1. Global Environmental Taxes: Theory and Practice

1.1 GLOBAL WARMING AND CARBON TAX

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The phenomenon of global warming can be attributed to the sustained increase in atmospheric concentration of the so-called greenhouse gases such as moisture and carbon dioxide. The atmospheric concentration of carbon dioxide, in particular, has been increasing at quite a rapid pace during the past two hundred years since the Industrial Revolution which propagated the economic pattern of mass-production and mass-consumption. This pattern, in turn, resulted in the mass-consumption of fossil fuels in the energy area and caused a massive release of carbon dioxide into the air. The destruction of forests, which have helped absorb atmospheric carbon dioxide, and the recent assailing devastation of tropical rain forest, in particular, appears to have too serious an impact to be disregarded.

Thus, the global warming issue is largely an economic phenomenon, and a fundamental viewpoint to study this phenomenon can be provided by the theory of Social Overhead Capital. By social overhead capital, it is meat such scarce resources that generate services crucial for the life and survival of the people, whose private ownership and control should be replaced by social management and stipulation of their use as common property of the community. In the case of accumulation of carbon dioxide in the air, it is responsible for global warming or an atmospheric disequilibrium, and hence is deemed as a negative social overhead capital.

The concept of "imputed price" as propounded by Carl Menger is central to a proper understanding of the standard to be followed in the management of social overhead capital. When we apply this concept to the question of carbon dioxide, its negative imputed price is the discounted present value obtained by calculating the social loss that will be caused by a marginal increase in its atmospheric content. By imposing a carbon tax based on this imputed price on all those economic activities that emit carbon dioxide into the air, it is possible to recover a socially equitable atmospheric equilibrium that takes into account not only the present generation but also all future generations.

A carbon tax is levied largely to cope with emissions of carbon dioxide arising from the combustion of fossil fuel such as oil and coal. However, the role of wooded lands and especially that of tropical rain forests in absorbing carbon dioxide cannot be disregarded. Consequently, a subsidy needs to be granted to the imputed price of atmospheric carbon dioxide reduction, while a charge must be levied to deforestation.

The concept of imputed prices as discussed above is applicable to all types of greenhouse gases including methane and chlorofluorocarbons. In extending the idea of carbon tax internationally, however, it is important to pay due attention to the economic and social gaps that exist between the developed industrial countries and the developing countries (the question of horizontal equity) as well as the inter-generational equity discussed above. According to the Uzawa's formula, a brief account of which will be given below, the system of imputed prices must be so determined as to be proportional to the per capita income of each country rather than uniform throughout the word. For the carbon tax system to be fully effective, not only in restoring the stability of

atmospheric equilibrium but also in remedying the existing international economic gaps, it would be critical to establish some global fund such as International Fund for Atmospheric Stabilization that can collect and recycle net tax revenues for international redistribution purposes.

On Uzawa's Formula

- The basic idea of the Uzawa's formula is to install a mechanism of efficient and inter-generationally equitable allocation of resources by employing the concept of imputed prices within a framework of dynamic optimal growth theory.

- On the basis of the existence of an efficient price mechanism, a carbon tax is levied to carbon dioxide emissions according to the imputed price per ton of carbon emission, and a subsidy is granted to fostering land forests that help absorb and sequester carbon dioxide, again according to the imputed price per hectare of forest land.

- In determining imputed prices, due attentions are paid to inter-country equity of income distribution as well as inter-generational equity. It can be shown that by adopting the system of imputed prices to be explained below, the atmospheric concentration of carbon dioxide will approach an optimum level from the long-term point of view.

- A Proposal for Establishing International Fund for Atmospheric Stabilization.

Each government contributes a certain percentage of net revenue arising from carbon tax and afforestation subsidy to establish an international fund. Resources made available are distributed to developing countries according to per capita national income gaps and population. The allocation is designed to compensate for the negative effect of carbon tax for economic development, to assist the development of energy conservation technology and of alternative energy sources, and to finance the restructuring of social overhead capital.

- Let the imputed price of carbon dioxide per ton be p_v and per capita national income by y_v for country v. Then,

$$p_v/y_v=\theta$$

where θ is a parameter common to all countries that can be expressed as

$$\theta=[\beta/(\delta+\mu)]\cdot[N/(\hat{V}-V)] \qquad (1)$$

δ: social discount rate (5 per cent)
μ: the percentage of carbon dioxide in the air absorbed by the surface of oceans per year (4 per cent)
$\hat{V}$: the critical level of atmospheric concentration of carbon dioxide beyond which drastic changes in environmental conditions would exert serious, irrevocable damage on human life (1,200 Gt.)
V: the current level of atmospheric carbon dioxide (700-800 Gt.)
β: the intensity showing how seriously the damage caused by global warming will be felt (here taken to be 0.1)
N: world total population (5.2 billion).

Substituting above values to equation (1), we obtain

$$\theta=0.01.$$

Therefore, the carbon tax to be levied by each country to carbon dioxide emission (per ton of carbon) is equal to

$$p_v = 0.01 \times y_v.$$

- Now, let the imputed price per hectare of forest land of county v be q_v.
Then,

$$q_v/y_v=\eta,$$

where η is a parameter common to all countries that can be expressed as

$$\eta = (\gamma/\delta)\cdot\theta, \qquad (2)$$

γ: the amount of atmospheric level of carbon dioxide absorbed by a marginal increase in the stock of land forests (equals 15 tons/ha for tropical rain forests and 5 tons/ha for temperate forests).

Substituting these values to equation (2), we have

η =3.0 (tropical rain forests)
=1.0 (temperate forests).

Therefore, the rate of subsidy for afforestation per hectare is

$$q_v=3.0 \times y_v$$

for tropical rain forests, and

$$q_v=1.0 \times y_v$$

for temperate forests.

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Table 1 Imputed Prices for Greenhouse Gases

Country	Population 1990 (million)	Per Capita National Income (assumed) ($)	Net Annual Atmospheric Increase CO_2 (mil. tons)	Net Auunal Atmospheric Increase CH_4 (mil. tons)	Carbon Equivalent (mil. tons)	Net Anuual Atmospheric Increase CFC Use (mil. tons)	Carbon Equivalent (mil. tons)	Net Annual Atmospheric Increase Total (mil. tonsC)	Per Capita (mil. tonsC)	Imputed Price ($/tC)	Total (mil. $)	Assessment Per Capita ($)
United State	249	15,000	540	7.1	130	197	350.0	1,000	4.0	150	150,000	600.0
Canada	27	12,000	48	1.7	33	21	36.0	120	4.5	120	14,400	540.0
United Kingdom	57	11,000	69	0.7	14	40	71.0	150	2.6	110	16,500	286.0
France	56	12,000	41	0.7	13	39	69.0	120	2.1	120	14,400	252.0
Germany, frm. W.G.	61	15,000	79	0.4	8	43	75.0	160	2.6	150	24,000	390.0
frm. E.G.	17	6,000	39	0.1	2	12	20.0	62	3.7	60	3,720	222.0
Italy	57	11,000	45	0.3	6	40	71.0	120	2.1	110	13,200	231.0
Indonesia	181	400	110	1.0	19	5	9.5	140	0.8	4	560	3.0
Japan	124	15,000	110	0.7	12	58	100.0	220	1.8	150	33,000	270.0
Korea	44	2,600	21	0.2	29	3	54.0	29	0.7	26	754	18.0
Malysia	17	1,800	22	0.1	1	1	2.5	26	1.5	18	468	27.0
Philippines	62	500	34	0.4	7	0	0.0	40	0.6	5	200	3.0
Singapore	3	7,000	3	0.0	0	2	3.7	7	2.4	70	490	168.0
Thailand	56	800	48	0.8	16	2	3.5	67	1.2	8	536	9.5
Australia	17	9,000	28	0.8	14	12	21.0	63	3.7	90	5,670	333.0
New Zealand	3	8,000	3	0.2	4	2	3.5	10	3.3	80	800	264.0

Sources: *World Resoucs, 1990-91*, Table 24.2, pp.348-9, and others

Table 2 Imputed Prices for Reforestation

Country	Forests and Woodlands (million ha)	Net Annual Reforesta -tion (1,000 ha)	Imputed Price ($/ha)	Assessment Total (million $)	Assessment Per Capita ($)
United State	300	1,600	15,000	24,000	96.4
Canada	436	720	12,000	8,640	320.0
United Kingdom	2	40	11,000	440	7.7
France	15	51	12,000	612	10.9
Germany, frm. W.G.	7	62	15,000	930	15.2
frm. E.G.	3	--	6,000	--	--
Italy	8	15	11,000	165	2.9
Indonesia	120	-800	1,200	-960	-5.3
Japan	25	200	15,000	3,000	24.2
Korea	5	80	2,600	210	4.7
Malysia	20	-230	5,400	-1,424	-73.1
Philippines	10	-80	1,500	-120	-1.9
Singapore	--	--	--	--	--
Thailand	16	-370	2,400	-890	-15.9
Australia	110	60	9,000	540	31.8
New Zealand	10	40	8,000	320	106.7

Sources: *World Resources, 1990-91*, Table 19.1, pp.292-3.

1.2 ASPECTS OF TAXATION FOR PROTECTING GLOBAL ENVIRONMENT

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1. GLOBAL ENVIRONMENTAL PROTECTION AND ECONOMIC INSTRUMENTS

Global environmental problems are caused by a wide range of economic activities world-wide and they require enormous cost and economic impacts to respond to them. Therefore, in order to solve them, it is important to reduce the tremendous costs and to achieve an appropriate sharing of the expenses by means of intervening in economic activities efficiently and effectively. The most effective means available is "economic instruments which try to settle the problems by using the market mechanism," such as environmental taxes levied on polluters and tradable emission permits dealt among polluters. Effective use of these instruments will be able to control pollution and destruction of the environment at a minimum cost, and to promote technological innovations for the long-term protection of the environment (Morita, (1990)). The economic instruments are generally superior to regulatory instruments which restrain on polluters directly. In particular as for taxes and charges, many institutions have been implemented until now to raise funds. Taxation for environmental protection has already been adopted in many countries and a carbon tax has been put into effect in some countries. The environmental tax is being debated in earnest.

This paper will review the outline of taxation systems for regional and global environmental management, and indicate several important aspects which must be assessed before actual implementation of carbon taxes.

2. STATUS OF TAXATION AS AN INSTRUMENT OF ENVIRONMENT POLICY

Many taxation institutions have already been introduced to preserve the environment. According to an OECD survey (OECD, (1989)), 81 institutions were reported as of 1987. Their purposes are wide-ranging: air pollution control, elimination of water contamination, noise control, disposal of waste materials, and promotion of recycling. Various taxation methods are used: effluent charge, which levies a tax according to the amount of pollutants discharged, a user charge which collects fees from users to finance the disposal of waste materials, a product charge levied at the production stage or at consumption and an administrative charge, which is paid for administrative supervision or services such as issuing permits. Most are designed to raise funds, but some offer environment preservation incentives. However, the tax rates as a whole are low and fall short of achieving a sufficient incentive effect.

The number of taxation systems is increased if we add those related to the preservation of the environment, although these do not stated the environmental goal. Listed in Table 1 are taxation systems recently introduced. Taxes on cars and car fuels are in force in almost all the developed countries, and many take into account air pollution and energy consumption. Many countries have already introduced the deposit-refund system, which encourages the collection of disposable containers or vessels and batteries, or systems offering tax breaks or a lower tax for investments in environmental

protections such as energy conservation or pollution-control facilities.

Japan previously levied a charge on plants according to the discharge of sulfur dioxide to compensate for damage to health resulting from air pollution. The tax was a very effective 25 yen to 31 yen per liter of heavy oil.

3. TAXATION FOR PROTECTING THE GLOBAL ENVIRONMENT

Recently, systems have emerged designed to protect the global environment: carbon dioxide tax (carbon tax), which controls the emissions of greenhouse gases responsible for global warming, and a tax on chloro-freon gas which depletes the stratospheric ozone layer. The carbon tax is already in force in four countries as shown on Table 2. The first country to adopt a clear carbon tax was Finland. That country imposed an additional tax proportional to the carbon content, in addition to the fuel tax on fossil fuels. The tax rate stood at a relatively low 24.5 Finnish marks (about 740 yen) per ton of carbon, except for car fuels. However, Sweden instituted a tough carbon tax in 1991, collecting 250 SEK (about 5,600 yen) per ton of carbon, more than seven times the Finnish rate. This is seen as part of a systematic reform of the energy taxation system aimed not only preventing global warming but also at restricting the emissions of regional air pollutants. Its tax revenues are included in general budget sources.

Table 2. Outline of existing carbon taxes

	Finland	Netherlands	Sweden	Norway
Effective date	Jan. 1990	Feb. 1990	Jan. 1991	Jan. 1991
Gasoline/diesel	9 yen/l	2.9 yen/l	13 yen/l	12 yen/l
Coal	432 yen/ton	188 yen/ton	12600 yen/ton	?
LPG	?	244 yen/ton	15200 yen/ton	?
Natural Gas	260 yen/m3	100 yen/m3	9600 yen/m3	?
Tax rate per carbon ton (tc)	800 yen/tc	300 yen/tc	20000 yen/tc -23000 yen/tc	10000 yen

Note: Assuming an exchange rate 140 Japanese yen per US dollar.

On the other hand, the introduction of an energy/carbon dioxide tax is being planned in the EC, which sets a tax by considering the amount of energy (calorific value) and the carbon content of the given fuel on a 50-50 basis. Its objective is to stabilize carbon dioxide emissions at the 1990 level by 2000. One proposal calls for a tax of three US dollars per barrel in terms of oil in 1993 and raise it by one dollar every year to 20 US dollars by 2000. The OECD is also considering the introduction of a carbon tax. The carbon tax is also being studied as a tool for raising the funds necessary to protect the global environment, with an eye to the Earth Summit slated in 1992. In Japan, the debate is getting heated, following the establishment of a study committee of environmental tax at the Environment Agency, with objections raised in the industry and labor communities.

Another taxes proposed for preserving the global environment are a comprehensive tax for stabilizing global climate considering CO_2, methane, and other greenhouse gases, a tax on the import and consumption of tropical rain forest timber, and a tax on the use of the high seas.

4. ASPECTS OF IMPLEMENTING CARBON TAXES

To implement carbon taxes for stabilizing global climate, it is necessary to discuss a host of important aspects, in addition to the basics, such as taxable objects and scope, the neutrality of tax revenues, the tax collector, and relations with the existing tax system. These important aspects are as follows;

(1) Existing distortions: At present, various taxes are in force, making it difficult for a new tax to produce the desired incentive. For example, to convert the present taxes on fossil fuels in Japan, the oil tax is 130 dollars per ton of carbon but the coal tax is zero (Hoeller *et al*, (1991)).

(2) Distributional incidence: The carbon tax imposes a heavier burden on the low-income brackets. According to Poterba's analysis (Poterba, (1991)), assuming a tax of 100 dollars on one ton of carbon, the wealthy people in the United States might have only to pay 1-2% of their income, while the poor people would have to pay 10%. A universal carbon tax throughout the world is likely to widen the distributional gap between the North and the South.

(3) Recycling of tax revenue: Revenues from the carbon tax will swell to an immense level and their use will require careful consideration. For instance, in Japan a carbon tax of 100 dollars per ton of carbon (about 9 yen per litter of gasoline) will generate revenues equivalent to one percent of GNP.

(4) Administration cost of tax collection: As a high tax rate of 200 dollars per ton of carbon will be required to stabilize the concentration of carbon dioxide, the criteria for tax collection will become complicate in order to introduce the exceptional provisions for handicaps. The cost of collecting the tax will grow significantly.

(5) Impacts of tax on the macroeconomy: The effects of a high tax rate on the macroeconomy will become too serious to ignore. According to projections available, the stabilization of carbon dioxide emissions in Japan will cause a loss of 0.6%-5% in gross domestic product and the worldwide stabilization of carbon dioxide discharge a loss of 1%-4% in gross product (Amano, (1991)). The estimates of the impacts differ widely, leaving methodological problems to be improved.

(6) Impacts of tax on international competitiveness: If only one country is subject to a high tax, its international competitiveness will be sapped. The EC's energy/carbon dioxide tax program does not propose imposing any taxes on steel and other energy-intensive industries until major outside competitors adopt similar steps.

(7) Relations with other policy instruments: Various means need to be used together for protecting the global environment. In few cases the carbon tax will be used independently. It is necessary to consider an effective combination with direct regulations, subsidies, and the international emission trading system.

(8) Relations with other policy aims: Taxation for preserving the global environment is very likely to aid other policy aims, such as improving the environment in some areas and contradict policies of fostering particular industries. Such indirect impacts warrant further investigation.

(9) Political preferences as regards taxation system: It is said that Japan's industry as a whole favors direct regulatory systems. A recent survey conducted by McKinsey (McKinsey and Company, (1991)) shows such a preference in Japan. Uncertainty over the taxation system and disadvantages of political negotiations seems to be a reason of the preference. It is also important to pay attention to the preferences of the public and the bureaucracy.

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Table 1. A list of Taxation Systems Related to Environmental Management Impremented in OECD Countries

		Australia	Austria	Belgium	Canada	Denmark	Finland	France	Iceland	Ireland	Japan	Nether-lands	Norway	Portugal	Sweden	Switzer-land	UK	US	Yugo-slavia
Taxes on registration and use of moter viecle	One-off taxes	-Sale tax -State taxes	-VAT -Income tax reduction	-VAT -Tax for incentive to install catalyic conv.	-Air conditioner tax -Excise tax	-Regist-ration tax	-VAT -Sales tax -Scrap-ping fee		-VAT -Import Tariff -Regist-ration fee -Excise	-VAT	-Local sales tax -Con-sumption tax -Acqui-sition tax	-VAT -Sales tax -Tax reduction for cata-lytic con.	-Import tax -Licence tax -Transfer tax	-VAT	-Sales tax	-Import tax	-Car tax -VAT	-Gas guzzler excise tax	-Turn-over tax
		-Weight tax -fees for licences	-ED -Road tax	-Road tax		-Weight tax	-ED		-Weight-distance tax -Weight tax	-Road tax	-Tonnage tax -Auto-mobile tax	-ED	-ED -Kilo-metre tax	-ED -Driving tax	-ED -Kilo-metre tax	-Moter vehicle tax -Moter-way tax	-ED		
Taxes on Moter fuels		-ED -VAT -Licence fee	-ED -VAT -Import tax	-ED -VAT	-ED -Goods & services tax	-ED -VAT	-ED -CO2 tax -General sales tax	-ED -VAT	-ED -VAT	-ED -VAT	-Petrotax -ED -Road tax -LPG tax -Con-sumption tax	-General funding tax -ED -VAT	-ED -CO2 tax -Sulphur tax	-ED -VAT	-CO2 tax -ED -Energy tax on sulphur and HC -VAT	-ED -Turn-over tax	-ED -VAT	-ED	-Turn-over tax
Waste disposal and management charges		-Waste manageme nt charge -Licence fee	-Con-taminated sites clean-up charges	-Ocian waste dumping charge		-Waste charge	-Oil charge -Water charge -Nuclear charge	-Waste oil charge		-Waste disposal charge		-Chem-ical waste charge	-Waste Oil charge		-Oil dumping charge			-Super-fund excise tax	
Taxes and charges on aircraft								-Aircraft noise charge				-Aircraft noise tax	-Aircraft noise tax	-Special aircraft tax	-CO2 tax	-Aircraft landing tax			
Taxes on other goods and services		-CFC -Recycl-ed paper -Solar power equip.	-Tyers -Refri-gerators		-Pack-aging	-Raw materials -Bever-age Con-tainer -CFC, etc	-Sand & gravel -Bever-age Con-tainer -CFC,etc	-Packag-ing					-Batteries -Bever-age Con-tainer -CFC, etc		-Bat-teries -Bever-age Con-tainer				
Deposit-refund system			-Batteries -Bever-age Con-taines -Light bubles		-Bever-age Con-taines	-Batteries	-Batterie -Bottles -Car hulks -Tyres	-Bever-ages				-Bottles	-Bottles -car wreeks					-Bottles -Almin-ium cans	
Tax incentives for environmental investments		-Land degradat. -Water conservatio n -Environ. impact Studies, etc.	-Energy saving -Low-noise lorries -Invest-ment in environ-ment	-Invest-ments to minimize negative env.iron-mental impacts	-Water and air pollution control investments	-Envi-ronmentl improve-ment on small farms	-Water and air pollution control investments	-Pollut-ion redu-ction equipmnt -Energy saving equip-ment		-Wood-land manage-ment -Effluent control -Land drainage etc.	-Energy saving -Pollut-ion redu-ction -Recycl-ing -Asbestos reduction			-Energy saving -Pollut-ion redu-ction -Alter-native energy develop.		-Energy saving -Alter-native energy develop-ment		-Solar and geo-thermal property	

Note 1: This list is based on the OECD survey in April 1991. Six countries that did not respond to the questionnaire are: Germany, Greece, Italy, Luxembourg, New Zealand, and Spain.

Note 2: VAT stands for "value-added tax", and ED for "excise duty".