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Issues in the Joint Implementation Program

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ABSTRACT

According to the input-output tables compiled for the analysis of air-pollutants in Japan and China, total CO_2 emissions in China and Japan in 1985 amounted to 2.376 billion ton and 0.986 billion ton (in molecular mass of CO_2) respectively. For SOx, generations amounted to 23.4 million ton from China and 3.5 million ton from Japan, and emissions amounted to 20.31 million ton from China and 1.15 million ton from Japan (in molecular mass of SO_2). By examining the difference in the pollution condition in the two countries, we found that there are great differences in energy efficiency across the industries. Measures such as the introduction of the environment tax and the establishment of the market for emission rights have been raised as possible policies against air pollution at the global level. The effects of environmental preservation policy on economic growth could be discussed in the following three perspectives, namely economic effectiveness, environmental effectiveness and equity. Firstly, for the issue on economic effectiveness, it may be further divided into the issues of economic efficiency and cost efficiency. Under perfect competition, it can be showed that market-based environmental policy instruments (the introduction of environmental tax and the creation of emission right market, etc.) are superior both in terms of economic efficiency and in the narrower definition of cost efficiency. However, even then there is no guarantee that these policy instruments satisfy the requirements on environmental effectiveness and equity with regard to costs and effects. From the point of view of balancing economic development and environmental preservation, the perspectives could also be extended to analyze the feasibility of an international joint implementation as an environmental policy. In discussing the effects of the implementation of the JI Project, it is important to consider the following 3 perspectives as in the case of all other policy instruments.

a) Environmental effectiveness - whether the implementation of the JI program is going to be useful as environmental preservation measures at the global level. b) Economic effects and the evaluation of their impacts - this issue involves the discussion on

economic effectiveness, and we need to form a clear view regarding their impacts based on 2 points of view. One is on the issue regarding the compatibility of development goal and environmental goal, and the other is on the narrow definition of cost efficiency. c) Evaluation of equity - the issue regarding equity in achieving environmental preservation and equity in burden bearing.

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by

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I. Introduction

According to the input-output tables compiled for the analysis of air-pollutants in Japan and China[1], total CO_2 emissions in China and Japan in 1985 amounted to 2.376 billion ton (in molecular mass of CO_2; or 0.648 billion ton in molecular mass of carbon) and 0.986 billion ton (in molecular mass of CO_2: or 0.269 billion ton in molecualr mass of carbon) respectively. For SOx, generations amounted to 23.4 million ton from China and 3.5 million ton from Japan, and emissions amounted to 20.31 million ton from China and 1.15 million ton from Japan (in molecular mass of SO_2). The above differences in the level of pollutant emission from the two countries are mainly due to the following factors. The first factor is the differences in the industrial structure and final demand in Japan and China. The second factor could be attributed to the differences in level of elimination activities, in particular, for the case of SOx. The third factor is the differences in the type of energy consumed in both countries. In contrast to Japan where petroleum is the major source of energy, China heavily depends on coal which contains high ratios of carbon and sulphur elements.

In addition, the other factor could be attributed to the difference in energy consumption per unit of product or the difference in energy inputs. Hence, the issue of lies in how could China and Japan, which are in different level of economic development, to increase energy efficiency in order to accomplish the goal of environmental protection via the introduction of energy saving technology.

The structure and the compilation of the input-output table for environmental analysis have been discussed in detail in the papers of this series[2]. In this paper, we will first focus on CO_2 and SOx, and the next section presents as on overview on the present condition of atmospheric pollution in Japan and China. By examining the difference in the pollution condition in the two countries, we found that there are great differences in energy efficiency across the industries. Measures such as the introduction of the environment tax and the establishment of the market for emission rights, which operate by market mechanism have been raised as possible policies against air pollution at the global level. In parallel to the above, the proposal for a joint implementation program, an international cooperation on the prevention of pollution, is also materializing gradually.

Working on the differences in energy efficiency between Japan and China can be considered as one of the effective ways in which environmental protection can be achieved. Section III thus put into perspective the significance and issues with respect to the joint implementation program. This is also useful in making clear the issues to be involved in our simulation exercise regarding the joint implementation program using the input-output table in the future.

II. CO_2 and SOx Pollution in Japan and China

The input-output table for the analysis of atmospheric pollution used in the project on Japan-China environmental problem analysis consisted of 45 common sectors in Japan and China (Table 1).

In the following, we provide an overview on the difference in the industrial and demand structure between Japan and China by using the 45-sector input-output table. In order to exclude the difference in commodity classification at the basic commodity classification level, the diagonal elements of the intermediate input coefficients are set to zero, and the $[I-(I-\tilde{M})A]$ model is used. According to the 1985 Japan-China input-output table based on this model, the inducement coefficients of induced domestic products with respect to the respective final demand items are shown in Table 2.

Other than net inventory increase, the inducement coefficients for all the final demand items are higher in China. In particular, the induced domestic product of total fixed capital consumption is near 2.0. On the other hand, the inducement coefficients of induced value added of Japan, are higher than that of China with the exception of exports. This showed that the industrial structure of China is highly dependent on

Table 1: The Common Industrial Classification used in the Input-output Table for the Analysis of Japan-China Atmospheric Pollutants

1.Agriculture and Forestry	24.Metal Products
2.Fishery	25.Machinery
3.Coal Mining	26.Transport Equipment
4.Petroleum and Natural Gas	27.Electrical Machinery
5.Metal Ore Mining	28.Electronics and Communication Equipment
6.Non-ferrous Metal Mining	29.Testing Machines · Measuring Instruments
7.Food Products	30.Machinery Equipment Repairing
8.Textiles	31.Other Manufacturing
9.Sewing and Leather	32.Construction
10.Wood and Furniture	33.Railway
11.Paper and Pulp	34.Road Freight Transport
12.Printing and Education	35.Road Passengers Transport
13.Electricity and Heat Supply	36.Air Transportation
14.Petroleum Refineries	37.Other Transport Industry
15.Coke Manufacturing	38.Communication
16.Gas and Coal Products	39.Commerce
17.Chemical Products	40.Restaurants/Eating Places
18.Medical Products	41.Public Enterprises and Non-profit Private Services
19.Rubber and Plastic Products	42.Education, Health and Scientific Research
20.Cement	43.Finance and Insurance
21.Ceramic, Stone and Clay	44.Administrative Organ
22.Iron and Steel	45.Other Services
23.Non-ferrous Metal	

Table 2: A Comparison of Various Emission Coefficients in Japan and China

	Production Induced Coefficient		Value Added Emission Coefficient		Production Induced Dependency Rate	
	Japan	China	Japan	China	Japan	China
Other Consumption Expenditure	1.4931	1.7571	0.9414	0.9144	0.1177	0.1020
Household Consumption Expenditure	1.4894	1.5753	0.8941	0.8834	0.4684	0.4086
Total Fixed Capital Formation	1.8207	1.9628	0.8971	0.8130	0.2648	0.3257
Net Inventory Increase	1.6267	1.5725	0.8527	0.8059	0.0055	0.0391
Exports	1.7840	1.8173	0.8722	0.8988	0.1436	0.1246
Total	1.6061	1.7337	0.8977	0.8648	1.0000	1.0000

domestic intermediate inputs, or the value added ratios are higher in the case of Japan. Further, with regards to ratios of distribution on final demand, whereas Japan is more dependent on household consumption and exports, China is relatively more dependent on other consumption expenditure, such as government expenditure, and total fixed capital formation. This could be seen as a reflection of the differences in both the development level and the economic systems between Japan and China.

These differences in the industrial structure and the structure of final demand, are also found in the differences in the final demand distribution ratios in the emissions of air pollutant such as CO_2 and SOx. With regard to the emissions of CO_2, in the case of Japan, emissions amount to 7.22% from other consumption expenditure, 48.03% from household consumption expenditure, 24.45% from total fixed capital formation, 0.62% from net inventory increase and 19.69% from exports, with relatively high shares of CO_2 emissions from household consumption and exports. On the other hand, in the case of China, the CO_2 emissions for each of the final demand items amount to 7.02%, 42.03%, 38.07%, 2.75% and 10.13% respectively, with notably high CO_2 emissions from total fixed capital formation.

With regard to the emission of SOx, in Japan the generation from other consumption, household consumption, total fixed capital consumption, net inventory increase and exports amounts to 7.06%, 39.58%, 21.51%, 0.70%, and 31.16% respectively. In contrast to the case in Japan where generation due to household consumption and exports are relatively high, similar generation of SOx amounts to 7.17%, 46.13%, 33.60%, 2.82% and 10.27% respectively, showing again a characteristically high share from total fixed capital formation(Table 3).

Table 4 and Table 5 showed for both Japan and China, classified by sector, the inducement coefficients per unit of production, inducement coefficient of induced energy by the respective pollutant particles (CO_2, SOx, and soot and dust), as well as the induced generation, emission and the quantity of induced energy per unit of final demand

Table 3: CO_2 and SOx Emissions induced Dependency Rate

	CO_2 Induced Dependency Rate		SOx induced Depnedency Rate	
	Japan	China	Japan	China
Other Consumption Expenditure	0.0722	0.0702	0.0706	0.0717
Household Consumption Expenditure	0.4803	0.4203	0.3958	0.4613
Total Fixed Capital Formation	0.2445	0.3807	0.2151	0.3360
Net Inventory Increase	0.0062	0.0275	0.0070	0.0282
Exports	0.1969	0.1013	0.3116	0.1027
Total	1.0000	1.0000	1.0000	1.0000

by pollutant agents, as estimated from the $[I-(I-\tilde{M})A]$ input-output open model. As mentioned above, while the differences in the pollutant emissions between Japan and China in the final demand items are due to the differences in the final demand structure and the structure of intermediate inputs, they also depend on the differences in per unit energy input in the two countries concerned. However, the results of such international comparison using the input-output table differ greatly by the method in which the values of the two currencies are converted to each other. Hence, for precise comparison, we need to estimate the relative prices for each commodity in the two countries concerned. Although macroeconomic method using the exchange rate and microeconomic method via the purchasing power parity index are possible, an accurate estimation on the relative price of each commodity is indispensable given the great difference in the relative prices between commodities in Japan and China. The above analysis is still work-in-progress and we shall report our findings later.

Hence, the results of the following analysis will be preliminary and the comparison on per unit coefficient and induced coefficient with respect to production and final demand assumed a 1 million yen unit for Japan and a 10 thousand yuan unit for China.

Firstly, we look at the values of the production and emission coefficients of CO_2 and SOx by sector as shown in columns 1, 2 and 3 of Table 4 and Table 5. With regard to

Table 4: Emission Coefficients and Energy Coefficients of Air Pollutants in Japan

Sector	Emission Coefficient Per Unit of Production(1 Mil. Yen)			Induced Emission Coefficient Per Unit of Production(1 Mil. Yen)			Energy Consump -tion per 1 Mil. Yen	Induced Energy per 1 Mil. Yen
	CO_2 ton	SOx kg	SOx Emission kg	CO_2 ton	SOx kg	SOx Emission kg	Tcal	Tcal
1. Agriculture and Forestry	0.438	0.799	0.396	1.324	4.466	1.560	0.0016407	0.0048187
2. Fishery	3.964	15.786	10.283	4.695	18.560	11.321	0.0144526	0.0171277
3. Coal Mining	1.848	1.967	1.241	4.662	10.779	3.569	0.0085599	0.0179044
4. Petroleum and Natural Gas	0.979	0.646	0.312	3.121	6.882	2.026	0.0105506	0.0174578
5. Metal Ore Mining	1.799	4.897	0.972	4.291	12.211	2.915	0.0076438	0.0157738
6. Non-ferrous Metal Mining	3.369	7.461	3.488	4.574	11.523	4.837	0.0120487	0.0163645
7. Food Products	0.363	2.182	1.427	1.779	7.572	3.347	0.0015544	0.0064901
8. Textiles	0.845	6.531	4.227	2.660	13.161	5.938	0.0035716	0.0098876
9. Sewing and Leather	0.269	0.964	0.486	1.987	8.250	3.239	0.0015294	0.0076898
10. Wood and Furniture	0.117	0.254	0.122	1.707	6.458	1.978	0.0009617	0.0064499
11. Paper and Pulp	3.858	48.894	9.752	6.295	56.977	12.090	0.0124996	0.0207235
12. Printing and Education	0.189	0.677	0.350	2.161	12.285	3.175	0.0011329	0.0078396
13. Electricity and Heat Supply	20.398	56.377	13.698	20.971	58.332	14.462	0.0641170	0.0661718
14. Petroleum Refineries	1.449	5.858	2.319	1.752	6.904	2.672	0.0060415	0.0071275
15. Coke Manufacturing	6.702	3.533	3.062	8.192	8.188	4.928	0.0221037	0.0273317
16. Gas and Coal Products	2.705	0.643	0.263	3.503	4.429	1.605	0.0082412	0.0111460
17. Chemical Products	2.040	10.696	1.641	4.611	19.528	4.191	0.0083127	0.0168553
18. Medical Products	0.159	0.515	0.252	1.881	7.371	2.042	0.0013652	0.0072086
19. Rubber and Plastic Products	0.246	1.221	0.797	2.523	9.754	2.917	0.0017531	0.0096777
20. Cement	70.661	112.364	12.750	75.170	126.418	16.741	0.0682742	0.0830728
21. Ceramic, Stone and Clay	1.752	10.899	4.637	8.427	25.384	7.737	0.0073071	0.0191991
22. Iron and Steel	4.506	30.494	5.694	7.993	39.822	8.783	0.0205415	0.0319069
23. Non-ferrous Metal	1.292	9.229	1.094	3.786	17.116	3.509	0.0057956	0.0138716
24. Metal Products	0.386	0.579	0.316	2.967	11.444	3.019	0.0021391	0.0116649
25. Machinery	0.520	1.558	0.881	2.727	10.387	3.168	0.0020474	0.0100875
26. Transport Equipment	0.169	0.499	0.257	2.081	7.653	2.255	0.0009978	0.0078741
27. Electrical Machinery	0.143	0.279	0.188	2.043	7.676	2.129	0.0010706	0.0077966
28. Electronics and Communication Equipment	0.120	0.182	0.105	1.768	6.030	1.719	0.0010736	0.0066846
29. Testing Machines Measuring Instruments	0.092	0.154	0.074	1.335	4.811	1.371	0.0006059	0.0051041
30. Machinery Equipment Repairing	0.124	0.380	0.211	1.612	5.629	1.755	0.0007824	0.0061318
31. Other Manufacturing	0.326	1.605	1.367	2.222	9.719	3.492	0.0013776	0.0082655
32. Construction	0.390	0.481	0.257	2.671	8.062	2.385	0.0016092	0.0083881
33. Railway	0.539	1.292	0.566	2.827	9.535	3.390	0.0042034	0.0117156
34. Road Freight Transport	2.296	5.454	2.731	3.089	9.057	3.868	0.0081390	0.0109293
35. Road Passengers Transport	2.130	2.655	1.332	2.595	4.725	2.183	0.0079333	0.0096093
36. Air Transportation	4.621	0.367	0.281	5.583	5.908	2.797	0.0167311	0.0201544
37. Other Transport Industry	6.372	80.619	43.937	6.973	82.639	44.655	0.0212164	0.0234291
38. Communication	0.117	0.247	0.125	0.736	2.145	0.713	0.0008860	0.0029673
39. Commerce	0.587	0.743	0.380	1.306	3.157	1.123	0.0024953	0.0049552
40. Restaurants Eating Places	0.596	0.592	0.301	1.680	4.279	1.714	0.0027163	0.0064790
41. Public Enterprises & Non-profit Private Services	0.730	0.836	0.573	1.338	2.853	1.185	0.0022550	0.0042830
42. Education, Health and Scientific Research	0.455	1.413	0.848	1.365	4.782	1.803	0.0021281	0.0052324
43. Finance and Insurance	0.026	0.009	0.006	0.415	1.296	0.435	0.0001540	0.0015092
44. Administrative Organ.	0.458	0.829	0.428	1.251	3.369	1.212	0.0020896	0.0048177
45. Other Services	2.306	8.152	3.160	4.226	14.963	5.195	0.0077498	0.0143419
46. Total	1.339	5.235	1.725				0.0048420	

Notes: 1) Energy values are the aggregation of fossil energy and electricity consumption.
2) The Inverse matrix of $(I-(I-\hat{M})A)$ is used in the calculation of the induced emission coefficient.

Table 5: Emission Coefficients and Energy Coefficients of Air Pollutants in China

Sector	Emission Coefficient Per Unit of Production (10,000 Yuan)			Induced Emission Coefficient Per Unit of Production(10,000 Yuan)			Energy Consump -tion per 1 Mil. Yen	Induced Energy per 1 Mil. Yen
	CO_2	SOx	SOx Emission	CO_2	SOx	SOx Emission		
	ton	kg	kg	ton	kg	kg	Tcal	Tcal
1. Agriculture and Forestry	1.505	12.324	12.324	5.485	52.435	46.356	0.0050546	0.0174783
2. Fishery	1.705	15.533	15.533	4.817	45.846	42.528	0.0056569	0.0153010
3. Coal Mining	25.559	231.496	222.236	41.321	397.629	374.706	0.0740502	0.1201632
4. Petroleum and Natural Gas	7.153	29.881	28.686	14.333	101.575	93.121	0.0382056	0.0590788
5. Metal Ore Mining	6.799	63.047	60.525	24.241	248.389	230.562	0.0248868	0.0764415
6. Non-ferrous Metal Mining	14.489	145.922	140.086	28.668	294.799	275.690	0.0484420	0.0906288
7. Food Products	2.038	22.593	21.689	8.462	83.976	76.796	0.0064364	0.0262960
8. Textiles	2.154	24.109	23.145	9.796	101.130	89.456	0.0070336	0.0308199
9. Sewing and Leather	1.041	10.162	9.756	7.857	79.222	70.555	0.0031312	0.0243950
10. Wood and Furniture	8.804	100.721	96.692	22.483	237.165	218.055	0.0252732	0.0665213
11. Paper and Pulp	11.794	138.984	133.424	24.139	267.901	249.575	0.0355737	0.0730656
12. Printing and Education	1.184	11.527	11.068	12.080	134.123	115.553	0.0036587	0.0372471
13. Electricity and Heat Supply	150.981	1737.413	1667.917	162.033	1840.090	1762.091	0.4427835	0.4763899
14. Petroleum Refineries	4.790	22.678	9.071	13.489	90.214	70.704	0.0177398	0.0513045
15. Coke Manufacturing	21.616	195.431	187.615	48.791	463.631	438.432	0.0569538	0.1369800
16. Gas and Coal Products	39.172	300.275	288.264	75.807	664.330	628.252	0.1273516	0.2361852
17. Chemical Products	11.328	108.384	54.192	28.192	286.785	219.584	0.0403605	0.0915062
18. Medical Products	3.593	40.951	20.476	12.916	136.156	104.354	0.0112764	0.0397480
19. Rubber and Plastic Products	3.417	33.117	29.806	16.076	163.084	137.985	0.0116609	0.0515230
20. Cement	76.896	421.230	155.855	105.931	729.590	446.141	0.1058628	0.1905360
21. Ceramic, Stone and Clay	30.476	335.740	302.166	51.363	535.716	474.763	0.0922510	0.1497417
22. Iron and Steel	23.701	126.586	112.311	42.990	331.097	300.269	0.0698334	0.1269884
23. Non-ferrous Metal	9.329	299.016	119.607	33.624	557.869	360.987	0.0347433	0.1073815
24. Metal Products	5.011	49.058	47.096	24.496	242.583	213.962	0.0151305	0.0736431
25. Machinery	3.684	37.276	35.785	17.628	174.939	156.516	0.0111563	0.0529835
26. Transport Equipment	1.897	19.215	18.446	14.608	143.929	127.618	0.0057286	0.0440698
27. Electrical Machinery	2.182	22.857	21.943	18.218	207.193	169.142	0.0067714	0.0559415
28. Electronics and Communication Equipment	0.650	7.114	6.829	9.513	103.789	88.324	0.0021995	0.0292150
29. Testing Machines · Measuring Instruments	1.550	14.820	14.228	11.663	122.909	105.633	0.0045840	0.0352394
30. Machinery Equipment Repairing	5.157	54.780	52.589	18.577	189.549	171.642	0.0158926	0.0561065
31. Other Manufacturing	4.988	47.749	45.839	16.850	169.867	150.704	0.0174229	0.0536036
32. Construction	1.412	10.000	9.600	27.879	243.403	200.871	0.0046775	0.0737872
33. Railway	24.047	229.343	220.169	30.253	290.714	276.365	0.0694942	0.0882642
34. Road Freight Transport	10.346	28.372	27.238	17.927	97.795	87.528	0.0333743	0.0579852
35. Road Passengers Transport	8.938	23.004	22.084	16.164	90.635	81.041	0.0289762	0.0521664
36. Air Transportation	12.172	9.226	8.858	18.586	66.846	58.908	0.0396473	0.0605568
37. Other Transport Industry	9.081	60.315	57.902	14.796	112.904	104.297	0.0293943	0.0479859
38. Communication	2.967	19.978	19.179	8.247	75.460	69.252	0.0107305	0.0264017
39. Commerce	1.815	17.678	16.971	7.694	76.651	69.104	0.0055548	0.0226917
40. Restaurants Eating Places	0.927	10.383	9.968	7.863	79.028	72.697	0.0034042	0.0247153
41. Public Enterprises & Non-profit Private Services	4.121	38.835	37.282	13.146	129.594	118.238	0.0127733	0.0387804
42. Education, Health and Scientific Research	2.265	22.517	21.617	12.636	128.379	115.004	0.0073144	0.0381374
43. Finance and Insurance	0.231	2.308	2.216	0.935	9.111	8.340	0.0006514	0.0027665
44. Administrative Organ.	2.861	27.193	26.105	8.685	82.481	75.780	0.0085461	0.0261867
45. Total	7.847	75.276	64.849				0.0230940	

Notes: 1) Energy values are the aggregation of fossil energy and electricity consumption.
2) 45.Other Services sector is not applicable to China.
3) The inverse matrix of $(I-(I-\hat{M})A)$ is used in the calculation of the induced emission coefficient.

CO_2 emission coefficient for 1 unit of production (1 million yen), in the case of Japan, (20) cement manufacturing sector topped with 70.7ton, followed by (13) electricity and heat supply 20.4ton, (15) Coke industry 6.7ton, (37) other transport industry 6.4ton, and (22) iron and steel 4.5ton. For China, (13) electricity and heat supply sector ranked highest at 151.0ton, even when calculated at a conversion rate of 1 yuan equals 223 yen, the CO_2 emission coefficient per unit of the electricity and heat supply sector in China is three times higher than that in Japan. In China, (20) cement manufacturing 76.9ton ranked second, followed by (16) gas and coal products 39.2ton, and (21) ceramic, stone and clay 30.5ton. Although there is no large difference in the emission coefficient per unit with regard to (20) cement manufacturing in both Japan and China, differences between the two countries are large in the rest of the major emission sectors[3].

Next, we focus on the production and emission coefficients for SOx in columns 4 and 5. In Japan, SOx production per unit is the largest in (20) cement manufacturing at 112.4kg. It is then followed by (37) other transport industry 80.6kg, (13) electricity and heat supply 50.3kg, (11) paper and pulp 48.9kg, and (22) iron and steel 30.5kg. However, with the introduction of desulphurization facilities in these industries, SOx can be removed by about 90% in cement manufacturing, 45% in other transport, 80% in paper and pulp, 80% in iron and steel, and 75% in electricity and heat supply sector. On the other hand, for the case of China, the production coefficient is the highest for (13) electricity and heat supply at 1.737kg per unit, 31 times larger than that in Japan. In addition, the removal rate of the sector remains at 4%, implying that almost no removal activities have been carried out. Other sectors such as (20) cement manufacturing, (21) ceramic, stone and clay, (16) gas and coal products, and (23) non-ferrous metal have also relatively large production coefficients, and removal procedure is not performed in most cases.

Column 4 to column 5 of Table 4 and Table 5 showed the emission of CO_2 and SOx per unit of final demand in each sector. Again, as we compare 1 million yen of final demand in Japan with 10 thousands yuan of final demand in China, which is equivalent to a conversion rate of 1 yuan to 100 yen, the actual difference may be larger than this. With these caveats in mind, for the case of CO_2, emissions per 10 thousands yuan of final demand is the highest in the electricity and heat supply sector at about 162 tons, followed by cement at about 105 tons, and gas and coal products 76 tons. In the case of Japan, the respective emissions from the above sectors amounted to 21 tons, 75 tons and 3.5 tons respectively. Also with regard to SOx, in China where the removal procedure is not performed in most cases, (13) electricity and heat supply industry recorded a high emission at approximately 1.84ton. On the contrary, with small generation coefficients and removal activities being performed in Japan, almost all sectors have smaller emissions as compared to China.

One of the factors that contribute to the above differences in the emission of pollutants in Japan and China is the amount of energy used in the industries. The last two columns in Tables 4 and 5 showed the induced emission coefficient per unit of production and the induced energy per unit of final demand for each industry. The unit of the coefficient is T-cal of induced energy per 1 million yen and 10 thousand yuan of production in Japan and China, respectively. The energy per unit in all sectors but fishery in China is higher than that in Japan. In other words, this shows that the energy efficiency is lower in China. In particular, the per unit energy in the (13) electricity and heat supply sector is 0.06412 T-cal in Japan, as compared to 0.4278 T-cal in China, which is equivalent to seven times difference. As a result, the direct and indirect energy emission induced by per unit of final demand in this sector, amounted to 0.4764 T-cal in China, seven times higher than the 0.0662 T-cal in Japan. Since the emission of CO_2 is directly effected by energy efficiency, raising energy efficiency in China is thus an important issue in reducing environmental pollution. As for SOx, while it is necessary to improve energy efficiency, policy planning to bring in removal facilities is also indispensable.

III. Framework and Issues in the Joint Implementation Program

(1) Content of the Joint Implementation Program

Through the compilation of the Japan-China input-output table for environmental analysis, and the examination of the present condition of air pollutants in Japan and China, it is found that the generation, removal and the level of emission in the two countries concerned are affected heavily by the differences in the industrial structure or final demand, and the technical coefficients of energy in Japan and China, which reflect the level of development in this two countries. As it goes without saying that economic development of a nation is important, environmental preservation at the global level must mean something that countries in the various stages of development can actually achieved without sacrificing the goal of attaining economic development. Hence, unless policy actions toward environmental preservation could go hand in hand with economic development, international agreement would be difficult to attain.

The effects of environmental preservation policy on economic growth could be discussed in the following three perspectives, namely economic effectiveness, environmental effectiveness and equity. Firstly, for the issue on economic effectiveness, it may be further divided into the issues of economic efficiency and cost efficiency. Under perfect competition, it can be showed that market-based environmental policy instruments (the introduction of environmental tax and the creation of emission right market, etc.) are superior both in terms of economic efficiency and in the narrower definition of cost efficiency. However, even then there is no guarantee that these policy instruments satisfy the requirements on environmental effectiveness and equity with regard to costs and effects.

For environmental preservation policies in the developed countries, in the case of Japan and the US, we evaluate the effects of the introduction of carbon tax on economic growth and resource allocation, and whether environmental protection and growth can be achieved together, based on the long term multi-sectoral model on optimum economic growth. With respect to the economic impact of carbon tax[4], our analysis shows that there are considerable differences even between Japan and the US in the economic effects of aiming to stabilize the CO_2 emission in year 2000 at the 1990's level. The carbon tax to achieve stabilized emissions amounted to 20 US dollars per ton of carbon in the year 2000, in contrast to 600-700 US dollars per ton of carbon in Japan[5].

However, we have to allow for a certain range of errors as there are uncertainties regarding the future economic prospect, the possibility of new technology development, and doubts on the appropriateness of the estimated values for price elasticity of energy and income elasticity, . However, even then, there is a considerable difference between these two countries and it illustrates that for the achievement a common stabilization goal, the respective burdens on the two countries are inequitable.In addition, one of the major factors attributing to the above difference is the present difference in energy efficiencies in the two countries.

At present, energy efficiency in Japan is higher than that in the US and for Japan to raise its energy efficiency further at the present technology level will entail greater cost than the US. This implies that to achieve the same level of environmental preservation, the US which presently has a lower energy efficiency, is more cost effective. However, this issue on the difference in present energy efficiencies is not restricted to Japan and the US. As reviewed in the previous section, the difference between the developing and the developed countries are extremely large based on data from Japan and China. For environmental policies which are not restricted to specific region, such as the case of greenhouse gases, an important perspective regarding the choice of policy instruments is to maintain equity with regard to measures and effects based on the premise of regional difference in energy efficiencies. In particular, this issue is important for Japan which is surrounded by developing and the newly industrialized countries. Hence, this point also lead to one of the issues examines in this paper.

The other point indicating that a one-county economic model will not be sufficient in dealing with the environmental problems at the global level, is that environmental policy undertaken by one country will have effects on other nations as well. The so called carbon leakage is the phenomenon which the implementation of carbon tax by one country results in an increase emission of CO_2 abroad, and the burden of the carbon tax on the implemented country put pressure on the international competitiveness of the nation, and this may further link to the phenomenon of deindustrilization. Hence, we also need to consider the impact of environmental policy on the comparative advantage structure of the Asian region.

Further, from the point of view of balancing economic development and environmental preservation, the above mentioned 2 perspectives, could also be extended to analyze the feasibility of a international joint implementation as an environmental policy. Western countries have already proposed and implemented several joint implementation programs. Although many of them still remain at the stage of case studies, it is also in the process of analysing the feasibility of implementation and the issues to be included in the program.

Firstly, the content of joint implementation is as follows,

> "Joint implementation (JI) is a mechanism for helping parties to the Framework Convention on Climate Change (FCCC) meet their (unilaterally or otherwise imposed) net emission limits by financing greenhouse gas reductions in other countries."[6]

In other words, the joint implementation (JI) is a plan between any 2 countries, for the purpose of achieving the control on the emission of greenhouse gases agreed under the United Nations' Framework Convention on Climate Change, by having one country providing the other country with financial or technical assistance. Theoretically, this joint implementation could also be extended to a joint implementation with multiple countries. The origin of this idea lies in premise that there are international differences in energy efficiency and hence for the achievement of the policy goal, there will be differences in both measures and costs. Therefore, through the achievement of environmental preservation at the global level, economically efficient methods could be discovered via international cooperation. However, it should be noted that there are several constraints and problems in the implementation of this program.

a) The Participatory Countries

The Framework Convention of Climate Change, consisted of the Annex-I countries (ICs) which have promised to follow the FCCC's restriction on emission quantity, and Non-annex-I countries (DCs) which are developing countries that are not participating in the commitments. Therefore the question is whether JI should limit to Annex-I Countries or should it extend to include both Annex-I and Non-annex-I countries. We will show later that the latter case does not necessarily guarantee the attainment of cost efficiency or equity in cost burden.

b) Sphere of JI's Activity

The next question is whether the scope of JI project should extend to include all greenhouse gases? Even when the subjective agent is limited to CO_2, question remains as whether the activity of JI should be limited to measures on the sources of pollution emissions or should it extend to include the creation of absorption bodies.

c) Participating and Implementing Subjects of the Joint Implementation

There are issues concerning the relationship between private firms and their governments which implement activities in the JI project, and in the case such as the establishment of global environment facility (GEF), ther are issues concerning the relationship between participating private firms from various countries and governments. In the case where the introduction of market mechanism is planned, such as the establishment of a 'clearing house' to act as the adjusting agent among multiple-country or several JI projects, international consensus regarding its role and the range of its participating subjects will be necessary.

(2) Effects of the Implementation of the JI Project

In discussing the effects of the implementation of the JI Project, it is important to consider the following 3 perspectives as in the case of all other policy instruments.

a) Environmental effectiveness - whether the implementation of the JI program is going to be useful as environmental preservation measures at the global level.

b) Economic effects and the evaluation of their impacts - this issue involves the discussion on economic effectiveness, and as pointed out before, we need to form a clear view regarding their impacts based on 2 points of view. One is on the issue regarding the compatibility of development goal and environmental goal, and the other is on the narrow definition of cost efficiency.

c) Evaluation of equity - the issue regarding equity in achieving environmental preservation and equity in burden bearing.

Further, in the case of JI

d) Perspective on whether it is useful as a policy in the preparatory stage of the introduction of more ideal environmental policy, such as trading quota system or international emission tax, in the future.

a) Environmental Effectiveness

(i) Whether JI serves the purpose as a measure against greenhouse effect at the global level ? If the restriction framework of JI with regard to the emissions of greenhouse gases in the future is to include only Annex-I countries, as the offset effect between targets set up can be indicated clearly, it is easy to find the correspondence with the global target of environmental preservation. However, in the case of JI including ICs and DCs, as DCs originally did not set up environmental targets for environmental preservation, it is difficult to compare the impacts on economic effectiveness and economic growth with and without JI implementation. In some cases, it is possible that through the effects such as technology transfer, JI may speed up economic development in the developing countries, stimulating further emissions of greenhouse gases. In such a case, the offset effect of reducing emission achieved through the ICs supplying capital to the developing countries will be reduced. While there need to be agreement among the ICs concerning regulation on emissions, at the same time, estimation and international agreement on the baseline scenario regarding economic development and environment in the developing countries is also necessary. However, agreement on such baseline scenario involving the developing countries is going to be difficult.

Therefore, at the present stage, it is considerably difficult to evaluate the environmental preservation effects of JI. At the present stage, limiting to cases in which the costs of JI and the effects on environmental preservation are comparatively clear, we could progress project-by-project. However, in these cases, we are still left with issues concerning 'cost efficiency' (to be mentioned later).

(ii) Will JI has negative effects on technology development ? It is inevitable that technology supplying countries will become less active in the development of more effective technology. Further, for the technology receiving countries, there are questions such as whether the technology supplied is appropriate and whether the technology is useful for the future development of the receiving countries. The first question depends upon whether the target set up for environmental preservation by the technology supplying country is sufficiently high in promoting technology innovation, and this illustrates the importance of the initial target set up.

b) Economic Effectiveness

Questions on economic effectiveness at the broader definition such as at what level should the target for environmental preservation be set or how will the target level affect economic growth are not questions limited to JI, and these are questions to be solved before defining the issues in JI. Therefore, with regard to JI, we focus on the point whether JI, as compared to having no JI, brings about cost efficiency. Here, we also need to differentiate between the case that involves only treaty-member (Annex-I) countries and the case involving both treaty-member countries and non-treaty-member (Non-annex-I) countries.

(i) JI Program with Treaty Member Countries Here examine the case of JI consisting of 2 countries in the framework convention which will stabilize emissions in year 2000 at the 1990 level. We assume behaviour under certainty, in which the target levels and the costs of pollution reduction in the 2 countries are fixed. Figure 1 gives a simplified illustration of the model. The X-axis shows the total emission quantity of pollution agents from the 2 countries. In the base year 1990, emissions from country s and country b are oKs and oKb, respectively. We assume that the increase emission of pollution agents in the 2 countries amount to quantity R in the year 2000, within which increase emissions from country s and country b amount to oa and ob, respectively. Under the convention, in the year 2000, emissions will have to be stabilized at the 1990 level, and the emissions oa and ob must be reduced. Consequently, for country s, as its emission in the year 2000 consists of the emission quantity oKs as in 1990 plus oa, the emission quantity oa needs to be reduced. Similarly, for country b, as its emission in the year 2000 consists of the emission quantity oKb as in 1990 plus ob, the emission quantity ob needs to be reduced.

The line from point a on the X-axis to the right is the marginal abatement cost curve (MACs) of country s. Similarly, the line drawn from b to the left is the marginal

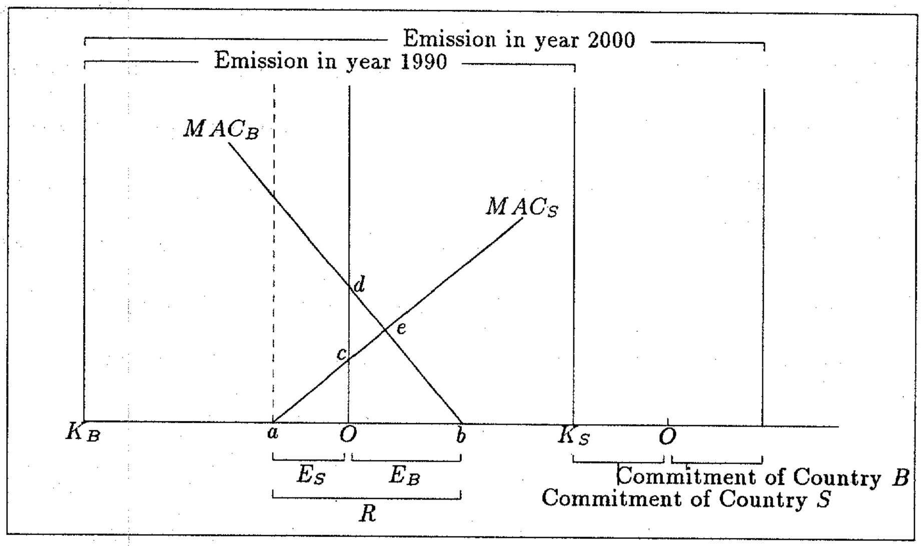

Figure 1: Joint Implementation Program of Treaty-Member Countries

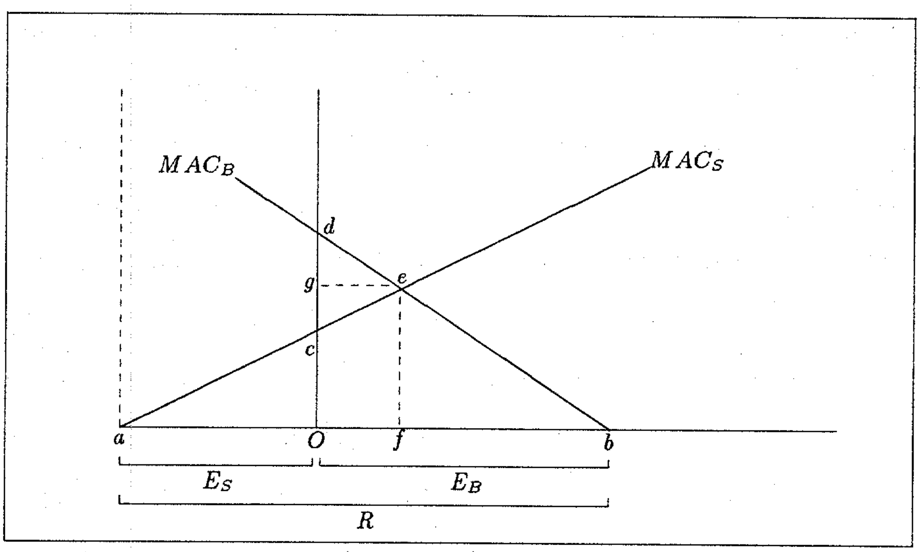

Figure 2: Distribution of Gain in Joint Implementation of Treaty-Member Countries

abatement cost curve (MACb) of country b. For the respective reductions of oa and ob to be achieved domestically, a marginal cost of oc and a marginal cost of od will be incurred by country s and country b respectively. If country b is to supply capital to country s to assist in the emission reduction in country s, additional reduction amounting to of could be achieved in country s and, this will also result in cost reduction in country b. Figure 2 shows the enlargement of a part of Figure 1. With country b supplying capital to country s, and with mission reduction of of being possible, the combined reduction target of the 2 countries will be achieved unchanged, while country b has the addition advantage of reducing marginal cost by triangle ged. Similarly, for country s, while achieving an additional reduction of of domestically, it also receives the advantage of capital supply illustrates by triangle ceg. Hence, the equilibrium is at point e where the marginal costs of the 2 countries are equal and this equilibrium is equal to the case in which emission right is sold from country s to country b.

With regard to the quantity of emission in the above case, for JI with countries which the target values are decided annually, JI with equalization in the marginal cost of reduction in the 2 countries can be achieved, regardless of the reduction level in the respective project. However, in this case, the monopolistic price in both countries can be decided through negotiation between governments, or through equilibrium achieved by the participation of many buyers and many sellers in the market. If competitive equilibrium can be achieved, the resultant effects will be identical to that obtained through the establishment of tradable quota. On the other hand, it must be noted that it is possible for market distortion to arise in the case where either the capital supplying or the capital receiving country possesses market power such that its own gain can be increased through under- or over-declaration of the respective marginal reduction costs. Case I and Case II in Figure 3 show respectively the case in which the capital receiving country over-declares its marginal cost and the case in which the capital supplying country under-declares its marginal cost. While the gain in individual country increases, total cost will become larger.

Therefore, this requires the establishment of international institutions that monitor the appropriateness of the respective marginal costs, or market function such as that of the clearing house.

(ii) JI Program with Non-treaty Member and Treaty Member Countries

Problem becomes more complex in the case of JI with treaty member country with stabilization target and non-treaty member country with no stabilization target. This is because, a) it is difficult to fix the base-line scenario regarding the future emissions of air pollutants in the non-treaty member countries; and b)it is difficult to estimate marginal reduction costs. In practice, we can only estimate the effects in each project. Even then, there is uncertainty in the estimation of emission reduction and the costs incurred in each project. Consequently, this inevitably leads to the increase in monitoring cost or transaction cost.

Figure 4, in comparison with Figure 1, illustrates the transaction in this case. Country b is the treaty member country, and to stabilize the quantity emission in the year 2000 at the 1990 level, emission reduction amounting to at least ob is required. In contrast, for country s, not only the emission level at 1990 is uncertain, the estimation of emission level in the year 2000 also contains uncertain elements. Here we assume, as shown in the figure, the emission in 1990 is at oKs and the increase in emission in the year 2000 amount to oa, even then, it is not necessary that reduction by country s in the year 2000 be greater than oa. Hence, the quantity of reduction is uncertain.

With the marginal cost curves of the 2 countries being MACs and MACb respectively, and in the case which the equilibrium point e is on the right of the origin o, for country b to attain the reduction target of ob, as its marginal cost is higher than that in country s, it is better for country b to participate in joint implementation. However, this possibility depends on the reduction target level in country s. The other question is that due to information uncertainty in country s, it is not possible to fix

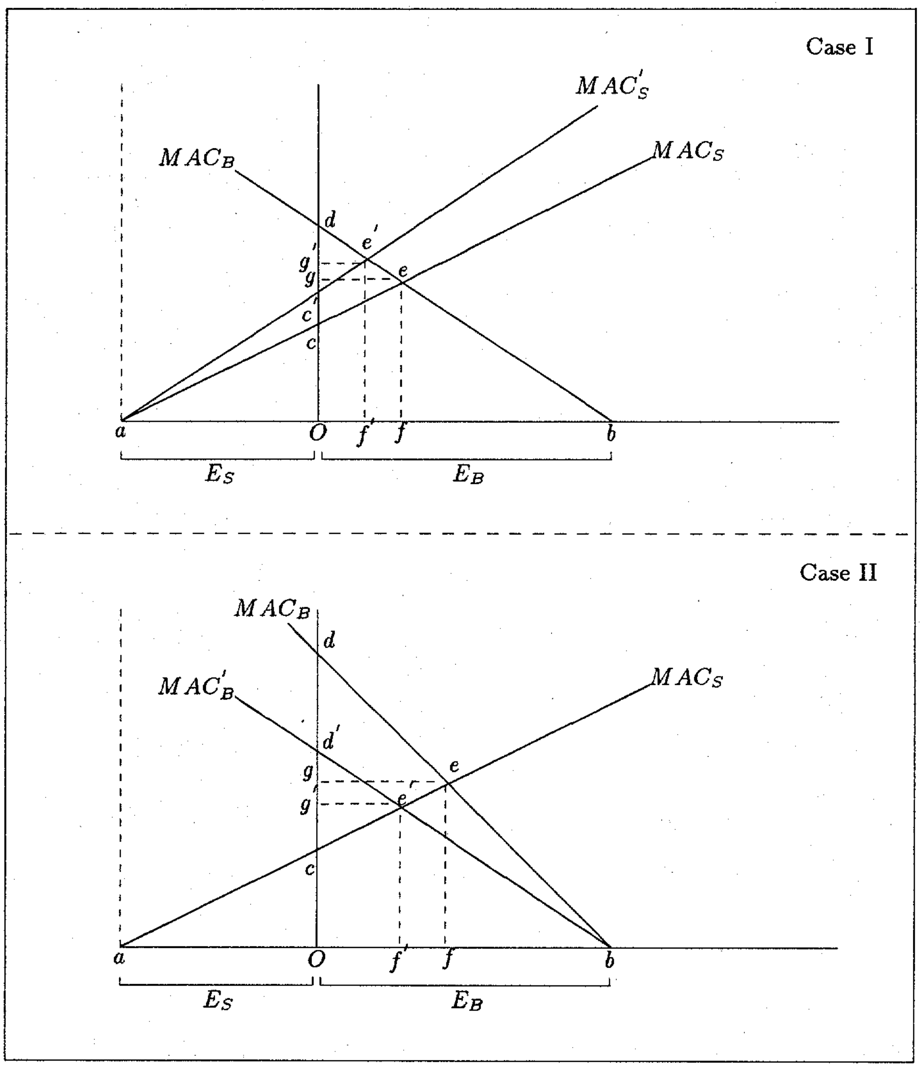

Figure 3: Possibility of Market Failure in Joint Implementation

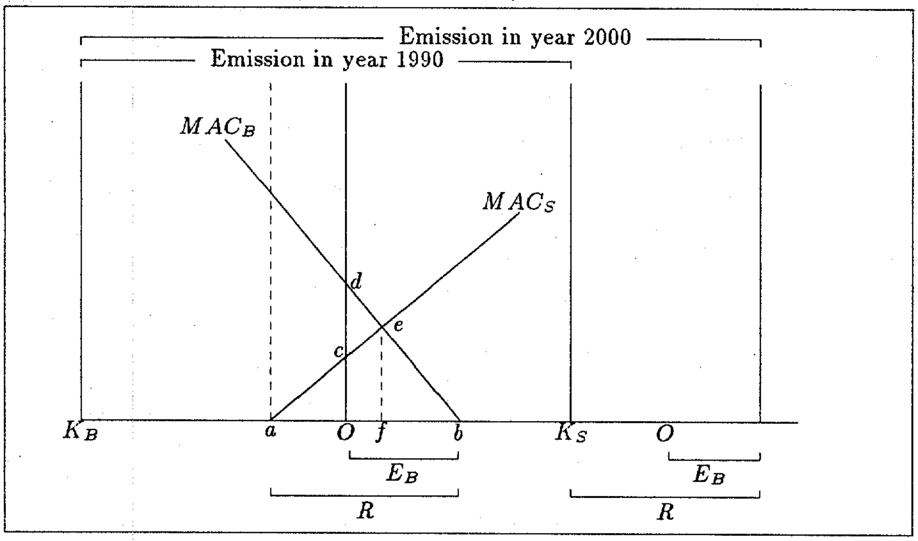

Figure 4: Joint Implementation by Treaty-Member Countries and Non-Treaty-Member Countries

the marginal reduction cost curve of country s. In this case, the cost and benefit of joint implementation will have to depend on the actual reduction scenario proposed by country b.

Figure 5 shows five possible projects. On the potential marginal cost curve are the 5 projects, and addition of all these results in MACs [overbar], an upward shift in the potential marginal cost curve. The equilibrium point in this case will be at point e', and not the point e on the potential marginal cost curve. The equilibrium cost level will be higher, and at the same time, the potential reduction quantity will also become smaller. Further, in the case in which the point e' is not on the right of point o, then country b will not opt to participate in the program.

c) Issue of Equity in Joint Implementation Program

In joint implementation program in which the reduction targets of the treaty member countries are defined, inequity due to the difference in marginal reduction cost that

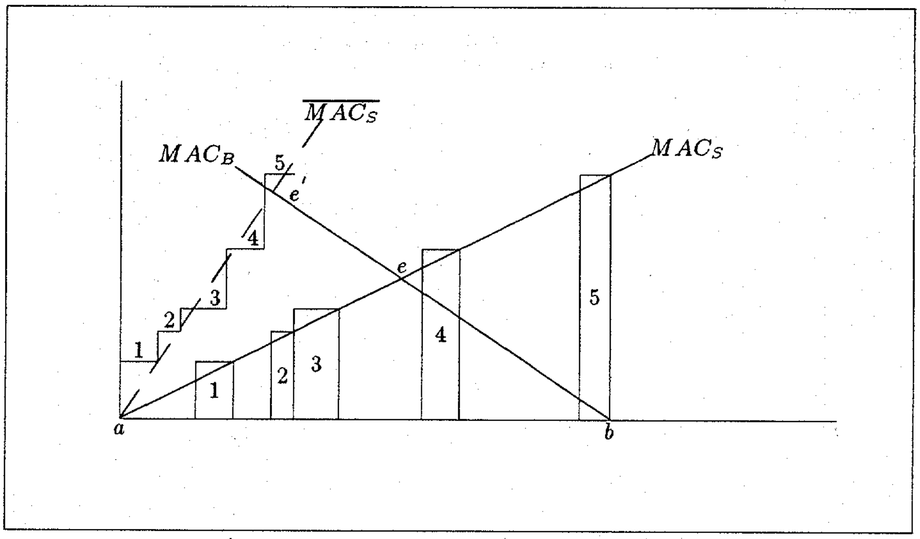

Figure 5: Project-based Joint Implementation

remains when market distortion is removed under no-regret policy can be corrected if the various uncertainties in the future are small and when the implementation of JI results in the market functioning efficiently. Further, inequity in the distribution of gain will still remain due to the country's position in negotiation.

The solution to the so called carbon leakage problem is mainly an issuebetween the industrialized and the developing countries. With the reductionbase-scenario or the estimation of the marginal reduction cost beinguncertain, it remains unknown if the solution is useful to emission reductionas a whole, and hence we are not able to evaluate if this can be link directly to the solving of the problem. Moreover, the issue on the uneven distribution of responsibilities for the environmental problems between the developed and the developing countries in a historical perspective, which developing countries call in question, cannot be solved through market based policies. Even when JI functions ideally based on information with certainty, this at most only guarantees cost efficiency, while with regard to distribution, Walras' reservation problem remains unsolved.

IV. Towards a Market Based System

Lastly, we consider the possibility of linking the joint implementation program with various market-based policies, such as the establishment of the emission rights market or the introduction of international environment tax. With regard to JI program among treaty member countries, if efforts are put into the establishment of clearing house or the removal of market distortions, it can be verified that the result will be equivalent to the establishment of a trading system. In the case of project-by-project based JI, the formation of the markets for emission right between 2 countries and within each country lead to the equalization of marginal cost, and this is in no conflict to the formation of a more complete emission right market.

However, for the case of JI between treaty member and non-treaty member countries, project-based JI will gradually result in the reduction of gain expected from the transaction of emission right in the non-treaty member country and the adherence on JI is also possible to result in disincentive to the transaction of emission right. On the other hand, from the point of view of treaty member country, as the project-based marginal cost is set higher than the competitive equilibrium price, the gain from JI becomes smaller as compared to the gain from the establishment of emission right market, and hence this leads to greater incentives in the establishment of emission right market.

From the point of view of information accumulation under various uncertainties, it is difficult to create an ideal market system, and hence at the present stage, the attempt to jointy implement the project-based program is a flexible policy instrument in terms of the accumulation of information and as a possible step-by-step improvement on environmental strategy. As a matter of course, the provision of technology or capital to the developing countries may also contribute to economic development in the developing countries.

Notes

(1) The Japan-China input-output table for the analysis of air pollutants is compiled under the joint program with the Ministry of International Trade and Industry in Japan, State Statistical Bureau (China), Environmental Protection Bureau (China) and Keio Economic Observatory of Keio University. All estimates on the generation and emission of pollutants are based on results of the above project.

(2) T. Kiji and H. Hayami[1995] and K. Yoshioka, H. Hayami, Wong Y.C. and T. Kiji[1995].

(3) For the estimation of CO_2 emissions from the cement manufacturing industry, while emissions from limestone could be estimated accurately in Japan, due to the unavailability of accurate data in China, the Chinese figure is approximated from the production of cement. See T. Kiji and H. Hayami[1995].

(4) M. Kuroda and K. Shimpo[1993].

(5) D.W. Jorgenson and P.J. Wilcoxen[1992].

(6) P. Bohm[1994].

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