC (National Development and Reform Commission) adopted a standard requiring all new coal-fired power plants to be state-of-the-art commercially available with better technologies. The world's most efficient coal-fired power plants are being built in China. Estimated by IEA (2009), by 2011, 80% of China's coal-fired power plants will be modern plants above 300 MW in capacity and this number will rise above 90% by 2020. At energy demand side, 'Top 1,000 Enterprises Program' is central to NDRC efforts to reduce energy intensity. Established in 2006, this program imposes a significant portion of overall 20% energy intensity by directly targeting around 1,000 largest state-owned enterprises with most in heavy industries. In 2005, these enterprises accounted for at least 33% of total primary energy demand and 47% of industrial energy demand. The program goal was met in the first year (Price et al., 2008). The successes were the deployment of a national monitoring system and firm-level creation of 'energy managers'. The program's five year target of 100 million tons coal equivalent (MTCE) reduction equals to about 250 million tons of CO_2.

Beyond industrial energy efficiency, China's policies aim to increase efficiency in sectors that are relatively modest energy users today but will inevitably grow. Much of the effort to combat this increase is contained in a set of policies the NDRC calls the '10 Key Energy Conservation Priority Programs'. Combined with industrial programs, NDRC estimates that this initiative will reduce GHG emissions by 550 million tons of CO_2 (NDRC, 2007).

China had a long history of using financial carrots and sticks to generate desired outcomes. Due to the centralized banking system, the government has a unique ability to encourage climate conscious investments via favorable and punitive loan policies. As an example, China invested US$12 billion in expanding renewable energy capacity (excluding large hydropower) in 2007, second only to Germany in the world (Xinhua News Agency, 2008). Although several of China's tax structures, including vehicle and value added taxes, have been designed with energy and environmental impacts in mind, China does not have necessary emissions tracking mechanisms and infrastructure in place to administer an emissions tax or cap. Proving its willingness to encourage changes in energy use through taxes, China increased fuel taxes levied on gasoline and diesel on January 1, 2009 (People's Daily, 2008). Nevertheless, there are technical and market capacity limitations in China hindering reliance on a cap-and-trade system in the short term.

2.2.3 The latest climate policies in Korea

On August 15 of 2008, Korea proclaimed 'Low Carbon, Green Growth' as its new national vision to shift the current quantity-oriented and fossil-fuel dependent growth to quality-oriented growth by emphasizing the use of new and renewable energies. The latest policy progress of climate change in Korea is listed in Table 3.

In order to face the economic crisis in late 2008, Korea launched a 'Green New Deal' in January of 2009. The stimulus package amounted to a total of US$38.1 billion, which equals to 4% of GDP and would be implemented during 2009-2012. Around 80% of the budget was allocated to environmental themes as renewable energies (US$1.80 bill.), energy efficient building (US$6.19 bill.), low carbon vehicles (US$ 1.80 bill.) and water and waste management (US$13.89 bill.). On November 17, 2009, the Green Growth Committee announced a decision to adopt a 30% reduction target of GHG emissions by 2020 compared with BAU (Business as Usual) levels. Along with the medium-term mitigation goal, the countermeasures include the adoption of a legal and regulatory framework, carbon emission trading, the creation of a national GHG inventory reporting system by 2010, in addition to raising the public awareness. The other measures include the adoption of new auto emission standards; a waste-to-energy program to reduce GHG emissions from wastes; promoting low carbon transportation; the introduction of light-emitting diodes (LEDs); stricter heat insulation standards for buildings; and development of CCS technologies.

Table 3: Latest progress of climate policies in Korea

Date	Chronicle of events
2010.04.14	Enact of Basic Act on Low Carbon and Green Growth
2009.11.17	Confirmed the 30% reduction target of national GHG emissions by 2020
2009.11.05	Presented the draft 27% or 30% reduction target of national GHG emissions
2009.07.06	Finalized the Five-Year National Plan for Green Growth
2009.02.25	Finalized government draft of Basic Act on Low Carbon and Green Growth
2009.02.16	Officially launched the first term of the Green Growth Commission
2009.01.15	Proclaimed Presidential Decree on the establishment and operation of the Green Growth Commission
2008.12	Proclaimed the enact of the Basic Act on Low Carbon and Green Growth and the establishment of Green Growth Planning Bureau
2008.11	Integrated review of National Commission against Climate Change, National Energy Commission, and National Commission on Sustainable Development

Source: Green Growth Committee website

3. Academic discussions of carbon tax policy with relevance to the three countries

Several pieces of literatures have analyzed carbon tax policy related to Japan, China and Korea at national macro-economy level, and provided meaningful discussions of the impacts of this policy.

Regarding the Japanese case, Nakata and Lamont (2001) examined the impacts of using carbon and energy taxes to reduce CO_2 emissions in Japan. A partial equilibrium model of Japanese energy sector was constructed to evaluate the changes of energy system out to 2040. Their results indicate that carbon tax does suppress the increase of CO_2 emissions. At a tax rate of 160 US$/t-C (43.6 US$/t-CO_2), the emissions would reach 391 Mt-C, corresponding to a reduction of 100 Mt-C. An energy tax of 4.5 US$/Mill. Btu will reduce the emissions to 400 Mt-C in 2040. Although energy tax would result in larger tax revenues, the carbon tax tends to eliminate coal as an energy resource. As Japan has to import nearly all of its fossil fuels, narrowing the energy mix would leave Japan more vulnerable to the international markets. The authors suggested energy tax as a more stable approach for Japan. Using a multi-sector dynamic CGE model allowing for 27 sectors and 100 years, Takeda (2007) examined the double dividend of carbon tax policy in Japan. The simulation incorporates capital income tax, labor income tax, capital tax, labor tax and consumption tax as the pre-existing distorted taxes. The assumption is to keep the government revenue constant by alleviating the distorted taxes while introducing carbon tax. A weak double dividend occurs. Using the new revenues from carbon tax to finance the reduction of pre-existing taxes is more beneficial than the policy of returning the revenues to the household in a lump-sum style. The strong double dividend does not arise from the reductions in labor and consumption taxes but arises from the reduction in capital tax. As Japanese industries are strongly opposed to carbon emission regulations including carbon tax policy, it would be possibly introduced and implemented if carbon tax policy could be combined with reductions of capital tax (Takeda, 2007).

The development and implementation of carbon tax policy in China would be complex. One of the primary concern is carbon tax has potential strike on the international competitiveness of energy-intensive sectors. Liang et al. (2007) established a CGE model simulating the carbon tax policy in China. By referring to the existing policy schemes in Europe, the authors assumed four carbon tax scenarios by defining whether tax relief measures adopted for the production sectors or not. The result confirms that the negative impact of carbon tax on the economy could be alleviated in case of relieving or subsidizing the production sectors. In order to increase political feasibility of carbon tax policy, tax relief and subsidy for energy-intensive sectors should be a principle. Carbon tax rate in different reduction targets was estimated under a preferable scheme with tax completely exempted for Iron and steel, building materials, Chemicals, non-ferrous metals and paper industry while being identical for all the other sectors. The tax rate is 163 Yuan/t-C (at 2002 constant price, US$5.4/t-$CO_2$) if the reduction target is set to be 5%. And the rate is 348 Yuan/t-C (about 11.5US$/t-$CO_2$) in the case of 10% reduction target.

For Korean case, Kwon and Heo (2010) first derived the impacts of carbon tax on commodity prices in Korea by using both an input-output model and a simple CGE model. Their results suggest that an upstream carbon tax equivalent to 36,545 Won/t-CO_2 (about 31.0 US$/t- CO_2) need to be imposed to meet the government' medium-term reduction target. It is interesting that this tax rate is similar to the current trading price in EU-ETS which is about 20 Euros. The anticipated amount of carbon tax revenue will be 26,079 billion Won (about US$22.1 bill.), which is about 16% of Korea's current total tax revenue. This study also finds that a carbon tax system without revenue-recycling is regressive. Whereas, recycling the revenue enhances income redistribution, and a lump-sum transfer of the revenue would make the carbon tax policy progressive. Lower income classes may obtain net gains from carbon taxes accompanied by revenue-refund. The finding reemphasizes the relative advantages of a tax system over a permit system in that the latter is less likely to collect substantial amount of government revenue to be recycled.

4. Actual progress of carbon tax policy in the three countries

4.1 Policy progress of carbon tax in Japan

4.1.1 Existing energy-related taxes in Japan

The existing energy-related taxes in Japan can be grouped into three categories: automobile fuel-related tax (gasoline tax, regional gasoline tax, diesel tax and liquefied petroleum gas tax); aviation fuel tax; and, petroleum and coal tax and promotion of power resources development tax. Table 4 shows the tax rate and revenue.

Table 4: Existing energy-related tax rates and revenues in Japan (Source: website of MOE, Japan)

Fuel	Unit	Energy Tax							Total: Yen	
		Gasoline Tax	Regional Gasoline Tax	Petroleum and Coal Tax	Diesel Tax	Tax for Promotion of Power-Resources Development	Liquefied Petroleum Gas Tax	Aviation Fuel Tax	Per unit	Per t-CO_2
Tax collector		National	National	National	Prefectural & city	National	National	National	--	--
Taxation position		Upstream[2]	Upstream	Most Upstream[1]	Downstream[3]	Downstream	Downstream	Downstream	--	--
Gasoline	Yen/l	48.6	5.2	2.04	--	--	--	--	55.8	24,052
Diesel	Yen/l	--	--	2.04	32.1	--	--	--	34.1	13,034
Heavy oil	Yen/l	--	--	2.04	--	--	--	--	2.0	753
Jet fuel	Yen/l	--	--	2.04	--	--	--	26	28.0	11,386
Coal	Yen/kg	--	--	0.7	--	--	--	--	0.7	291
LNG	Yen/kg	--	--	1.08	--	--	--	--	1.1	400
LPG	Yen/kg	--	--	1.08	--	--	17.5	--	18.6	6,193
Electricity	Yen/kWh	--	--	--	--	0.375	-	--	0.4	675
Tax revenue (2010)	100 Mill. Yen	25,760	2,756	4,800	8,432	3,300	240	910	--	--

Notes: [1] Most upstream: Taxation at import or extraction stage;

[2] Upstream: Taxation at shipment stage out of manufacturing site;

[3] Downstream: Taxation at supply stage for the consumer.

The existing energy taxes in Japan are not directly levied for the reduction of carbon emissions although they have certain effects for mitigating energy use and corresponding emissions. In addition, the existing energy taxes are obviously a double taxation system since petroleum and coal taxes are levied at the most upstream, and more taxes are levied on several types of secondary energy products from petroleum and coal. The tax rates vary considerably if converted by carbon content of the energies. The highest rate is 24,052 Yen/t-CO_2 for gasoline, and the lowest is 291 Yen/t-CO_2 for coal. The energy-related taxes were estimated to contribute to 0.9% of carbon emission reduction (Kawase et al., 2003).

4.1.2 Carbon tax proposal of MOE of Japan

Carbon tax proposal in Japan has a long history and was discussed since early 1990's in consecutive working groups of MOE. The policy options have been narrowed to mainly two different streams: high tax rate, or low tax rate in combination with subsidies for anti climate change activities. According to the simulation of CEC (Central Environmental Council), Japan, the CO_2 reduction effect of levying carbon tax with a rate of 3,400 Yen/t-C and using all the tax revenue (around 950 Bill. Yen) as specific budget for the anti climate change activities might equal to another option of levying carbon tax with a high rate of 45,000 Yen/t-C (CEC, 2003). During 2004-2006, MOE has presented its own carbon tax proposals three times as expressed in Table 5. Because of lacking civic support, resistance from a business lobby (Keidanren) and the indifference of MOF (Ministry of Finance), the proposals were a low-rate carbon tax earmarked for anti-global-warming measures. MOE claims that, in comparison to the high carbon tax which is enough to induce all economic actors to cut CO_2 emissions significantly, its plan would achieve equivalent reduction with lower costs. Actually, the proposal of MOE is the fruit of the internal discussions of several working groups, which have studied theoretical and practical aspects broadly, including the research of foreign examples and a few simulation studies.

Table 5: Carbon tax proposal of MOE of Japan during 2004-2006

	Proposal 2004	Proposal 2005	Proposal 2006
Tax rate	2,400 Yen/t-C (655 Yen/t-CO_2, 5.45 US$/t-$CO_2$)		
Revenue (Ind.: Ser.: Hou.)	490 Bill. Yen (150:200:140)	370 Bill. Yen (160:110:100)	360 Bill. Yen
Use of the revenue	Subsidy for climate change and forestry (340); reduction of social security (150)	General budget; But subsidy for climate change and forestry	General budget, But subsidy for climate change and forestry
Special treatment	Exemption for steel, agriculture, forestry and fishery; Reduction for heavy industry, diesel, small firms	Exemption for steel; 50% reduction for large emitter which performed reduction activity; 50% reduction for	Exemption for steel and fishery; 80% reduction for large emitter which performed reduction activity; 50% reduction for

	and household	Kerosen; Put-off motor fuel	Kerosen; Put-off motor fuel

The latest version of MOE's carbon tax proposal under its tax revision request of FY2010 consider to impose the tax on the importers and exploitation enterprises of fossil fuels such as crude oil, petroleum products (gasoline, diesel, heavy oil, heating oil and aviation fuel), gaseous hydrocarbon (Natural gas and LPG) and coal. In addition, carbon tax on gasoline levied from the refinery companies has been also considered but the tax on diesel is still under consideration. As shown in Table 6, the sum of the newly proposed carbon tax and existing energy tax by energy type of Japan is still much lower than the average level of carbon tax rate of European countries like UK, Germany, France, Netherlands, Finland and Denmark. Estimated by MOE, a total of 2.0 trillion Yen revenues may be achieved by introducing the proposed carbon tax, with the tax revenue from all fossil fuels being a little bit more than 1.0 trillion and the extra tax on gasoline being a little bit less than 1.0 trillion.

Table 6: The latest carbon tax rate proposal of Japan and existing tax of EU countries (Unit: Yen/t-CO_2)

Country		Gasoline	Diesel	Heavy oil	Coal	Natural Gas
Japan	Energy tax	24,052 (12,831*)	13,034	753	291	400
	Carbon tax	8,531 *	1,064 **	1,064	1,174	1,064
	Total	21,362 *	14,098	1,817	1,465	1,464
UK		45,543	40,368	7,200	1,083	1,820
Germany		45,388	28,915	1,458	587	1,930
France		42,087	26,333	989	588	1,044
Netherlands		47,780	25,632	24,777	865	12,002
Finland		43,481	22,374	3,583	3,375	1,622
Denmark		38,651	25,506	17,429	15,256	23,692
EU-Average		43,822	28,188	9,239	3,626	7,018

Source: Ministry of the Environment website, as of September 6, 2010.

Note: * The latest carbon tax rate for gasoline is set under a prerequisite to change the existing temporary energy tax of gasoline to the number in the parenthesis.

** Additional tax on diesel is still under consideration.

Relief measures for the proposed carbon tax policy in Japan include the exemptions for the following items: 1) Fossil fuel as raw material like Naphtha; 2) Coal and cokes for iron and steel manufacturing; 3) Coal for cement manufacturing; and, 4) Bunker A for agriculture, forestry and fisheries. Specific industries should receive tax relief from the viewpoint of international competitiveness. The companies subject to the domestic emission trading scheme (ETS) should also receive tax relief after the domestic ETS had been introduced. The latest proposal suggests that carbon tax revenue should be marked as general budget but should be used preferentially for the expenditure and tax relief related to against global warming.

Regarding the effects of carbon tax policy, it has been estimated that the final energy use of industry would be reduced by 5.2% and 5.7% respectively in 2020 and 2030 compared with the BAU levels if a carbon tax of 10,000 Yen/t-C (2,727 Yen/t-CO_2) was introduced since 2009. If the carbon tax level was 2,400 Yen/t-C (655 Yen/t-CO_2), the final energy consumption of industry would be reduced by 1.3% and 1.5% from BAU levels in 2020 and 2030 respectively. There would be further carbon reduction effect if the carbon tax revenues could be used for the measures against global warming.

4.2 Policy progress of carbon tax in China

4.2.1 Existing energy-related taxes in China

In China, the taxes concerning environment and resource issues mainly include resource tax, consumption tax, tax on vehicles and vessels use and vehicle purchase tax, etc. Some of them is related to energy use and carbon emissions and is thus summarized in Table 7.

Table 7: Taxes related to energy use and carbon emissions in China

Name	Item	Tax rate	Note
Resource tax	Crude oil	8-30 Yuan/t	Except oil refined from bituminous shale
	Natural gas	2-15 Yuan/1,000 m^3	Except natural gas from coal mine
	Coal	0.3-5 Yuan/t	Referring raw coal, ex. washed and separated coal
Consumption tax	Gasoline	0.2 Yuan/l	
	Diesel	0.1 Yuan/t	
	Motorcycle	10%	
	Automobile	3-8%	
Tax on vehicles and vessels use	Vessel	1.2-5.0 Yuan/t.a	Classified by the tonnage
	Vehicle	16-320 Yuan/a	Different by the use purpose and type
Vehicle purchase tax	Vehicle	10%	

4.2.2 Carbon tax scheme proposal in China

In recent 2 or 3 years, the experts from research institutes under Ministry of Environmental Protection (MOEP), Ministry of Finance (MOF) and State Administration of Taxation (SAT) strongly discussed how to develop carbon tax policy in China. The main points are selected and summarized as follows.

Regarding the targets and scope of carbon tax, as CO_2 is mainly emitted from the consumption of fossil fuels, carbon tax shall be limited to fossil fuels including coal, oil and natural gas. Li (2010) suggested that carbon tax should not be charged on electricity in China. This is because coal-fired power plants are major producers of electricity of China. Double taxation may occur if both coal and electricity are taxed. The other reason is that taxation on electricity will increase the cost of whole industries. Basically, there are two types of methods for calculating carbon tax. One is to use the actual amount of CO_2 emissions as the basis. The other is to use the carbon content of fossil fuels to estimate the amount of CO_2 emissions. The former approach needs the monitoring of CO_2 emissions, which is technically difficult in China and costly. Considering the actual country situation, Li (2010), Wang et al. (2009) and Su et al. (2009) suggested that carbon tax shall be calculated by using the carbon content of fossil fuels in China.

Generally, there are two choices of the spots for carbon taxation. One is to impose carbon tax on the producers of fossil fuels. The other is to impose the tax on the wholesalers and retailers of fossil fuels. Under the first choice, the producers would pass the cost to the final customers by increasing prices of fossil fuels. But as the producers stay far away from the end users, the price signal due to carbon tax would decrease along the supply chain of fossil fuels, which would lead to a relatively weak effect of carbon tax on CO_2 emission reduction (Li, 2010). As the number of the producers is much smaller than consumers, the cost for tax collection would be low in this case. To impose carbon tax on consumption processes means that the energy users are direct taxpayers. The users are in large numbers and widely distributed, which makes the tax collection very difficult. But since the tax is collected directly from CO_2 emitter, it is supposed to more effectively encourage the consumers in reducing energy consumption (Cui, 2010). Considering the cost on tax collection, Cao (2009) suggested that carbon tax should be imposed at the source of energy exploitation or energy distribution hub. Su et al. (2009) also suggested the collection of carbon tax in energy production processes. In specific, for coal, petroleum and natural gas, tax should be paid by the resource exploitation companies; for refined oils like gasoline and diesel, etc., tax should be paid by the refinery companies. Li (2010) proposed one more option, to impose carbon tax for the secondary energy products, such as oil, kerosene, and gas, on the wholesalers and retailers in the middle.

The determination of carbon tax rate should consider the cost for CO_2 emission reduction from long run and its impact on the economy. The setting of tax rate should be a gradual process and differential tax rates should be adopted. Tax rate should be low at the early stage and then rise gradually (Su et al., 2009). Li (2010) suggested that low tax rate should be applied for the energy-intensive industries, such as steel and power industries. Meanwhile, attention should be paid to the energy structure of China. Carbon tax rate on coal should not be too high as most of coal is consumed by mid-low-income class. Su et al. (2009) conducted a simulation research on carbon tax in China by using CGE model, and gave suggestions of carbon tax rates as shown in Table 8.

Referring to international experience with China's actual conditions, Li (2010) suggested several possible carbon tax relief measures. Firstly, appropriate tax exemption and return mechanism should be established for those energy-intensive industries which are more likely to be affected by the introduction of carbon tax policy. However, energy-intensive industries may enjoy this preferential measure only under conditions such as signing agreements with the government to promise the reduction of CO_2 emissions or improvement on energy efficiency, and making efforts in energy saving. Secondly, tax refund is provided as incentives for the enterprises which have shown significant emission reductions, or increased investment in energy saving, improved the energy efficiency by using advanced facilities and technologies. Lastly, for low-income groups, tax return shall be offered to guarantee their basic living and maintain social stability.

Table 8: Proposal of carbon tax rate of China

Items	Tax rate	
	From 2012	From 2020
Carbon tax (Yuan/t-CO_2)	10	40
Carbon tax of coal (Yuan/ton)	19.4	77.6
Carbon tax of oil (Yuan/ton)	30.3	121.2
Carbon tax of gasoline (Yuan/ton)	29.5	118
Carbon tax of kerosene (Yuan/ton)	31.3	125.2
Carbon tax of natural gas (Yuan/ 1,000 m^3)	2.2	8.8

As the imposition of carbon tax will have an impact on macro economy and social actors at micro-level, it has to overcome the obstacles from taxpayers and consider domestic and international economic conditions. Su et al. (2009) pointed out that according to the 'Bali roadmap', not only developed countries are required to commit to a deep emission reduction which is measurable, reportable and verifiable, but developing countries are requested to take proper actions to reduce GHG emissions. China will face greater pressure to control its GHG emissions after 2012. Therefore, to impose carbon tax around 2012 is consistent with Chinese strategy of adding policies on controlling CO_2 emissions in a timely manner to satisfy the needs of international climate negotiations.

4.3 Policy progress of carbon tax in Korea

4.3.1 Energy-related tax in Korea

Korea has no environmental related tax law as a national tax but only a transportation tax related to air pollution as a local tax. However, there is energy-related tax in Korea. According to Lee (2005), refinery prices of gasoline and diesel were 0.21 and 0.20 US$/l respectively in 1999. Their after-tax wholesale prices were 0.94 and 0.40 US$/l respectively at that time, which means 0.73 and 0.20 US$/l energy tax for gasoline and diesel respectively at that time. From an international comparison, Korea had a higher energy tax rate (74.8%) for gasoline than Japan (56.2%) and the U.S. (31.0%). In case of transport diesel, Korea has a lower tax rate (39.9%) than Japan (52.4%) and UK (72.1%). This indicates that Korean government has generally supported industrial rather than household fuel consumption through the use of different tax rates. Energy prices in Korea have been subject to heavy regulation and taxation and believed to be seriously distorted. The Korea government has taken steps towards reforming the pricing and taxing practices in a step-wise manner (Kim et al., 2001). Industrial sectors would face higher prices and oil products would share their current high burden of taxes with other fuels. However, high taxation on transport fuels (gasoline, diesel and LPG) would continue with some burden on gasoline shifting to diesel and LPG. One of the key targets in the reform plan is to reduce the price differences in different transport fuels by increasing the price of diesel and LPG up to 80% and 65% of gasoline price. For the industrial fuel, one proposal is to increase the price of Bunker C by 28% and keep the price of LNG unchanged. The other proposal is to adjust import charges based on calorific values if fuels to induce fair competition among the industries. The expected effect of the reform would be around 7.6% of reduction of CO_2 emissions (Lee, 2005).

4.3.2 Discussions of carbon tax proposal in Korea

There is debate in Korea regarding the introduction of carbon tax policy. To reduce the carbon emissions, the best way is to levy the tax according to the emission quantity if it can be measurable. This method, however, is unable to measure accurately and requires a lot of cost related to administration and information. A simple alternative method is to levy the tax on the fuel containing carbon, which can satisfy the Polluter Pays Principle (PPP) (Kim, 2008). Kim (1997) argued for indirect tax scheme rather than direct method to internalize the external cost caused by CO_2 emissions. As the production structure of Korea has a lower substitutability of other inputs for energy input, the carbon tax system will stimulate the substitution effect, which will transform the economic structure through energy-saving production technology (Park, 2003). Choi et al. (2000) asserted that the big fluctuation in price changes by industry would occur at the high carbon tax rate and suggested to apply a dem policy in the industries having big price changes.

About the matter of introduction of carbon tax, Cho (2005) explains negative or positive aspects that may arise in Korea. The negative opinion is of the possibility of transferring the carbon tax burden from producers to consumers. This happens when the product is price inelastic. This price increase implies that a part of the environmental tax burden to producers is transferred to the consumers who cannot find a substitute product. The dem and decrease due to the price increase may lead to production decrease that may yield wage decrease and unemployment. The positive aspect is the possibility of enhancing the competitiveness of firms or industries caused by investing in research and development projects. The production process innovation leading to increasing return to scale may disconnect the negative tie between economic growth and environment. The innovation for clean products and production processes may accompany the environmental protection with firms' competitiveness enhancement. In the long run, the initial impact on the energy price increase due to carbon tax can be an economic benefit.

Kim and Shin (2007) analyzed that Korea depends on petroleum and coal products more than China, Japan and the U.S. in response to the carbon tax. In case of introducing carbon tax, Korea will be the worst victim compared with its main trading countries. However, the general attitude toward the carbon tax in Korea is rather positive among the environment related scholars and specialists. Many Koreans think they have experienced the dependency on fossil fuel using production technologies and it is necessary to develop energy efficient production structure.

5. A comparative analysis of carbon tax proposals in the three countries

Considering the cost and difficulty of tax collection, all the proposals of carbon tax policy in the three countries suggest levying the tax on the fuels containing carbon. This means that the importers, producers, wholesalers and retailers of fossil fuels at most upstream or upstream would be possibly defined as the targets for the levy of carbon tax. A shortage of this choice is the relatively weak effect of the price signal from carbon tax since the energy producers stay far away from the large number of end users.

Due to the concern of negative impacts of carbon tax on economy growth and industrial competency in the international market, especially for those energy and carbon-intensive industries, the proposed carbon tax rate is low. The latest carbon tax proposal of MOE of Japan suggests a rate of 1,064Yen/t-CO_2 (about 12.5US$/t-$CO_2$, 1US$ ≈ 85Yen at current change rate) for the energy types under consideration except for gasoline. This rate is much lower than the rate (43.6US$/t-$CO_2$) discussed by Nakata and Lamont (2001). Actually, carbon tax proposal of Japan could be regarded as a supplementary of existing energy-related taxes. As we compared earlier, the sum of the proposed carbon tax and existing energy-related tax by energy type in Japan is still far lower that the average levels of EU countries having carbon tax policy. Similarly, carbon tax proposed by the governmental affiliated experts in China is a low tax rate too (about 1.5US$/t-$CO_2$ from 2012, 1US$ ≈ 6.8Yuan at current change rate). This rate is also far lower than the options suggested by Liang et al. (2007) (5.4-11.5 US$/t-$CO_2$, 1US$ ≈ 8.3Yuan at change rate in 2002). Specific rate of carbon tax proposal could not be found in Korea based on the available information. However, we can not expect a high tax rate there due to heavy reliance of energy imports of Korea and higher sensitivity of Korean energy system to the introduction of carbon tax (Kim and Shin, 2007).

All the discussions and proposals of carbon tax in the three countries considered tax relief measures in order to reduce the negative impacts of this policy on economy and industries. The proposed carbon tax policy in Japan excludes fossil fuel as raw material, coal and cokes for iron and steel manufacturing, coal for cement manufacturing and heavy oil for the use of agriculture, forestry and fisheries. The companies subject the domestic ETS would also receive tax relief. Certain Japanese scholar recommends reducing the capital tax of enterprises rather than the labor and consumption taxes by using carbon tax revenue as the strong double dividend arise in this case (Takeda, 2007). Appropriate tax exemption and return mechanism is also suggested for the energy-intensive industries in China (Li, 2010). Basically, carbon tax refund is preferred to work as incentives for the efforts of energy saving and CO_2 emissions reduction of the enterprises. In similar, the experts in Korea suggested applying a dem and management measure for the industries with large cost changes due to the introduction of carbon tax (Choi et al., 2000). Kwon and Heo (2010) suggest that a lump-sum transfer of revenue makes the carbon tax policy progressive.

Although there is certain progress of carbon tax discussions in the three target countries, high barriers still exist and are hindering the actual implementation of this policy.

In Japan, the carbon tax is in a political stalemate. From the view of an aging society, the shift of taxation from labor to environment is very important and inevitable. The strong resistance of industrial lobbies, such as Keidanren, is the most crucial factor blocking the implementation of carbon tax. The highly multifaceted political issue like the environmental tax reform requires inter-ministerial cooperation between competent ministries such as MOF, METI (Ministry of Economy, Trade and Industry, competent for energy policy), MLIT (Ministry of Land, Infrastructure and Transportation, competent for spending of gasoline tax revenue), MAFF (Ministry of Agriculture, Forestry and Fisheries of Japan) and MOEJ. However, it is very hard to harmonize their interests. An interesting and encouraging thing is the increasing support of the public to carbon tax policy in Japan. According to the government poll in 2007, the proponents for carbon tax have increased to 40.1% while 32.0% of the population was against. And more than 70% of proponents preferred the total tax revenue to be earmarked for anti-global-warming (Cabinet Office of Japan, 2007). In 2005, only 24.8% of the respondents were proponents and 32.4% were against in the similar survey. This shows the needs for better public understanding of environmental tax reform.

The Chinese experts are relatively optimistic to the introduction of carbon tax in China due to the comparative advantages of this policy to ETS and its limited negative impacts to the economy. The research report of ERI (Energy Research Institute) under NDRC on carbon tax scheme in 2009 pointed out that the loss of GDP would be less than 0.5% by 2025 due to the introduction of this policy (Jiang, 2010). The attitudes of related ministries at national level, such as MOEP, NDRC, MOF and STA, are positive to the reform of environmental taxes. However, as carbon tax is a new category of tax in China, the enterprises will be reluctant at the beginning. It will take time for the public to recognize and well understand this new tax. The additional barriers include the decrease of product competency in international market, the impacts on the people with different income levels and carbon leakage problems due to the implementation of carbon tax policy (Jiang, 2010).

In Korea, Along with a planned emissions trading system, imposing a carbon tax on products and services should be aimed at containing the use of fossil fuels and promoting renewable energy sources. However, policymakers must overcome major obstacles to create the tax (The Korea Times, 2010). First, they will have to work out measures to absorb a possible shock to manufacturing industries. It is urgent to push structural reform of the nation’s economy and industries so that businesses can adjust themselves to the low-carbon strategy. Second, a carbon tax should not serve as a means to raise tax burdens on consumers. No matter how good the purpose of the tax is, people will resist it if they are forced to give up their money. Thus, it is necessary to press ahead with overall tax reform. Most of all, the government must make efforts to build public consensus on the tax issue in particular.

6. Conclusions

This paper provides a preliminary but integrative summary of ongoing discussions of carbon tax policy in the three countries based in Northeast Asia based on available information. A comparative analysis is conducted to identify opportunities and barriers of introducing carbon tax in this region from a multiplier viewpoint. It is indicated that the design of carbon tax scheme, including the scope, tax rate, collection and utilization of the tax is very important and need to adapt the actual situations of each country, which thus requests much heavy discussions for convincing the decision-makers. Our comparison also identifies the problems of target countries in implementing carbon tax policy due to political resistance and energy structure characteristics. As the taxation of carbon may cause a shift from coal to other low carbon energy, the existing energy tax with additional carbon tax as the supplementary would be a more stable and acceptable approach for Japan and Korea which highly rely on energy imports from abroad. As the way forward, discussions of acceptability to carbon tax from the perspective of individual companies are highly necessary to overcome their resistance to this policy. Their reactions to optional tax scenarios and corresponding behavioral changes, especially on technological innovations and the choice of greener technologies, bear in-depth analysis.

Acknowledgements:

The authors would like to express our gratitude to Associate Prof. Can Wang at Department of Environmental Science and Engineering, Tsinghua University for providing part of the information related to China. Thanks are also given to Ms. Yan Hong and Ms. Akiko Mizumoto for their assistance during the preparation of this manuscript.

References:

Andersen, M.S., Ekins, P. (Eds.), 2009. Carbon Taxation: Lessons from Europe, Oxford University Press, Oxford/New York.

Cabinet Office of Japan, 2007. Public opinion on anti-global warming (in Japanese). Available at: http://www8.cao.go.jp/survey/h19/h19-globalwarming/index.html.

Cansier D., Krumm R., 1997. Air pollution taxation: An empirical survey. Ecological Economics 23(1): 59-70.

Cao J., 2009. Low carbon development: China's carbon policy design and CGE model analysis. Journal of Financial Research (in Chinese) 12: 19-29.

CEC (Central Environmental Council), 2003. Concrete plan for anti-global warming taxes (in Japanese), Report of Central Environmental Council of Japan.

Cho Y., 2005. Environmental strategy of OECD members. Journal of Economics and Management 5(1): 153-191.

Choi Y.H., Lim W.Y., Kim S.H., 2000. The price variable effect of carbon tax per industry. Quarterly Review of Economics and Business 28(1): 1-17.

Cui J., 2010. Thinking about levying carbon tax in China. Taxation Research (in Chinese) 1: 41-44.

IEA (International Energy Agency), 2009. Cleaner coal in China, pp.104-117.

Jiang K.J., 2010. The loss of GDP due to carbon tax is less than 0.5% (in Chinese). Available at: http://finance.jrj.com.cn/people/2010/05/2709097536091.shtml.

Kawase A., Kitamura Y., Hashimoto K., 2003. CO2 emission reduction effect by energy tax and reform of green taxation plan – simulation analysis by applied general equilibrium model. Japan Economy Research (in Japanese) 48: 76-98.

Kim H.G., 2008. On the views of carbon tax in Korea. American Journal of Applied Sciences 5(11): 1558-1561.

Kim H.G., Shin H.J., 2007. An analysis of changes in production and trade of US, Japan, China and Korea affected by levy of carbon tax. International and Area Study Review 11 (1): 273-291.

Kim S.H., 1997. A study on the effect of carbon taxes on the industrial sector in Korea. Journal of Regional Development 3: 263-284.

Kim S.H., Kim T.H., Kim Y.D., Na I.G., 2001. Korean energy demand in the new millennium: outlook and policy implications, 2000-2005. Energy Policy 29(2001): 899-910.

Kwon O.S., Heo D.Y., 2010. The incidence of green tax in Korea, paper presented in the 1st Congress of East Asian Association of Environmental and Natural Resource Economics, August 18-19, 2010, Hokkaido University, Sapporo, Japan.

Liang Q.M., Fan Y., Wei Y.M., 2007. Carbon taxation policy in China: How to protect energy and trade-intensive sectors? Journal of Policy Modeling 29(2007): 311-333.

Lee M.K., 2005. Reviewing tax system and its reform plan for the fuel market in South Korea. Energy Policy 33(2005): 475-482.

Li C.X., 2010. Study of carbon tax policy framework for addressing climate change. Law Science Magazine (in Chinese) 6: 20-22.

Mankiw G. (2007). One answer to a global warming: a new tax. New York Times, September 16, 2007.

MOE (Ministry of Environment), 2010. Medium and long term roadmap related to global warming countermeasures, March of 2010, Sourced from: http://www.env.go.jp/earth/ondanka/domestic.html.

Nakata T., Lamont A., 2001. Analysis of the impacts of carbon taxes on energy systems in Japan. Energy Policy 29(2001): 159-166

NDRC (National Development and Reform Commission), 2007. China National Climate Change Program, June 2007.

Park J.S., 2003. An economic approach to climate change policy. Journal of Social Science 20(2):233-259.

People's Daily, 2008. http://english.peopledaily.com.cn/90001/90776/90785/6548233.html, December 6, 2008.

Price L., Wang X.J., Yun J., 2008. China's Top-1000 Energy-Consuming Enterprises Program: Reducing Energy Consumption of the 1000 Largest Industrial Enterprises in China, LBNL-519E, available at: http://ies.lbl.gov/iespubs/LBNL-519E.pdf.

Su M., Fu Z.H., Xu W., Wang Z.G., Li X., Liang Q., Research on levying carbon tax in China. Review of Economic Research (in Chinese) 72: 2-16.

Takeda S., 2007. The double dividend from carbon regulations in Japan. Journal of the Japanese and International Economies 21(2007): 336-364.

The Korea Times, 2010. Carbon tax: Time to put green growth strategy into action. Available at: http://www.koreatimes.co.kr/www/news/opinon/2010/02/137_60889.html.

Wang J.N., Yan G., Jiang K.J., Liu L.C., Yang J.T., Ge C.Z., 2009. The study of China's carbon tax policy to mitigate climate change. China Environmental Science (in Chinese) 29(1): 29-32.

Xinhua News Agency, 2008. China focus: China takes responsible attitude to climate change and environmental protection, April 2008.