3.3 ENVIRONMENTAL POLICY AND WORLD ECONOMY

Databank Bureau

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The present project has been intellectually inspired and financially supported by Global Environment Forum-KANSAI(GEF-KANSAI), which is a non-profit, interim organization composed of private corporations, local governments, unions, consumer groups, and academics that are active in the Kansai area. In this paper we are going to present the results of our carbon tax simulation exercises based on an annual econometric model, which have taken our forecast of the global economy and of world energy consumption through 2010 as a baseline. The purpose of the project lies primarily in obtaining information on the relationships between model assumptions and the outcomes of CO2 reduction measures. The present research, therefore, does represent none of policy recommendations of GEF-KANSAI. (See Figures 1 and 2 for an overview of the model.)

1. OUTLOOK OF WORLD ECONOMY AND CO2 EMISSIONS THROUGH 2010 : BASELINE SCENARIO

World economy growing at a little less than 3% p.a.

Table 1 reports our outlook of the world economy in the baseline scenario. In this scenario where no particular measures against CO2 emissions are assumed, world real GDP is expected to grow at 2.9% p.a. for the period 1990-2000, and at 2.7% p.a. for 2000-2010. Regions registering higher growth than others are South and South-East Asia and China, where industrialization is going to proceed smoothly. Japan is expected to remain on a comparatively high-level growth path of 3% p.a., although growth rates will be coming down gradually.

CO2 emissions expected to grow at 2% p.a. to become 1.5 times larger in 2010

Global CO2 emissions will increase at about 2% p.a., reflecting high energy consumption growth. In 2010, the emission level will amount to some 9 billion tons of carbon, or 1.5 times that in 1990.

Growth rates of CO2 emissions are likely to be less than those of real GDP, however, as carbon free energy such as nuclear and hydro power will be developed further, and growth of CO2 emissions from the industrialized countries will be slow on the whole. In the industrialized countries where the service sector is dominant, the economy can grow without raising energy consumption proportionately. This keeps the income elasticity of energy consumption low, and helps keep the pace of CO2 emissions slower than real economic growth. Moreover, energy efficiency can be expected to show continuing improvements in the industrialized region for some time.

CO2 emissions from developing countries, on the other hand, will show higher growth than in the OECD countries. The following factors are responsible for higher energy consumption growth in this region: a)industries that are heavy users of energy are expanding; b)household energy demand is expected to rise as the income level rises; c)population generally grows more rapidly in these countries.

The most remarkable regions contributing to the global CO2 emissions are South and South East Asia and China. Emissions from these regions account for almost a half of

Table 1 Outlook of World Economy through 2010 : Baseline Scenario

	1990	2000	2010	average growth rate(%)	
				1990-2000	2000-2010
〈Real GDP〉					
World (bil $US)	13,613	18,146	23,744	2.9	2.7
OECD	9,677	12,613	16,145	2.7	2.5
Japan	1,696	2,406	3,321	3.6	3.3
CPE	1,837	2,629	3,694	3.6	3.5
LDC	2,098	2,903	3,904	3.3	3.0
〈Energy consumption〉					
World (mil TOE)	8,041	9,919	11,967	2.1	1.9
〈CO_2 emissions〉					
World (mil tons)	6,099	7,449	8,882	2.0	1.8
OECD	2,817	3,068	3,280	0.9	0.7
Japan	319	358	392	1.2	0.9
CPE	1,949	2,486	3,048	2.5	2.1
LDC & others	1,333	1,895	2,554	3.6	3.0
〈Population〉					
World (billion)	5.29	6.12	6.88	1.5	1.2
〈Crude oil price〉 ($US/bbl)	21.6	29.4	47.9	3.1	5.0

Note:"OECD" = Japan, United States, and Western Europe.
"LDC" = South-East Asia, Latin America, and Middle East
"CPE" = former Soviet Union, Eastern Europe and China
"TOE" = tons oil equivalent

the 2% annual expansion of global emissions. More than 80% of the increment in global CO2 emissions for the next 20 years may be attributed to countries other than Japan, United States, and those of Western Europe. The share of present OECD countries in the global CO2 emissions will decline by around 10 per cent by 2010.

2. IMPACTS OF CARBON TAXES ON THE WORLD ECONOMY

Carbon taxes to be raised gradually

Let us assume that global taxes on fossil fuels are introduced to limit CO2 emissions, with tax rate being varied according to the amount of carbon contained in oil, coal, and natural gas (see second column of Table 2).

In order to stabilize global CO2 emissions at the 1990 level, tax rates will have to be raised to around $550/tC in 2000 and $1,800/tC in 2010. These taxes will raise the tax-inclusive price of oil 3.4 times in 2000 and 5.7 times in 2010 compared with those of the baseline scenario. These increases in energy prices may, however, be viewed as quite moderate in terms of annual rates of change if one compares them those in the past oil crises when oil prices more than tripled in a year.

Growth rates of the world economy reduced by 0.4% p.a.

Carbon taxes will raise end-use energy prices, resulting in higher inflation rates. In Japan, annual inflation rates in terms of wholesale prices will be up by 0.4%. Higher inflation rates will depress real income of the private sector, and hence bring about a slowdown in consumption and investment. Thus, the world economic growth rates through 2010 will come down from 2.8% p.a. in the baseline scenario to 2.4% p.a. The level of world real GDP in 2010 will be reduced by 4.7% in 2000 and by 8.4% in 2010 relative to the baseline case.

The growth rates of Japan's economy will also become lower by 0.4% p.a. compared with the baseline. Per capita real GNP in Japan is predicted to reach $26,000 in 1985 price, almost twice of the current level. It will be reduced by 6% in the carbon tax scenario. A decline in the growth rate will also lead to a reduction in employment. Employment in Japan in 2010 will be curtailed by 210 thousand persons, or 0.3% of total employment, compared with the baseline scenario.

Recycling tax revenue slightly mitigates the depressive effects

Let us now assume that carbon tax revenue is recycled to the private sector by cutting other indirect taxes. This will help, to some extent, lower the price level pushed by carbon taxes(see the column of Table 2).

We examined to what extent lower indirect taxes can reduce the price level by using an input-output table of Japan. When a carbon tax of, say, ¥5,000/tC is imposed, the price level will rise by 0.62% for the whole industrial sector and by 0.98% for the manufacturing sector. On the other hand, when 1.5 trillion yen of tax revenue raised by carbon tax is recycled by cutting indirect taxes, the price level will be reduced by 0.30% for the industrial sector as a whole and 0.36% for the manufacturing sector. This shows that, even if the revenue neutrality is maintained, the inflationary influences of carbon taxes remain. The reason is that while the cost push pressures of carbon taxes fall heavily on basic material industries, spreading over other industries, some indirect taxes such as liquor and tobacco taxes give only limited effects in the economy.

With such price stabilizing effects of indirect tax cut embedded in the macro model, the impacts of carbon tax look slightly different. Drop in inflation rates makes a slowdown in consumption and investment somewhat moderate. The average annual growth rate of the world economy is higher by a little less than 0.1% compared with the case where tax revenue is not recycled.

Expansion of carbon free energy to reduce carbon tax rates

If we can develop carbon free energy substantially, the costs of CO2 emissions stabilization will become much smaller. Consider an option of expanding nuclear energy which is superior in economic efficiency to other carbon free energy sources such as solar, marine, and wind. Even in the baseline scenario, nuclear energy is expected to increase more rapidly than other sources to become twice as large in 2010. In the present scenario, we assume that 50% more nuclear energy is added by 2010 than in the baseline case (see the fourth column of Table 2).

Compared with the case of no additional nuclear energy expansion, carbon tax rates to stabilize global CO2 emissions at current level will be lowered by $600/tC in 2010 to become $1,180/tC. The average growth rate of the Japanese economy is improved by 0.1% p.a. Contraction of her employment will be reduced from 210 thousand to 80 thousand persons.

Keeping OECD emission level flat does not guarantee global stabilization

We finally consider a case in which industrialized regions including Japan, United States, and Western Europe are assumed to introduce carbon tax, going ahead of

developing countries that are reluctant to take measures to restrain CO2 emissions (see the final column of Table 2).

A tax of $216/tC in 2000 and $601/tC in 2010 will be required to stabilize CO2 emissions from OECD countries. The tax-inclusive fossil fuel prices in OECD countries will be tripled, and the average growth rates for the next 20 years in OECD countries and in Japan will decline by 0.2% p.a. and 0.1% p.a. respectively.

Developing countries are expected to suffer a little from the growth deceleration in the OECD region. Exports from developing countries to the OECD region, however, will not necessarily be hampered because higher prices in the OECD countries make export goods from developing countries more competitive. A decline in economic growth is expected to be generally limited in other regions, while Middle East is likely to show relatively severe slowdown owing to the decrease in oil exports to the industrialized countries.

Global emissions of CO2 cannot be expected to decline markedly in the present scenario, since emissions from other regions will remain almost unchanged. The level of global emissions, albeit declining by 0.3% in annual growth rates, will reach in 2010 the level 37% above that in 1990.

<OUTLINE OF THE MODEL>

The model used for the forecast and simulations has the following structures:

1) The model is an annual econometric model.

2) Macroeconomic block is basically built in Keynsian framework: total output (GDP or GNP) of each region is primarily determined in demand side.

3) In Japanese and US block, macroeconomic production functions are estimated to give potential output level. A gap between aggregate demand and supply could affect inflation rates, unemployment, and corporate profits.

4) Each region is linked with an international trade matrix of 8 × 8 regions.Fluctuations in GDP, inflation, and energy demand in one region could give influence to others.

5) Primary energy consumption includes oil, coal, natural gas, nuclear and hydraulic energies.

6) We ignored other new energies such as solar, marine and wind. Thus we do not take an account of "back stop technologies".

Table 2 Impacts of Carbon Taxes on the World Economy

	Baseline scenario	Global stabilization by universal taxes			stabilization in OECD area
			revenue recycled	nuclear power expanded	
〈Taxes / Energy prices〉					
CO_2 tax at 2010	0	1780	1780	1180	601
Oil price at 2010	47.9	274	274	198	123
〈CO_2 emissions growth〉 (averages for 1990-2010)					
World	1.9	0.0	0.1	0.0	1.6
OECD	0.8	-0.5	-0.5	-0.7	0.0
Japan	1.0	-0.6	-0.5	-0.9	0.1
United States	0.9	-0.5	-0.5	-0.5	0.1
Western Europe	0.4	-0.6	-0.5	-1.0	-0.1
LDC	3.5	0.9	0.9	1.0	3.4
South-East Asia	4.0	1.3	1.3	1.4	4.0
Latin America	2.2	0.3	0.5	0.7	1.9
Middle East	3.9	0.7	0.7	0.3	3.7
CPE	2.3	0.3	0.3	0.5	2.3
Soviet & E.Europe	1.4	0.0	0.0	0.0	1.4
China	3.6	0.8	0.9	1.2	3.6
others	2.8	0.2	0.3	0.5	2.4
〈Fuel dependence ratios〉 (global average in 2010)					
Oil	33.0	30.1	30.2	26.5	32.6
Coal	29.6	23.7	23.7	24.1	28.2
Natural gas	22.6	26.8	26.8	26.4	23.7
Hydro	7.5	9.8	9.8	9.4	7.8
Nuclear	7.3	9.6	9.6	13.6	7.7
〈Real growth rates〉 (averages for 1990-2010)					
World	2.8	2.4	2.4	2.5	2.7
OECD	2.6	2.2	2.3	2.4	2.4
Japan	3.4	3.1	3.2	3.2	3.3
United States	2.3	1.9	2.0	2.0	2.1
Western Europe	2.6	2.2	2.2	2.4	2.4
LDC	3.2	2.6	2.7	2.6	3.1
South-East Asia	4.3	4.0	4.1	4.1	4.3
Latin America	2.3	1.9	2.0	2.0	2.2
Middle East	2.2	0.7	0.7	0.2	2.0
CPE	3.6	2.8	2.9	3.0	3.5
Soviet & E.Europe	3.3	2.4	2.4	2.7	3.3
China	4.5	4.0	4.2	4.2	4.4

Note:Carbon taxes are expressed in $US/tC, and oil prices in $US/bbl. These are global averages except in the final conlumn where they represent OECD averages. Growth rates of GDP and CO_2 emissions are average annual rates in per cent. Fuel dependence ratios are in %. Tax revenues are not recycled unless specified otherwise.

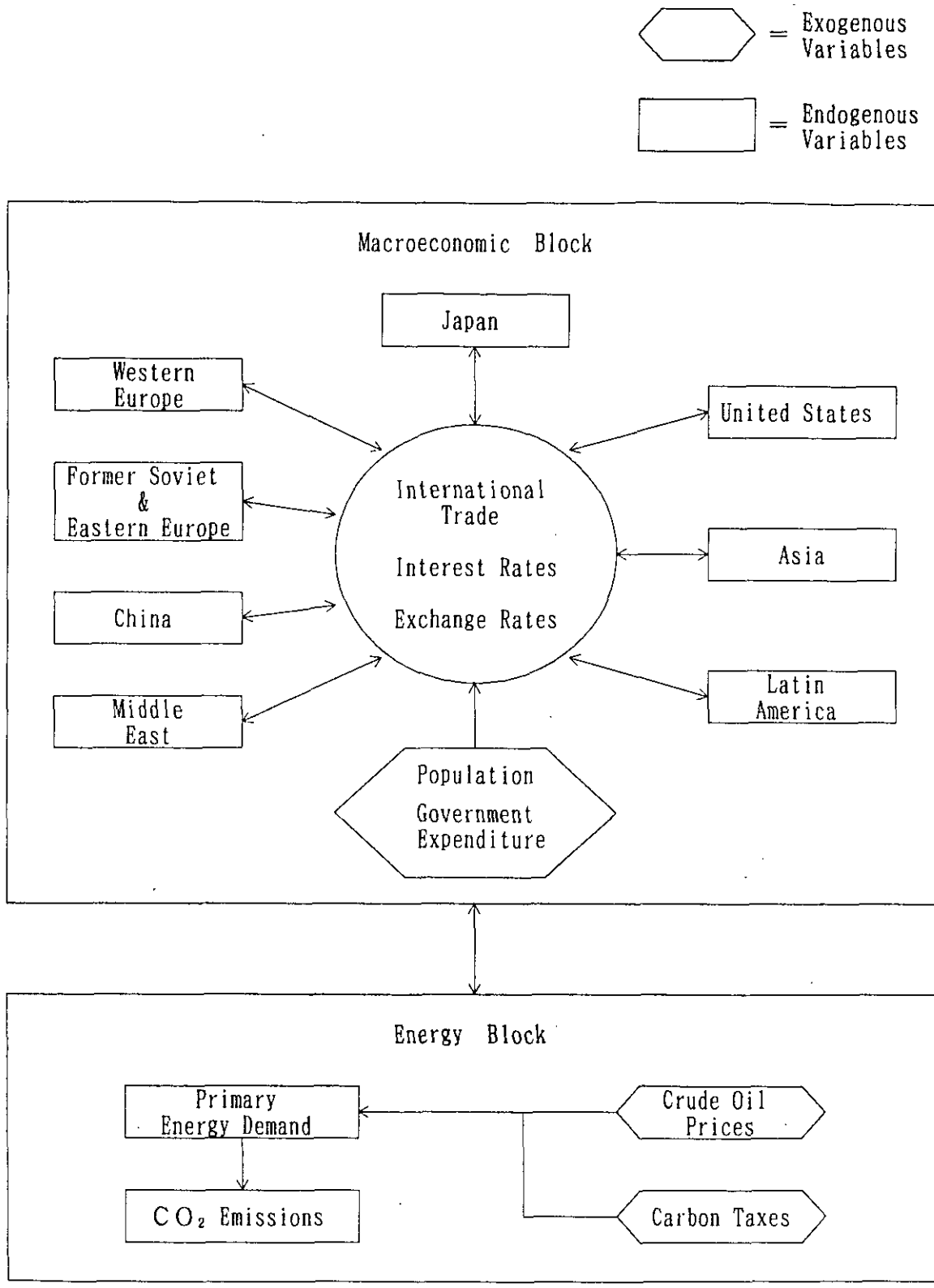

Figure 1 Overview of the Model

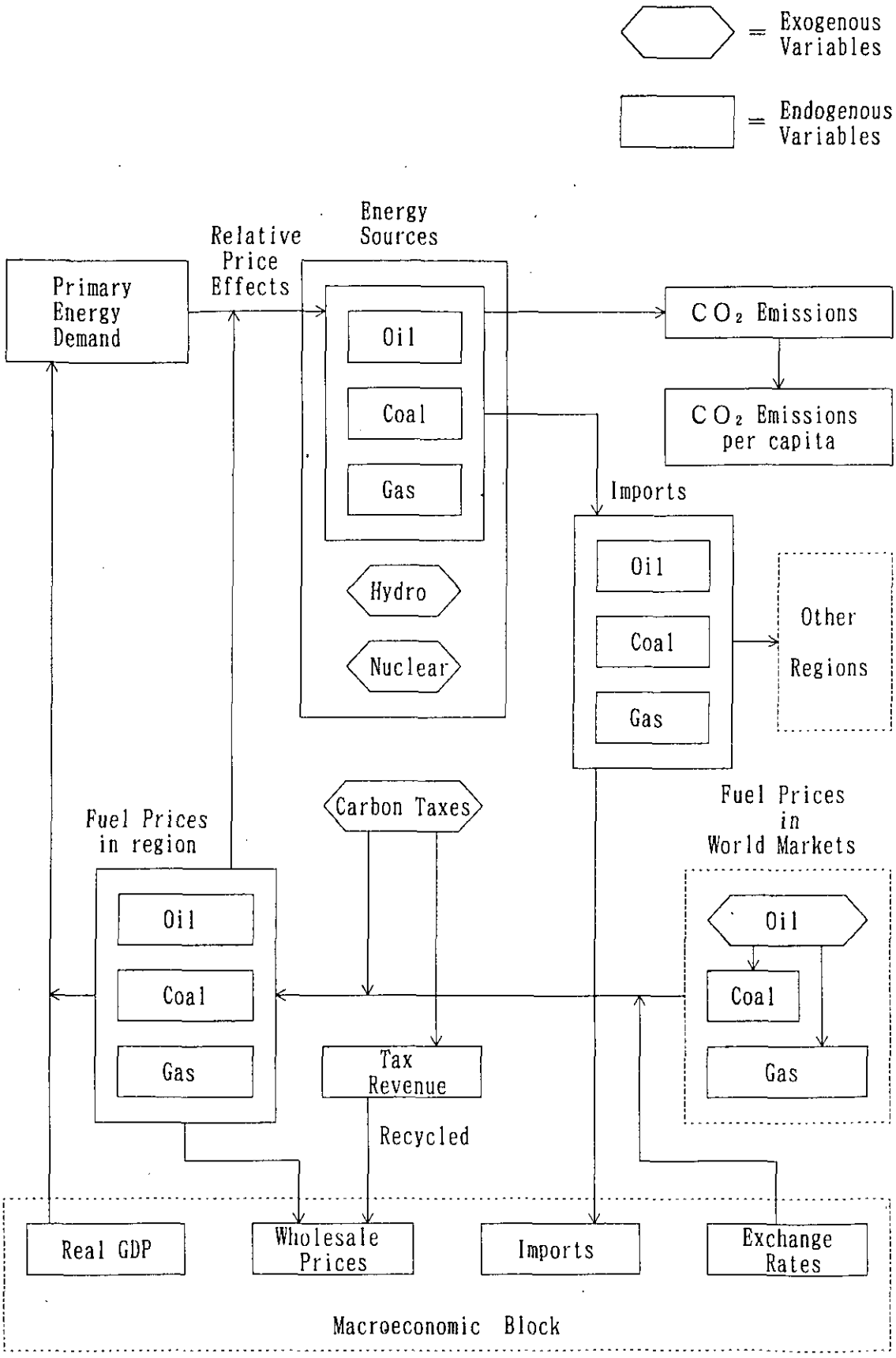

Figure 2 Overview of the Energy Block