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Economic and Environmental Interdependency
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Analysis for Economic and Environmental Interdependency in East Asian Countries

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July, 2000

Abstract

The purpose of this paper is to analyze the economic and environmental structure of the nine East Asian countries. We compiled the 1990 Input-Output Table for Analysis of environmental factors and energy efficiency (Economic Development and Environmental Navigation, hereafter EDEN I-O Table) for each nine East Asian country and linked the nine EDEN I-O Tables (the East Asian International Input-Output Table) through each country's foreign trade matrix (sector by country among nine East Asian Countries and the rest of the world). We could calculate the magnitude of the Economic and Environmental Interdependency by applying the Leontief Open Model. And then we divided nine countries to four groups such as Japan, NIEs, ASEAN, and China and found "Kuznets curve as environment" which reflecting the relation between economic development and economic problem. There is much still to learn about the sustainable growth among these countries and to learn about simulations which are how to save energy and how to reduce CO₂ and SO₂ by introducing past Japanese experiences and technological transfers.

Analysis for Economic and Environmental Interdependency in East Asian Countries*

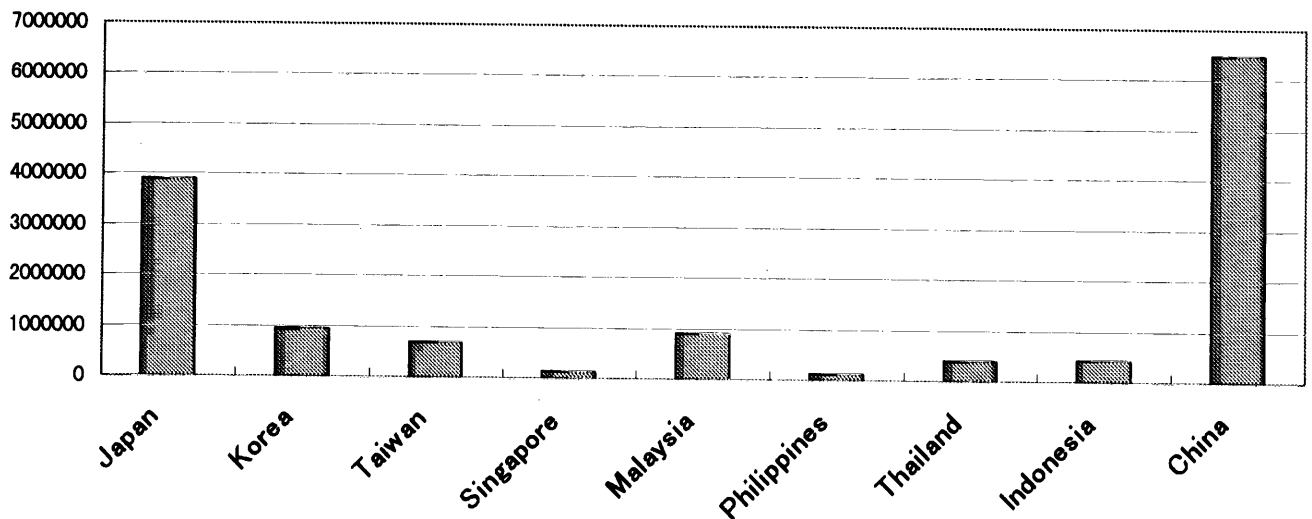
Kozo Ishida★、Hikaru Sakuramoto★★、Masahiko Shimizu★★★、
Ayu Washizu★★★★、Naoko Takenaka★★★★★

Ch.1 Energy Consumption

1 – 1 Structure of Energy Consumption in East Asian countries

This chapter analyzes the structure of energy consumption in East Asian 9 countries which is called EDEN countries (Japan · Korea · Taiwan · Singapore · Malaysia · Philippines · Thailand · Indonesia · China) based on EDEN 1990 D table (The energy consumption calory is showed) .

Figure 1 Energy consumption in East Asian countries



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Figure 1 shows that Energy consumption in East Asian countries. As a whole, China is the biggest total quantity of energy consumption country, and the next three are Japan, Korea, and Malaysia. On one hand, the worst two in East Asia are Philippines and Singapore. In comparison to the other East Asian countries, China and Japan stand out of the quantity of energy consumption and both of them occupy about 73.8% of the whole in East Asia.

<Structure of energy consumption in EDEN country>

Table 1 is more detailed information about figure 1 and arranged all kind of energy in order of size in each country. To see each country, a key distinguishing feature of Japan's energy consumption is not only depend on one energy too much, but also on a lot of kind of energies. And four high-ranking rate energies that is "diesel oil (15.27%)", "fuel oil (14.13%)", "LNG (11.81%)", and "gasoline(8.925)" occupy about 50% of the whole. And "electricity" is the lowest rate (0.02%) in Japan. In Korea, "fuel oil (19.37 %)" and "diesel oil(15.92 %)" are two top of the quantity of energy, and the rate of "Industrial waste Gas(COG)(11.38)" and "electricity(10.39%)" are high comparatively. Taiwan is only country that "Crude Oil" is the highest rate (17.68%), moreover "coal (15.8%)" and "electricity (10.36%)" are very high comparatively. In Singapore, "fuel oil" accounts for roughly 50% .On the other hand, the rates of "Coal (0.39%)" and "natural gas (0%)" are very low. In Malaysia, both "Vegetable fuels (60.86%)" which is the highest rate energy and "Natural gas (32.67%)" the second highest rate energy occupy about 90% of total energy consumption. In Philippines, it has a feature that the rates of "fuel oil (31.95 %)" and "diesel oil (23.82 %)" are the two highest and the rates of "electricity (14.69%)" and "coal (7.75%)" are very high comparatively than the other countries. In Thailand, it is especially high rate of "Natural gas (22.44%)" in comparison to the other East Asian countries. And three high-ranking energies of all that is "diesel oil (25.60 %)", "natural gas (22.44%)", and "fuel oil (11.84%)" occupy about 60% of total energy consumption. And As well as Taiwan and Philippines, the rates of "Electricity (9.19%)" and "Coal (8.97%)" are comparatively high. "Diesel oil"(23.87%) is the highest in Indonesia, likewise Thailand. And "Kerosene" which is the second highest in Indonesia occupies 12.85% of whole energy consumption. So in comparison to the other EDEN countries, this rate is very high. And it is high rate of "coal (11.21%)" and "electricity (7.38 %)", too. China has a distinctive feature in EDEN countries that it depends on "Coal (66.86%)" too much. "Industrial or General Waste" is used only three EDEN countries such as Japan(3.64 %), Thailand(3.27 %), and Indonesia(0.62%), but the rate is very low.

<Structure of main energy>

Next we see factors of each major energy (which is more consumed energy). In almost countries "coal" mainly comes from "thermal power", especially in Thailand the rate is very high about 80%. On the other hand, "thermal power" is not high-ranking only in Singapore. And the heavy industry such as "cement", "coke and other coal products", "iron and steel", and "other chemical products" commonly occupy high rate in each country. "family consumption" ranked within top ten only China and Malaysia. Especially in China, the cause of it is to use "coal" too much in a family heater. And "railway transport" ranked within top ten industries in Indonesia, Malaysia, and China. The difference of structure as "natural gas" in each country is comparatively big. In Japan, it comes from mainly "gas supply" about 67.5%, in Taiwan it comes from "family consumption" about 47.71%, and in Indonesia it comes from "thermal power" about 53.01%. In Thailand, two top industries "gas supply (47.91%)" and "thermal power (44.535)" occupy over 90%. Two top industries are "Crude oil and natural gas (22.2%)" and "family consumption (16.08%)" in China and the rest are occupied with manufacturing industry and generation of electric power industry. As to "diesel oil", it is common feature that the biggest industry is "road transport" and the second is "fishing" in Japan, Korea, Taiwan, and Thailand. On the other hand, "family industry" accounts for 46.3% of whole and the rate is higher than "road transport" only in Malaysia, its rate is higher than "road transport". In Singapore, "commerce" occupies 27.59% of whole, in another word, it comes from mainly service industry as a whole.

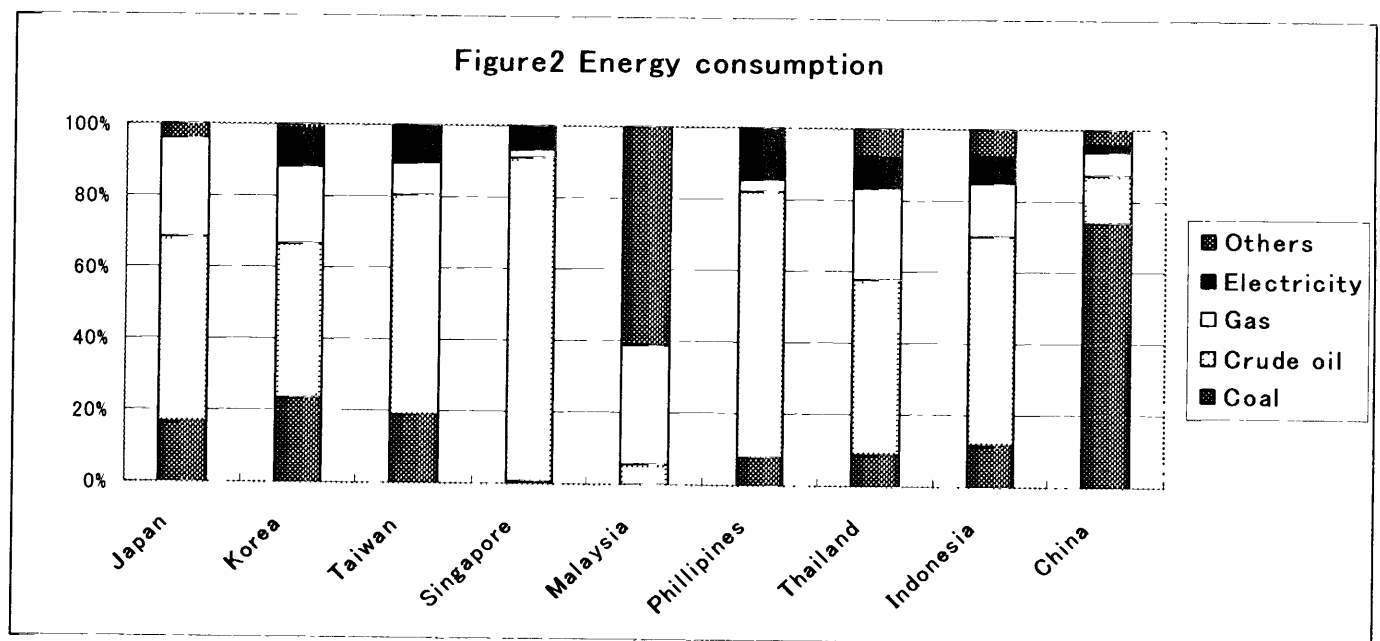
<Structure of more energy consumption industry>

This paragraph deals with industry which consumes more energy. The structure of energy consumption as "pulp, paper and paper products" in each country is very different. "Fuel oil" is the highest rate in three countries Korea(71.41%), Taiwan (55.82%), and Philippines (68.5%), and Japan is "industrial or general waste (41.77%)", Singapore is "electricity (36.65%)", Malaysia is "vegetable fuels(99.31%)", and Singapore is "natural gas(46.02%)" is the highest of whole. Moreover "coal" occupies 30.27% in Thailand and 77.79% in China, so its rate is the highest. And "coal" occupies 10.32% in Japan, 34.13% in Taiwan, so its rate is the highest. The structure of "cement and other non-fabricated metal products" is comparatively same in all country that the rates of "coal" and "fuel oil" are the highest in EDEN countries except "fuel oil" of Malaysia and Indonesia. "Coal" is the highest in seven EDEN countries except Malaysia and Thailand. In Malaysia, the highest energy is "town gas (99.30%)" and in Thailand is "fuel oil(28.99%)". It has a future that "electricity" occupies over 10% and

high-ranked in Singapore, Philippines, and Thailand. As to “iron”, it depends on “coke” too much in Japan, Korea, Taiwan, and China. And in China, type of coal energy such as two top industries “coke” and “coal” occupy about 70% of total energy. Singapore, Philippines and Thailand depend on “Electricity”, on the other hand, “natural gas” occupies about 70% in Indonesia and the rates of “coal” and “coke” are only below 1%. And “fuel oil” is high-ranked energy in EDEN countries except Malaysia but the rate is low. As to industry of “electricity, gas, and water”, it has a different structure in each country. “Liquefied natural gas” in Japan, “industrial waste gas” in Korea, “electricity” in Taiwan, “crude oil” in Singapore, “fuel oil” in Philippines, “natural gas” in both Malaysia and Thailand, and “coal” in both Indonesia and China is the highest rate energy. As to industry of “transport”, “diesel oil” in Japan, Korea, Philippines, Thailand, and Indonesia, “gasoline” in Taiwan, “fuel oil” in Singapore, and “coal” in China is the highest energy.

<Five type of energy>

Figure 2 shows that the structure of energy consumption of five type of energy that is 「Coal」 「Crude Oil」 「Gas」 「Electricity」 「Others」 which is divided into 5 from 22 energies in each country.



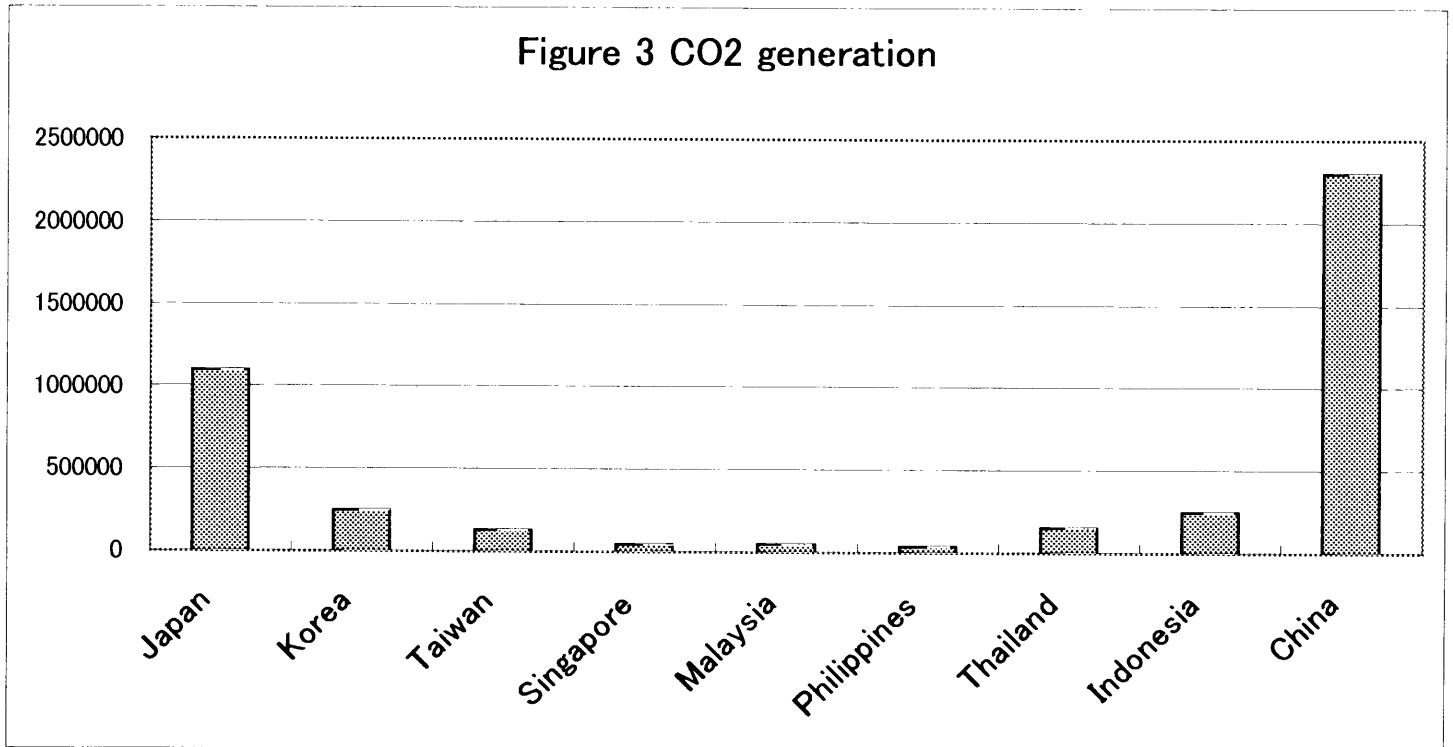
At first, as to 「Coal」, the rate of it is very high remarkable in China(73.67%). but its rate of Singapore is very low(0.392%). In China, “electricity, gas, and water” occupies 31.09%, “family consumption” occupies 12.96%, “cement and other non-fabricated metal products” occupies 9.48%, “iron” occupies 9.21% of 「Coal」. Actually China occupies

about 81.31 % of whole 「Coal」 in East Asia. The rate of the other country is about under 20%. As to 「crude oil」, the rate of its is very high in EDEN countries except China and Malaysia. Above all, its rate is 90.98% in Singapore and three top industries are “oil and coal products (35.37%)”, “transport (30.12%)”, and “electricity, gas and water(11.81%)”. In Philippines, 「crude oil」 occupies 72.2% of whole, and two top industries are “transport(37.11%)” and “electricity, gas and water(29.95%)” .As to 「Electricity」,

The highest rate country is Philippines about 14.69%,the second is Korea(10.39%), the third is Taiwan(10.36%), the forth is Thailand(9.19%) and Japan is only about 0.03%.In Philippines, the two main industries of 「Electricity」 are “family consumption(25.53%)” and “foods (11.0%)” and in Korea, the first is “family consumption (20.34%)”,the second is “other services (12.43%)”,the third is “electricity, gas and water (9.59%)”,and the forth is “iron (7.25)”. And in Taiwan, “electricity, gas and water” is the main industry of 「Electricity」 and occupies 70.8% of whole.

1 – 2 CO₂ generation

Figure 3 shows CO₂ generation in EDEN countries based on EDEN 1990 E table.

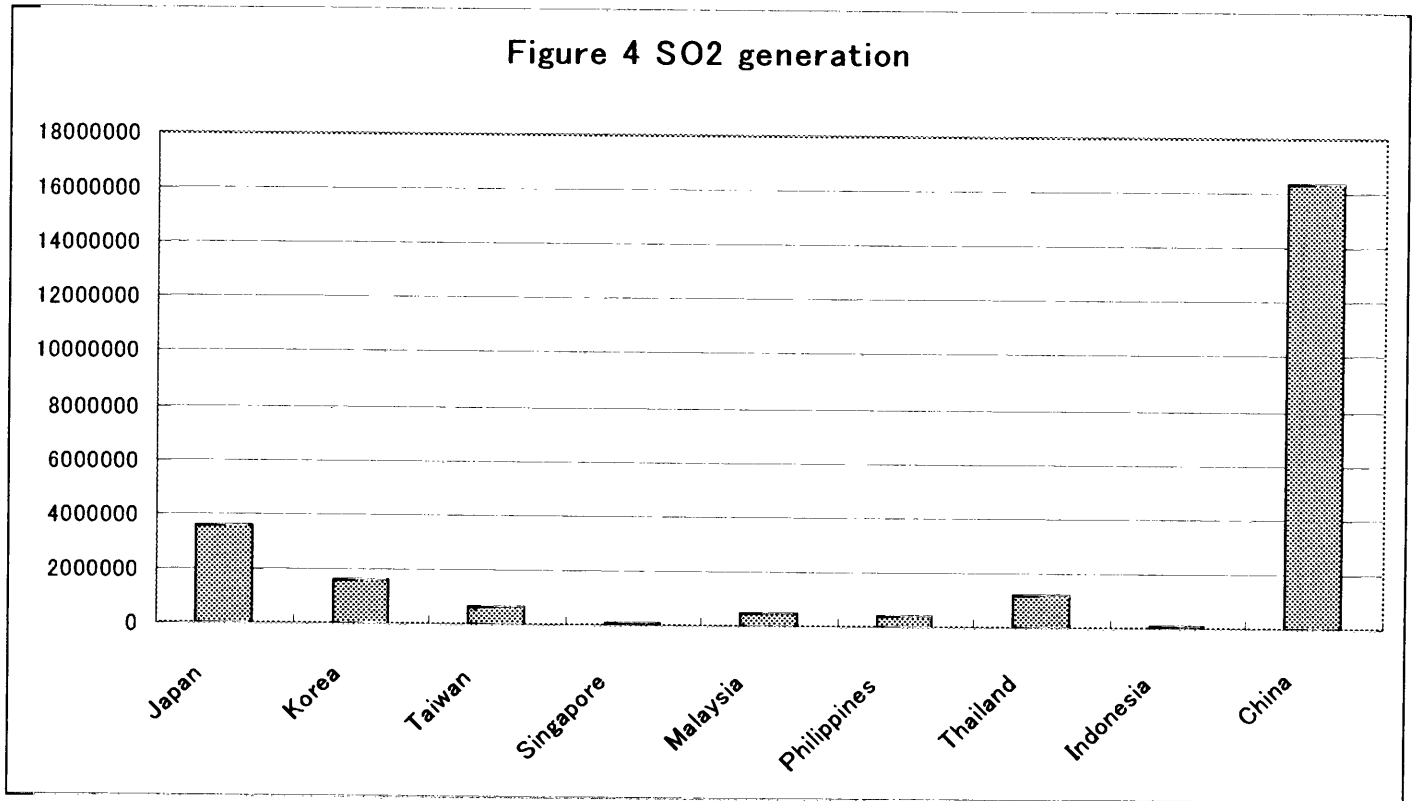


China is the biggest quantity of CO₂ generation countries, and the second is Japan, the third is Indonesia, the fourth is Korea, the fifth is Taiwan. On the other hand, the worst two countries are Philippines and Singapore, the sum of CO₂ generation of both are only 2% of that of China which is the most generation country. China occupies 53.28% of whole of the CO₂ generation and Japan occupies 25.45% similarly. Table 2 shows more detailed information about figure 3 and picks up top ten industries in each country. CO₂ generation of five countries such as "Japan (27.70%)", "Taiwan (29.51%)", "Thailand (33.435)", "Indonesia (50.94%)", and "China (24.52%)" mainly comes from "thermal power". In Japan, three top industries of "thermal power (27.7%)", "family consumption (11.09%)", and "road transport (10.75)" occupy about over 50% of CO₂ generation. Korea is the only one country that comes from mainly "family consumption". And next three are "thermal power (16.78%)", "road transport (8.94%)", and "water transport (4.77%)". In Taiwan "thermal power (29.51%)" and "road transport (15.67%)" are two top industries. Singapore has a feature that "petroleum refinery products (36.94%)" and "air transport (16.47%)" are two top industries. In Malaysia, four top industries "crude oil (31.54%)", "family consumption (23.75%)", "thermal power (19.74%)", and "railway transport (8.0%)" occupy about over 84%. And the rate of "family consumption" in Malaysia is the highest in the East Asian country.

Philippines is the only country that “road transport (31.18%)” is the highest industry, and next two industries are “thermal power (24.26%)” and “family consumption (5.95%)”. In Thailand, three top industries are “thermal power (33.43%)”, “gas supply (14.36%)” and “road transport (12.85%)”. In Indonesia, it has feature that the rate of “thermal power” occupies 50.9% of total and next 4 factors that is “cement (14.36%)”, “iron and steel (13.86%)”, and “gas supply (10.36%)” occupy 89.5% of whole. In China, two top industries of whole is “thermal power (24.52%)” and “family consumption (24.52%)”.

1 – 3 SO₂ generation

Figure4 shows SO₂ generation in EDEN countries based on EDEN 1990 E table.



China is the biggest country as quantity of SO₂ generation and it occupies 66.87% of East Asia. And the second is Japan (14.77%), the third is Korea (6.38%), the fourth is Thailand (4.78%), and the fifth is Taiwan (2.57%). Indonesia and Singapore are the worst two countries, the former occupies about 0.31% and the latter occupies about 0.40% of East Asia. Table 3 shows top ten industries as SO₂ generation in each country. Japan is "water steam and hot water supply, sewage (33.06%)", and six EDEN countries that is Korea (19.45%), Taiwan (39.43%), Philippines (40.97%), Thailand (44.57%), Indonesia (32.35%), and China is "thermal power(25.27%)", Singapore is "petroleum refinery products (51.50%)", and Malaysia is "family consumption (26.81%)" is the biggest SO₂ generating industry. As a whole, all country has a common feature that the manufacturing industry such as "iron and steel", "pulp paper and paper products", "chemical products", "cement", and "coal products" is high-ranking industry but Singapore is the only country that the type of service industry like "commerce" and "service" is within top ten industry. Malaysia has a feature that "family consumption (26.81%)" and "crude oil and natural gas (17.45%)" is high-ranking industry.

Table 2 Top ten industry of CO2 generation (1000T-co)

Sector		Japan		Korea		Taiwan		Singapore		Malaysia					
		303929	27.701%	Family consumption	53910	21.785%	Thermal power	38805	29.515%	Crude oil	15521	36.942%	Crude oil and natural gas	16618	31.542%
1	Thermal power	120785	11.009% <td>Thermal power</td> <td>41523</td> <td>16.780%<td>Railway transport</td><td>20604</td><td>15.671%<td>Air transport</td><td>6920</td><td>16.470%<td>Family consumption</td><td>12515</td><td>23.753%</td></td></td></td>	Thermal power	41523	16.780% <td>Railway transport</td> <td>20604</td> <td>15.671%<td>Air transport</td><td>6920</td><td>16.470%<td>Family consumption</td><td>12515</td><td>23.753%</td></td></td>	Railway transport	20604	15.671% <td>Air transport</td> <td>6920</td> <td>16.470%<td>Family consumption</td><td>12515</td><td>23.753%</td></td>	Air transport	6920	16.470% <td>Family consumption</td> <td>12515</td> <td>23.753%</td>	Family consumption	12515	23.753%
2	Family consumption	117401	10.700% <td>Railway transport</td> <td>22128</td> <td>8.942%<td>Iron and steel products</td><td>13048</td><td>9.924%<td>Thermal power</td><td>4903</td><td>11.670%<td>Thermal power</td><td>10401</td><td>19.741%</td></td></td></td>	Railway transport	22128	8.942% <td>Iron and steel products</td> <td>13048</td> <td>9.924%<td>Thermal power</td><td>4903</td><td>11.670%<td>Thermal power</td><td>10401</td><td>19.741%</td></td></td>	Iron and steel products	13048	9.924% <td>Thermal power</td> <td>4903</td> <td>11.670%<td>Thermal power</td><td>10401</td><td>19.741%</td></td>	Thermal power	4903	11.670% <td>Thermal power</td> <td>10401</td> <td>19.741%</td>	Thermal power	10401	19.741%
3	Railway transport	62252	5.674% <td>Water transport</td> <td>11818</td> <td>4.776%<td>Crude oil</td><td>8112</td><td>6.170%<td>Water transport</td><td>2112</td><td>5.023%<td>Railway transport</td><td>4254</td><td>8.075%</td></td></td></td>	Water transport	11818	4.776% <td>Crude oil</td> <td>8112</td> <td>6.170%<td>Water transport</td><td>2112</td><td>5.023%<td>Railway transport</td><td>4254</td><td>8.075%</td></td></td>	Crude oil	8112	6.170% <td>Water transport</td> <td>2112</td> <td>5.023%<td>Railway transport</td><td>4254</td><td>8.075%</td></td>	Water transport	2112	5.023% <td>Railway transport</td> <td>4254</td> <td>8.075%</td>	Railway transport	4254	8.075%
4	Water steam and hot water	41609	3.792% <td>Cement</td> <td>9807</td> <td>3.963%<td>Chemical products</td><td>7797</td><td>5.930%<td>Railway transport</td><td>2018</td><td>4.802%<td>Cement</td><td>1432</td><td>2.719%</td></td></td></td>	Cement	9807	3.963% <td>Chemical products</td> <td>7797</td> <td>5.930%<td>Railway transport</td><td>2018</td><td>4.802%<td>Cement</td><td>1432</td><td>2.719%</td></td></td>	Chemical products	7797	5.930% <td>Railway transport</td> <td>2018</td> <td>4.802%<td>Cement</td><td>1432</td><td>2.719%</td></td>	Railway transport	2018	4.802% <td>Cement</td> <td>1432</td> <td>2.719%</td>	Cement	1432	2.719%
5	Iron and steel	38782	3.535% <td>Commerce</td> <td>9018</td> <td>3.644%<td>Water transport</td><td>5575</td><td>4.200%<td>Commerce</td><td>1786</td><td>4.250%<td>Commerce</td><td>1407</td><td>2.671%</td></td></td></td>	Commerce	9018	3.644% <td>Water transport</td> <td>5575</td> <td>4.200%<td>Commerce</td><td>1786</td><td>4.250%<td>Commerce</td><td>1407</td><td>2.671%</td></td></td>	Water transport	5575	4.200% <td>Commerce</td> <td>1786</td> <td>4.250%<td>Commerce</td><td>1407</td><td>2.671%</td></td>	Commerce	1786	4.250% <td>Commerce</td> <td>1407</td> <td>2.671%</td>	Commerce	1407	2.671%
6	Other power	34689	3.162% <td>Gas supply</td> <td>7744</td> <td>3.130%<td>Non-ferrous metal products</td><td>5427</td><td>4.128%<td>Family consumption</td><td>1784</td><td>4.247%<td>Fishing</td><td>1060</td><td>2.012%</td></td></td></td>	Gas supply	7744	3.130% <td>Non-ferrous metal products</td> <td>5427</td> <td>4.128%<td>Family consumption</td><td>1784</td><td>4.247%<td>Fishing</td><td>1060</td><td>2.012%</td></td></td>	Non-ferrous metal products	5427	4.128% <td>Family consumption</td> <td>1784</td> <td>4.247%<td>Fishing</td><td>1060</td><td>2.012%</td></td>	Family consumption	1784	4.247% <td>Fishing</td> <td>1060</td> <td>2.012%</td>	Fishing	1060	2.012%
7	Gas supply	34348	3.131% <td>Iron and steel</td> <td>7303</td> <td>2.951%<td>Iron and steel</td><td>4747</td><td>3.610%<td>Other transport</td><td>1209</td><td>2.877%<td>Other power</td><td>740</td><td>1.405%</td></td></td></td>	Iron and steel	7303	2.951% <td>Iron and steel</td> <td>4747</td> <td>3.610%<td>Other transport</td><td>1209</td><td>2.877%<td>Other power</td><td>740</td><td>1.405%</td></td></td>	Iron and steel	4747	3.610% <td>Other transport</td> <td>1209</td> <td>2.877%<td>Other power</td><td>740</td><td>1.405%</td></td>	Other transport	1209	2.877% <td>Other power</td> <td>740</td> <td>1.405%</td>	Other power	740	1.405%
8	Water transport	31297	2.853% <td>Coke and other coal products</td> <td>6136</td> <td>2.479%<td>Family consumption</td><td>4119</td><td>3.133%<td>Civic engineering</td><td>813</td><td>1.936%<td>Forestry</td><td>690</td><td>1.310%</td></td></td></td>	Coke and other coal products	6136	2.479% <td>Family consumption</td> <td>4119</td> <td>3.133%<td>Civic engineering</td><td>813</td><td>1.936%<td>Forestry</td><td>690</td><td>1.310%</td></td></td>	Family consumption	4119	3.133% <td>Civic engineering</td> <td>813</td> <td>1.936%<td>Forestry</td><td>690</td><td>1.310%</td></td>	Civic engineering	813	1.936% <td>Forestry</td> <td>690</td> <td>1.310%</td>	Forestry	690	1.310%
9	Pulp paper and paper product	30349	2.766% <td>Chemical products</td> <td>4896</td> <td>1.978%<td>Fishing</td><td>2904</td><td>2.209%<td>Business services</td><td>764</td><td>1.818%<td>Buildings</td><td>648</td><td>1.229%</td></td></td></td>	Chemical products	4896	1.978% <td>Fishing</td> <td>2904</td> <td>2.209%<td>Business services</td><td>764</td><td>1.818%<td>Buildings</td><td>648</td><td>1.229%</td></td></td>	Fishing	2904	2.209% <td>Business services</td> <td>764</td> <td>1.818%<td>Buildings</td><td>648</td><td>1.229%</td></td>	Business services	764	1.818% <td>Buildings</td> <td>648</td> <td>1.229%</td>	Buildings	648	1.229%
10	Iron and steel products														
Total		1097167	100.000%	Total	247462	100.000%	Total	#####	100.000%	Total	42016	100.001%	Total	52687	100.000%

Philippines			Thailand			インドネシア			China			
1	Railway transport	11994	31.183%	Thermal power	51513	33.432%	Thermal power	#####	50.947%	Thermal power	563501	24.527%
2	Thermal power	9331	24.260%	Gas supply	22560	14.642%	Cement	36064	14.364%	Family consumption	261091	11.364%
3	Family consumption	2292	5.958%	Railway transport	19814	12.858%	Iron and steel	34800	13.860%	Iron and steel	159022	6.922%
4	Cement	1544	4.015%	Family consumption	7684	4.987%	Gas supply	26019	10.363%	Cement	120476	5.244%
5	Water transport	1477	3.840%	Cement	6238	4.049%	Pulp paper and paper products	5002	1.992%	Chemical products	103369	4.499%
6	Metal ores mining	1263	3.284%	Water transport	4682	3.039%	Family consumption	3990	1.589%	Non-ferrous metal products	78505	3.417%
7	Other edible crops	1195	3.107%	Other edible crops	4291	2.785%	Non-ferrous metal products	3118	1.242%	Fertilizer	78103	3.400%
8	Water transport	988	2.569%	Fishing	3297	2.140%	Civic engineering	2141	0.853%	Iron and steel products	62709	2.730%
9	Coke and coal products	797	2.073%	Air transport	3192	2.071%	Railway transport	1936	0.771%	Water/steam hot water	51318	2.234%
10	Fishing	783	2.035%	Other power	3063	1.988%	Buildings	1641	0.653%	Coke and other coal products	50180	2.184%
Total		38464	100.000%	Total	154084	100.000%	Total	#####	100.000%	Total	2297434	100.000%

Table 3 Top ten industry of SO2 generation (100T)

Japan		Korea		Taiwan		Singapore		Malaysia				
	Total		Total		Total		Total		Total			
1	Water, steam and hot water	1189494	33.060%	Thermal power	302653	19.450%	Thermal power	50395	51.509%	Family consumption	86818%	
2	Thermal power	554588	15.414%	Family consumption	232420	14.936%	chemical products	9107	9.308%	Crude oil and natural gas	88689	17.458%
3	Iron and steel	472129	13.122%	Water transport	135889	8.733%	Water transport	54542	9.046	Thermal power	71892	14.150%
4	Pulp paper and paper product	379448	10.365%	Iron and steel	99757	6.411%	Iron and steel products	40714	6.486%	Water transport	6747	6.897%
5	Railway transport	178549	4.962%	Chemical products	65477	4.208%	Petroleum refinery products	32170	5.125%	Commerce	4613	4.715%
6	Other power	123609	3.435%	Cement	61176	3.931%	Non-ferrous metal products	27989	4.459%	Other transport	3282	3.355%
7	Water transport	107439	2.986%	Railway transport	55988	3.599%	Pulp paper and paper products	19186	3.057%	Business services	2086	2.132%
8	Cement	89120	2.477%	Commerce	49904	3.207%	Railway transport	16630	2.649%	Railway transport	2083	2.129%
9	Chemical products	69158	1.922%	Iron and steel products	37669	2.421%	Iron and steel	14395	2.293%	Civic engineering	2007	2.051%
10	Iron products	44382	1.234%	Petroleum refinery products	36072	2.318%	Spinning	12614	2.010%	Public administration	1399	1.430%
Total		3597988	100.000%	Total	#####	100.000%	Total	#####	100.000%	Total	97838	99.999%

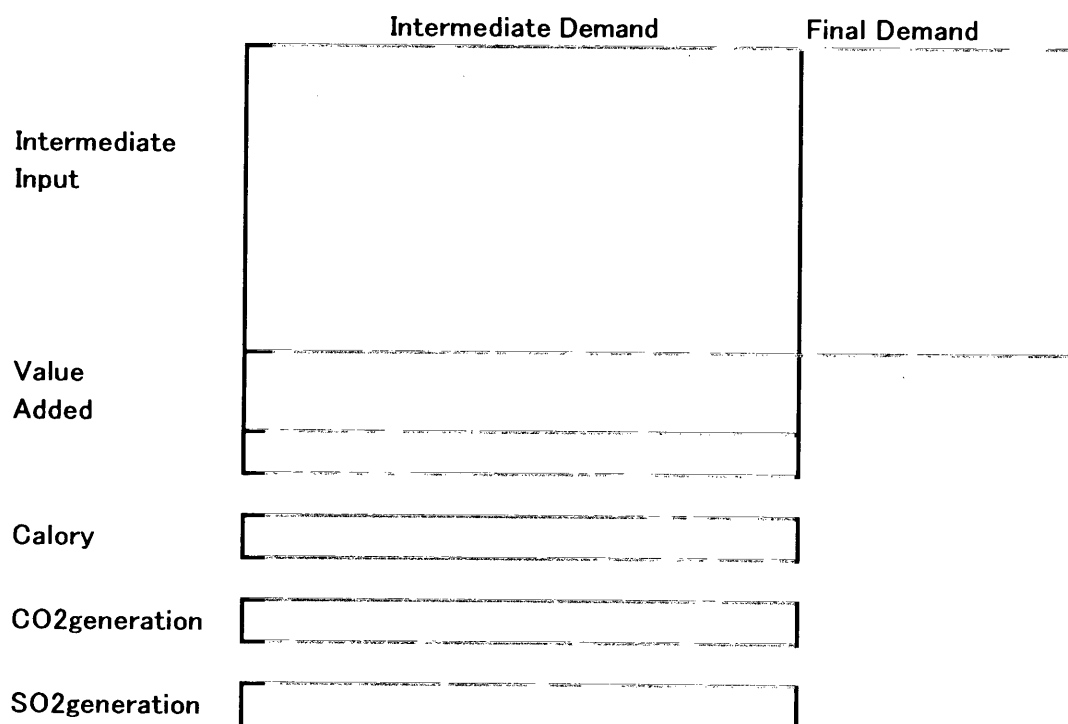
Philippines			Thailand			Indonesia			China			
1	Thermal power	179162	40.976%	Thermal power	519843	44.576%	Thermal power	24787	32.354%	Thermal power	4491244	27.572%
2	Cement	36145	8.267%	Gas supply	130433	11.184%	Family consumption	6467	8.441%	Family consumption	2093749	12.854%
3	Other edible crops	29509	6.749%	Railway transport	102674	8.804%	Non-ferrous metal products	4992	6.515%	Cement	989593	6.075%
4	Railway transport	26407	6.040%	Cement	90024	7.719%	Railway transport	4784	6.245%	Iron and steel	851634	5.228%
5	Water,Steam&hot water suppl	24811	5.675%	Water transport	54944	4.711%	Civic engineering	4654	6.075%	chemical products	586350	3.600%
6	Metal ores mining	22941	5.247%	Other edible crops	25245	2.165%	chemical products	4177	5.451%	Non-ferrous metal products	580025	3.561%
7	Water transport	15750	3.602%	Fishing	20952	1.797%	Buildings	3651	4.768%	Fertilizer	557078	3.420%
8	Coke and other coal product	10418	2.383%	Non-ferrous metal products	14233	1.220%	Other electrical machinery	3628	4.735%	Coke and other coal products	411560	2.527%
9	Pulp paper and paper product	9659	2.209%	Pulp paper and paper products	14052	1.205%	Cement	3257	4.251%	Water,steam&hot water supply	396778	2.436%
10	Commerce	9063	2.073%	Other power	13298	1.140%	Coal products	2346	3.062%	Spinning	367500	2.256%
Total		437236	100.000%	Total	#####	100.000%	Total	76614	100.000%	Total	#####	100.000%

Ch.2 International Interdependency

This chapter understands the interdependency in East Asia as induced energy consumption, SO₂ generation, and CO₂ generation follow with economic behavior in each country by analysis of EDEN 1990 tables with import and export trade matrix in 1990 made by IDE (Institute of Developing Economics). But this paper treats only about induced CO₂ generation.

<Conception of International Input-Output table>

Country in inter sector is nine East Asian countries that is China, Indonesia, Japan, Korea, Malaysia, Taiwan, Philippines, Singapore, and Thailand. Final demand is composed of four factors in each country and moreover includes, "export to another country except nine countries mentioned above". The below figure is the conception of International Input-Output table to use this chapter. But this analysis treats energy problem and environmental load in each country by only process of production and not consumption by final demand.



<Equation>

Equations to calculate induced calory and induced CO₂ • SO₂ generation by each good and service is showed (1) to (4) as below. To calculate inverse we use $(I - A)^{-1}$ which is known as Leontief inverse of matrix because we assume that goods and services are produced only domestic.

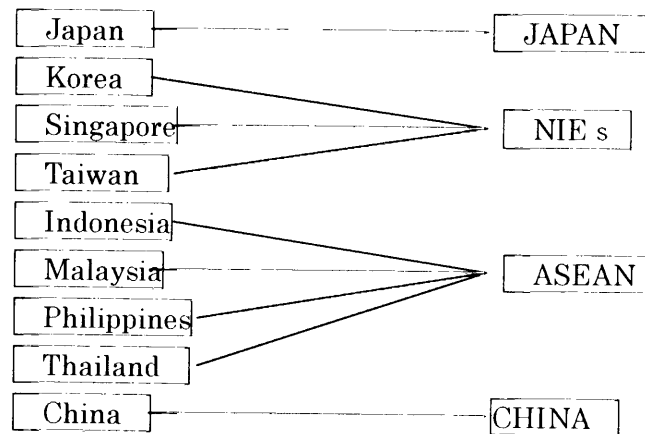
- induced production (1) $X = (I - A)^{-1} F$
- induced Calory generation (2) $Cal = \hat{c}_a (I - A)^{-1} F$
- induced CO₂ generation (3) $CO_2 = \hat{c} (I - A)^{-1} F$
- induced SO₂ generation (4) $SO_2 = \hat{s} (I - A)^{-1} F$

X : vector of domestic production I : identity matrix A : input coefficient matrix
 F : vector of final demand
 $\hat{c}_a, \hat{c}, \hat{s}$: diagonal matrix of calory coefficient , CO₂ and SO₂ generation coefficient
per unit of production

Equation (1) is used to calculate induced production by final demand both direct and indirect. As well, equation(2),(3),and(4) are used to calculate induced energy, induced CO₂ ,and induced SO₂ generation both direct and indirect by increase of final demand with use of each coefficient of generation per unit of production. The estimate was done for nine countries mentioned above.

<Classification country>

In generally, it is often said that the circumstance of economic development in Asia country and region compares to “the form of flying goose”. This means that the developing countries will catch up with developed countries in short terms by the former get into some technologies and experiences which the latter have and as total of Asia will develop more. In another word, to keep the stage of economic development in Asia, NIE s (Newly Industrializing Economies) develops to catch up with Japan which has accomplished economic development already, ASEAN (Association of South-East Asian Nations) develops to catch up with NIE s , and CHINA is now developing steadily follow with ASEAN by call in the system of socialistic market economy. Then we divided EDEN nine countries to four groups as grade of economic growth mentioned above.

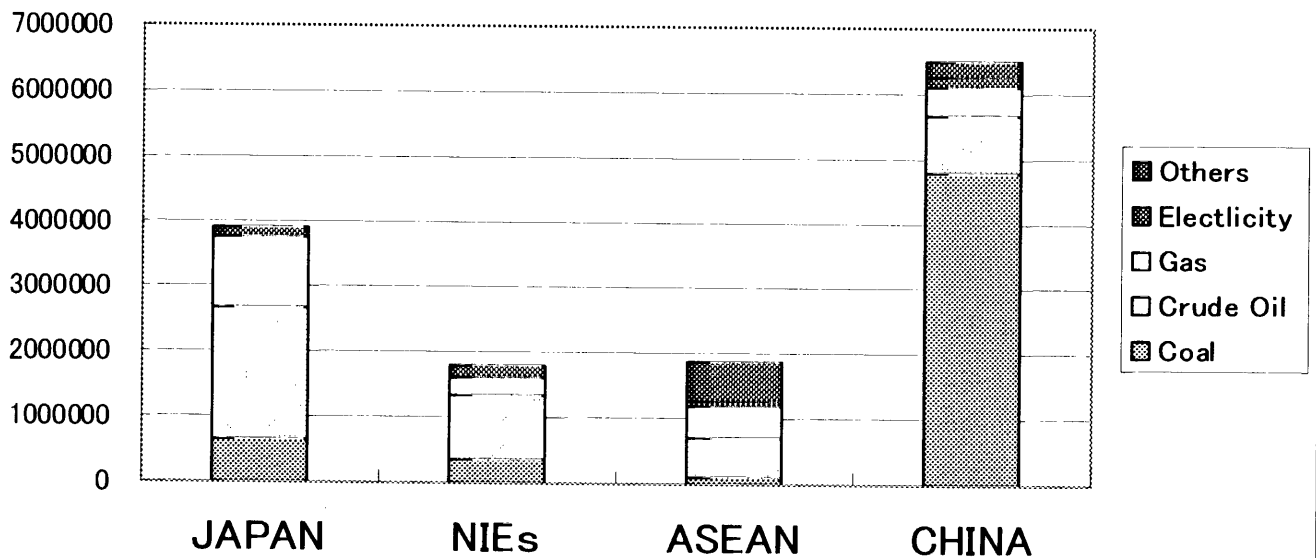


But the word 「NIE s」 used in this paper means three EDEN countries such as Korea, Taiwan, and Singapore but lacking Hong Kong from NIEs which is said in general and 「ASEAN」 means four EDEN countries such as Indonesia, Malaysia, Philippines and Thailand which is generally called “ASEAN4”. And 「JAPAN」 and 「CHINA」 mean only one country. Then we will continue analyze assuming that 「Japan」 means only one country, 「NIE s」 means three countries, 「ASEAN」 means four countries, and 「China」 means only one country .

2 - 1 Structure of Energy in 4 groups

This section treats the structure of energy consumption in 4 groups based on EDEN 1990 D Table. And 22 kinds of energy divide to 5 types of energy mentioned at Ch.1.

Figure 5 5 type of energy



As to the sum of the quantity of energy consumption, the biggest group is CHINA, the second is JAPAN, the third is ASEAN, and the fourth is NIEs. (But now, don't forget two points that the sum of NIEs means the aggregation of the quantity of energy consumption of three countries mentioned above and the sum of ASEAN means the aggregation of four countries as well. And this figure is influenced by scale of economy, population, and technology in every country and group.) 「Crude oil」 occupies over 50% of whole in both Japan and NIEs. The more detailed information about Japan is as previously described at chapter 1. And in NIEs the industry of "transport" is 24.23% of 「Crude oil」. Moreover 「Electricity」 is comparatively high in NIEs (10.08%), but the rate is very low in JAPAN (0.02%). And in NIEs three industries "electricity, gas and water (32.92%)", "family consumption (14.725)", and "other services (8.05%)" occupy 32.92% of 「Electricity」. And in ASEAN which includes Malaysia mainly depends on "vegetable fuels", 「Others」 occupies 32.47% of whole and two main industries are "cement and other non-fabricated metal products (43.92%)", and "foods (19.09%)". So over 95% of 「Others」 in the East Asia comes from ASEAN. Moreover, ASEAN has a feature of that the rate of 「Coal」 is comparatively low (5.27%). And 「Coal」 in China is as mentioned at chapter 1.

<More energy consumption industry>

Table 4 is a list of industries of more energy consumption. As to “Pulp, paper and paper products”, the rate of 「Crude oil」 is the highest in JAPAN and NIEs, and 「Others」 is the highest in ASEAN as well. On the other hand, CHINA depends on 「Coal」 too much. As to “cement and other non-fabricated metal products”, the rate of 「Crude oil」 is very high in JAPAN, NIEs, and CHINA, on the other hand, ASEAN is only group that is the rate of 「Others」 is the highest and 「Crude oil」 occupies only 6.93% of all. As to “iron”, except JAPAN that has negative data, NIEs and CHINA are the rate of 「Coal」 is the highest and 「Others」 is very high in ASEAN. As to “electricity, gas and water”, JAPAN and ASEAN are 「Gas」 is very high, NIEs is 「Crude oil」, and CHINA is 「Coal」 is very high. As to “transport”, three groups JAPAN, NIEs, and ASEAN are commonly 「Crude oil」 is the biggest commonly and next is 「Gas」. And CHINA is 「Crude oil」 is the biggest that occupies 61.96% of all, and next is 「Coal」 that occupies 36.95%. As to the sum of five major energy consumption industries, the biggest is 「Crude oil(46.06%)」, the second is 「Gas(25.43%)」, the third is 「Coal(22.88%)」 in JAPAN, the biggest is 「Crude oil(47.34%)」, the second is 「Coal(24.33%)」, the third is 「Gas(18.89%)」 in NIEs, finally the biggest is 「Crude oil(32.67%)」, the second is 「Gas(21.87%)」, the third is 「Coal(9.79%)」 in ASEAN, and the biggest is 「Coal(78.8%)」, the second is 「Crude oil(12.40%)」, the third is 「Gas(5.76%)」 in CHINA. So as to 5 major industries, JAPAN, NIEs, and ASEAN commonly depend on 「Crude oil」, on the other hand, CHINA is only group that depends on 「Coal」 too much.

Table 4 Structure of Energy JAPAN·NIEs·ASEAN·CHINA

		Pulp·paper·paper		Cement·non·fabrica		Iron		Electricity·Gas·W		Transport		Total of five	
JAPAN	Coal	10133	10.72%	67294	63.54%	285298	101.05%	217198	15.18%	40	0.01%	579963	22.888%
	Crude Oil	41334	43.72%	31609	29.84%	20252	7.17%	505182	35.30%	568851	91.72%	1167228	46.064%
	Gas	3560	3.77%	6553	6.19%	-23279	-8.25%	606437	42.38%	51275	8.27%	644545	25.437%
	Electricity	28	0.03%	14	0.01%	57	0.02%	19	0.00%	27	0.00%	145	0.006%
	Others	39493	41.77%	444	0.42%	0	0.00%	102108	7.14%	0	0.00%	142045	5.606%
	Total	94549	100.00%	105914	100.00%	282328	100.00%	1430943	100.00%	620193	100.00%	2533927	100.000%
NIES	Coal	2766	15.84%	42627	63.56%	65510	48.10%	95890	26.31%	433	0.16%	207227	24.339%
	Crude Oil	11943	68.39%	17719	26.42%	17990	13.21%	117636	32.27%	237793	89.35%	403081	47.343%
	Gas	49	0.28%	2263	3.37%	43269	31.77%	89577	24.57%	25717	9.66%	160875	18.895%
	Electricity	2685	15.38%	4441	6.62%	9354	6.87%	61430	16.85%	2189	0.82%	80098	9.408%
	Others	19	0.11%	18	0.03%	83	0.06%	0	0.00%	5	0.00%	125	0.015%
	Total	17462	100.00%	67068	100.00%	136206	100.00%	364533	100.00%	266137	100.00%	851407	100.000%
ASEAN	Coal	738	2.84%	21987	6.93%	70	0.22%	67620	19.23%	16	0.01%	90430	9.795%
	Crude Oil	2796	10.77%	14281	4.50%	3711	11.72%	89398	25.43%	191462	97.27%	301649	32.673%
	Gas	871	3.35%	7834	2.47%	6048	19.09%	183086	52.07%	4153	2.11%	201991	21.879%
	Electricity	1343	5.17%	3970	1.25%	3159	9.97%	9023	2.57%	1200	0.61%	18695	2.025%
	Others	20217	77.86%	269069	84.84%	18692	59.00%	2473	0.70%	13	0.01%	310465	33.628%
	Total	25965	100.00%	317141	100.00%	31680	100.00%	351600	100.00%	196844	100.00%	923230	100.000%
CHINA	Coal	72539	78.22%	453900	89.65%	440760	66.37%	1487786	86.62%	91535	36.95%	2546519	78.873%
	Crude Oil	4792	5.17%	35960	7.10%	43793	6.59%	162618	9.47%	153496	61.96%	400658	12.409%
	Gas	616	0.66%	5945	1.17%	135596	20.42%	43363	2.52%	600	0.24%	186121	5.765%
	Electricity	2928	3.16%	8379	1.66%	13778	2.08%	17818	1.04%	1985	0.80%	44887	1.390%
	Others	11861	12.79%	2145	0.42%	30199	4.55%	6122	0.36%	138	0.06%	50466	1.563%
	Total	92736	100.00%	506329	100.00%	664126	100.00%	1717707	100.00%	247753	100.00%	3228650	100.000%
TOTAL	Coal	86176	37.35%	585807	58.79%	791638	71.04%	1868494	48.35%	92024	6.91%	3424139	45.430%
	Crude Oil	60865	26.38%	99569	9.99%	85746	7.70%	874834	22.64%	1151602	86.53%	2272616	30.152%
	Gas	5096	2.21%	22595	2.27%	161634	14.51%	922462	23.87%	81745	6.14%	1193532	15.835%
	Electricity	6984	3.03%	16804	1.69%	26348	2.36%	88289	2.28%	5400	0.41%	143825	1.908%
	Others	71590	31.03%	271676	27.26%	48975	4.40%	110703	2.86%	156	0.01%	503101	6.675%
	Total	230712	100.00%	996452	100.00%	1114340	100.00%	3864783	100.00%	1330927	100.00%	7537214	100.000%

2 – 2 Interdependency as induced production by final demand in 4 groups

Figure 6 shows the sum of the quantity of production to induce at EDEN countries both direct and indirect, this means that it includes not only own group but also the other groups, by increase of final demand of each group. And this figure shows International Interdependency of four groups as economy. For example, if final demand of JAPAN increased, the direct demand would increase to fill with the quantity of domestic and import goods which are bought by final demand of JAPAN and then the goods would more produce to keep the direct demand. Moreover, the indirect demand which is the demand for domestic and import goods to fill with the direct demand would increase and then continue expanding production of goods both direct and indirect.

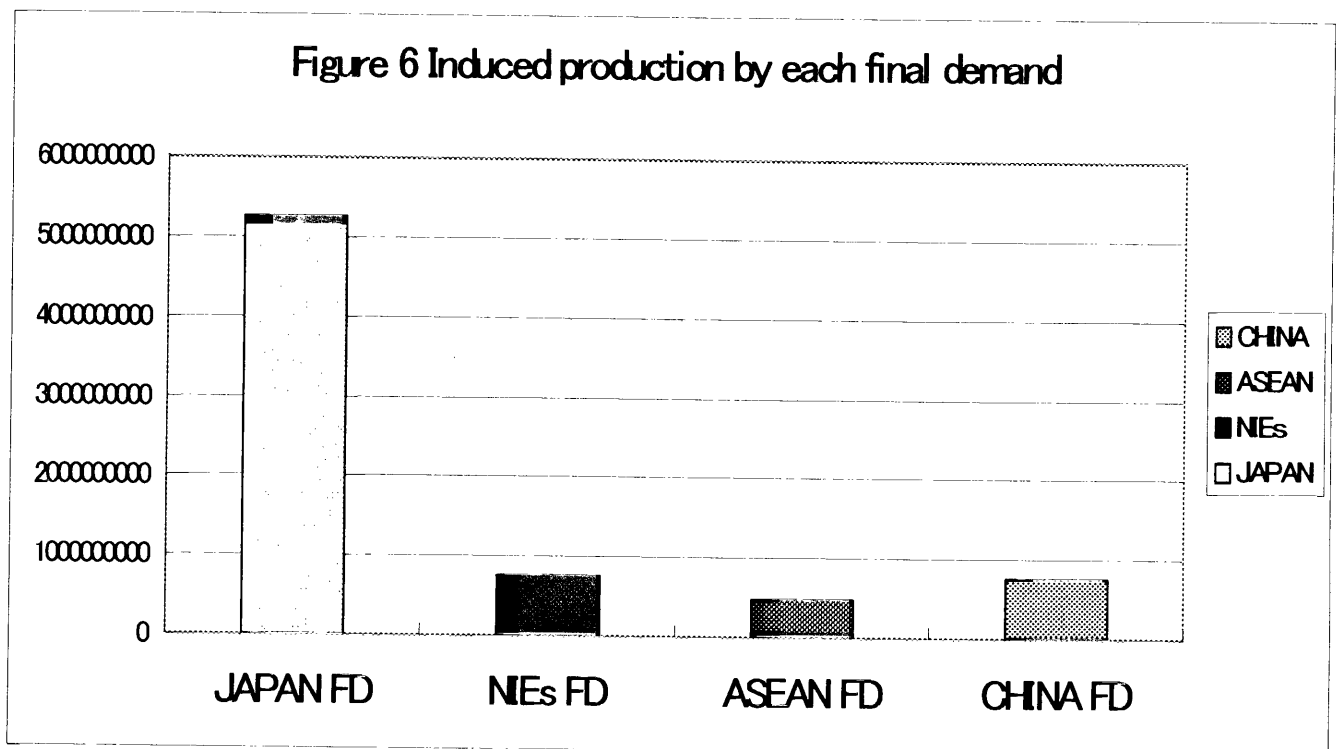
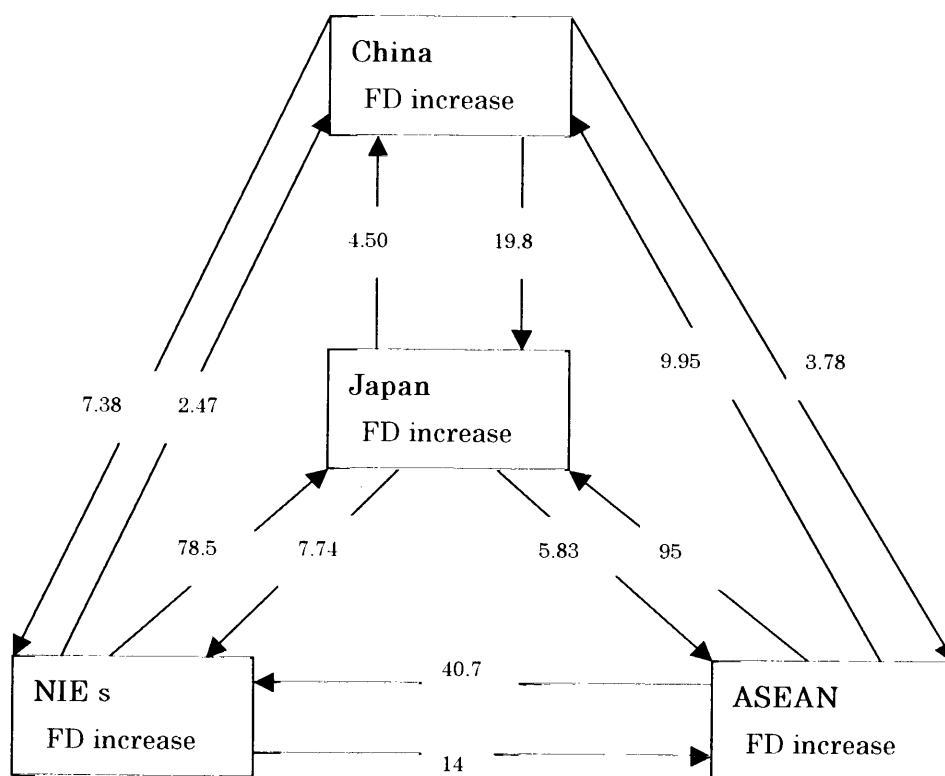


Figure 6 shows that final demand of JAPAN causes a lot of production to the East Asia, and we understand how big of JAPAN's impact. The quantity of production by final demand of ASEAN is the lowest in four groups. The rate of production by increase of final demand of own is 98.19% in JAPAN, 90.48% in NIEs, 85.38% in ASEAN, and 96.90% in CHINA. That is to say, it is very high in JAPAN but very low in CHINA. Eventually, as to the rate of production to the other groups, ASEAN is the highest rate in 4 groups.

<The quantity of production to only the other groups by increase of final demand of each groups about ten billions \$>

Next figure shows the quantity of production to the other groups by each final demand of JAPAN, NIEs, ASEAN, and CHINA increase about 10 billions\$, in a word, this figure shows the overview of Interdependency in 4 groups as induced production by final demand.

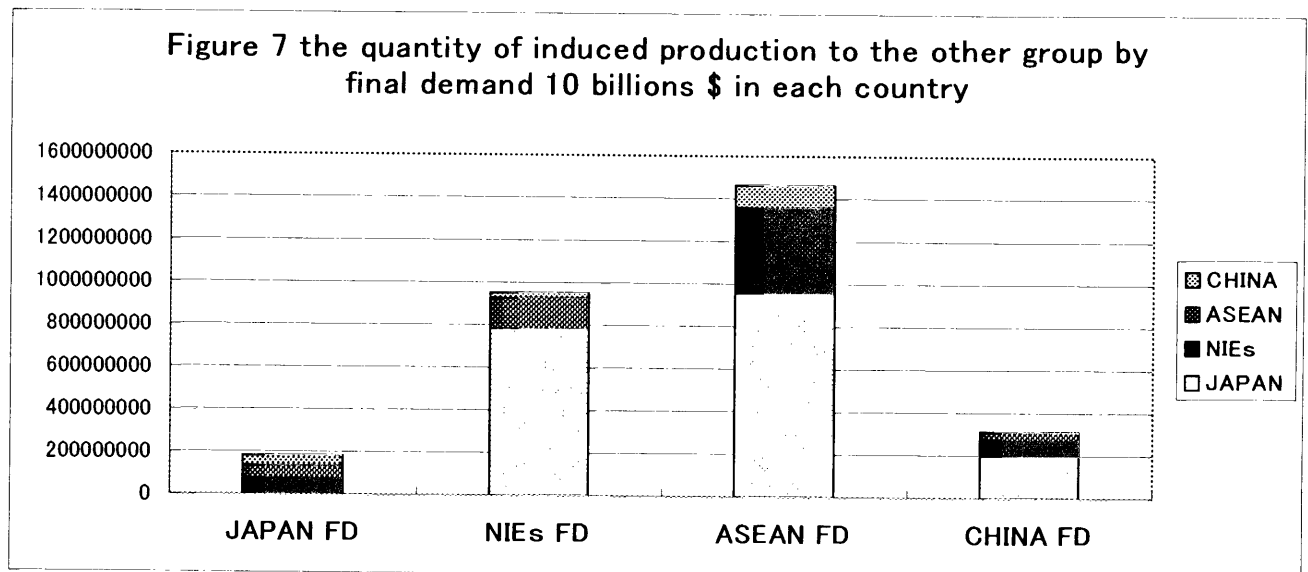


(Unit : ten millions \$)

For example, in case of Japan's final demand increases 10 billions \$, it induced production to NIEs about 77.49 millions\$, to ASEAN about 58.3 millions\$, and to CHINA about 45.01 millions\$, so that is to say, it induced production about 0.18 billions \$ to the other three groups. On the other hand, JAPAN is influenced produce about 0.78 billions \$ by increase of final demand of NIEs, about 0.95 billions \$ by that of ASEAN, and about 0.19 billions \$ by that of CHINA. So, the most influenced group to JAPAN is ASEAN, and the most induced production group by JAPAN is NIEs. To see the other three groups as well, the most influenced group to NIEs is ASEAN, and the

most induced production group by NIEs is JAPAN. And the most influenced group to ASEAN is NIEs, and the most induced production group by ASEAN is JAPAN. AND the most influenced group to CHINA is ASEAN, and the most induced production group by CHINA is JAPAN.

Figure 7 is the another figure to show only effect to the other goup. Figure 6 shows the total quantity of induced production in own and the other groups by each final demand, on the other hand, figure 7 shows the quantity of induced production to only the other groups by increase of final demand in each country.



As to the quantity of induced production to the other groups by each final demand about same 10 billions \$, the biggest is ASEAN, the second is NIEs, the third is CHINA, and the worst is JAPAN. In JAPAN, NIEs, and CHINA, the biggest quantity of induced production is by increase of final demand of ASEAN, on the other hand, it is the smallest by that of JAPAN. (The ratio of 10billions\$ in each group is different. So it needs to mention here one important aspect that to compare them with the quantity of domestic final demand. Actually the rate is 0.34% in JAPAN, 2.25% in NIEs, 3.35 in ASEAN, 2.8% in CHINA.)

As to the quantity of induced production by increase of final demand of JAPAN, the biggest is NIEs(42.84%),the second is ASEAN(32.26%),the third is CHINA(24.88%) .As well, as to the quantity of induced production by increase of final demand of NIEs, the biggest is JAPAN(82.51%),the second is ASEAN(14.77%),the third is CHINA(2.7),so especially its rate of JAPAN stands out. As to the quantity of induced production by increase of final demand of ASEAN, the biggest is JAPAN (65.32%), the second is NIEs(27.86%),the third is CHINA(6.81%). Finally as to the quantity of induced

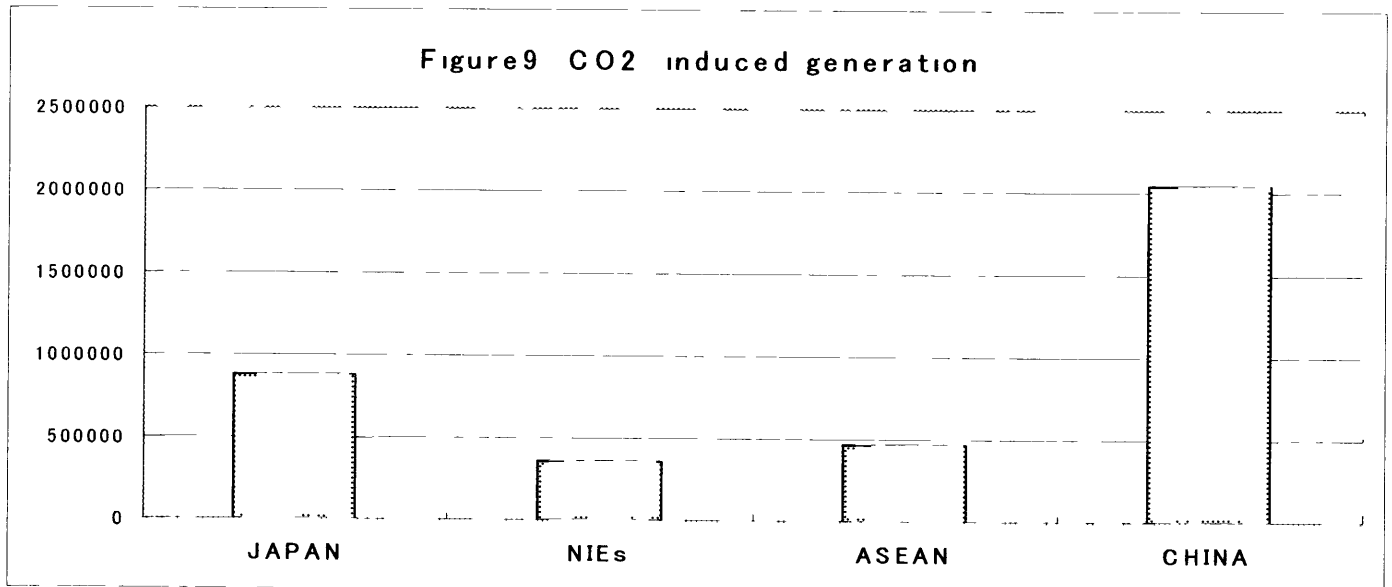
production by increase of final demand of CHINA, the biggest is JAPAN (63.95%), the second is NIEs (23.81%), the third is ASEAN(12.22%). That is to say, JAPAN is the biggest group as the quantity of induced production by increase of final demand of all groups, on the other hand, it is the smallest in CHINA by them.

Table 5 shows top ten industry in all groups by increase of final demand of each group. Four groups have a common feature that “other services” is the top industry as the quantity of induced production by final demand of own group and “commerce”, “transport”, “buildings”, “civil engineering”, and “foods” are ranking within top ten industry except for “building” in CHINA. Top ten industry is relatively almost same in JAPAN, NIEs, and ASEAN, but “daily farming”, “edible crops”, and “spinning and weaving” are high-ranking industry only in CHINA. And it has a tendency that the early developed group induced to the secondary industry (especially light industry) at first and next, the primary industry to groups which is the latter developing group than own group, so many names of both industry are put in the south below of the table.

As to JAPAN, the main industry which is induced production by increase of final demand in JAPAN about 10 billions \$ is the tertiary industry in JAPAN own as mentioned above, the heavy industry such as “electrical machinery”, “iron”, and “chemical products” in NIEs, “forestry”, “timber and wooden products”, and “petroleum refinery and coal products” in ASEAN, the light industry such as “spinning and weaving” in CHINA. The main industry which is induced production by increase of final demand in NIEs is the heavy industry such as “machinery” or “iron” and services industry in JAPAN, the tertiary industry in NIEs own as mentioned above, “electrical machinery”, “forestry”, and “timber and wooden products” in ASEAN, and “edible crops”, and “spinning and weaving” in CHINA. The main industry which is induced production by increase of final demand in ASEAN is “services”, “commerce”, and the heavy industry such as “general and electrical machinery”, “iron”, “motor vehicle”, “chemical products” in both JAPAN and NIEs, the tertiary industry such as “services”, “commerce”, and “transport” in ASEAN own, “iron”, “spinning and weaving”, “edible crops” in CHINA. Finally, the main industry which is induced production by increase of final demand in CHINA is the secondary and the tertiary industry such as “iron”, “machinery”, “commerce”, “financial and insurance services” in both JAPAN and NIEs, “timber and wooden products”, “chemical products”, “edible crops”, and “commerce” in ASEAN, and “services”, “dairy farming”, “machinery”, and “spinning and weaving” in CHINA own. As to “crud oil and natural gas”, it is induced by increase of final demand except ASEAN.

2 – 3 Induced CO₂ generation

We calculate induced CO₂ generation by equation (3) Figure 9 shows the sum of the quantity of induced CO₂ generation as 4 groups In this section it is deal with energy and environmental problem with process of production but not consumption by final



demand As to the sum of the quantity of induced CO₂ generation CHINA is the biggest country and the second is JAPAN, the third is ASEAN, and the worst is NIEs And China is 2.23 times of Japan which is the second highest rate, and 5.75 times of NIEs China occupies 54.48% of total of induced CO₂ generation in the East Asia And two top groups CHINA and JAPAN occupy 77.9%, NIEs occupies 9.47%, and ASEAN occupies 12.54% of whole As to total of induced CO₂ generation, NIEs which includes three countries and ASEAN includes four countries are smaller than that of JAPAN and CHINA which include only one country because of the difference of economic scale and the structure of economic which does not induced much CO₂

Figure 10 is more detail about figure 9 and shows the structure of induced CO₂ generation with process of production in each group

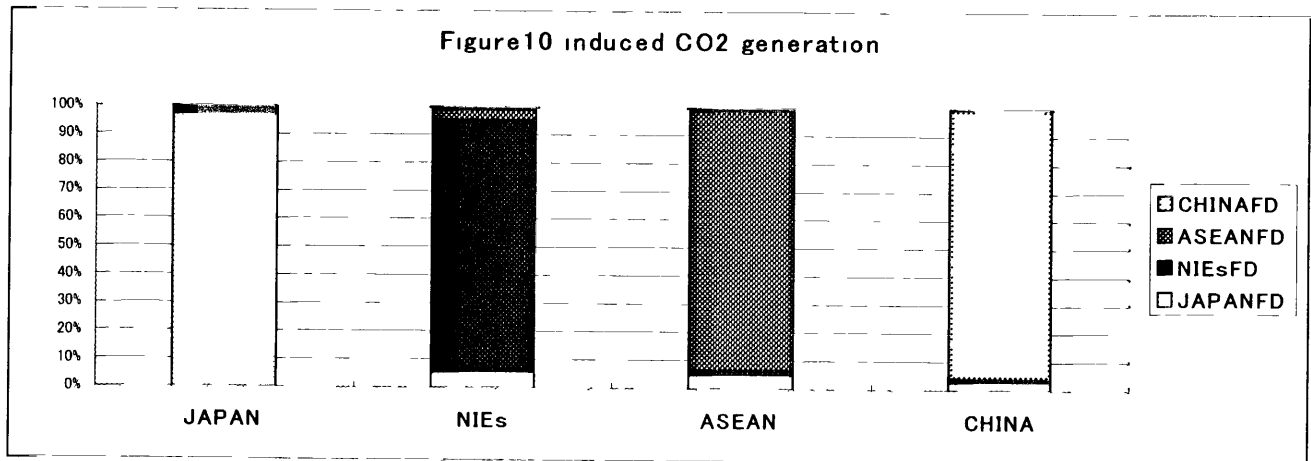
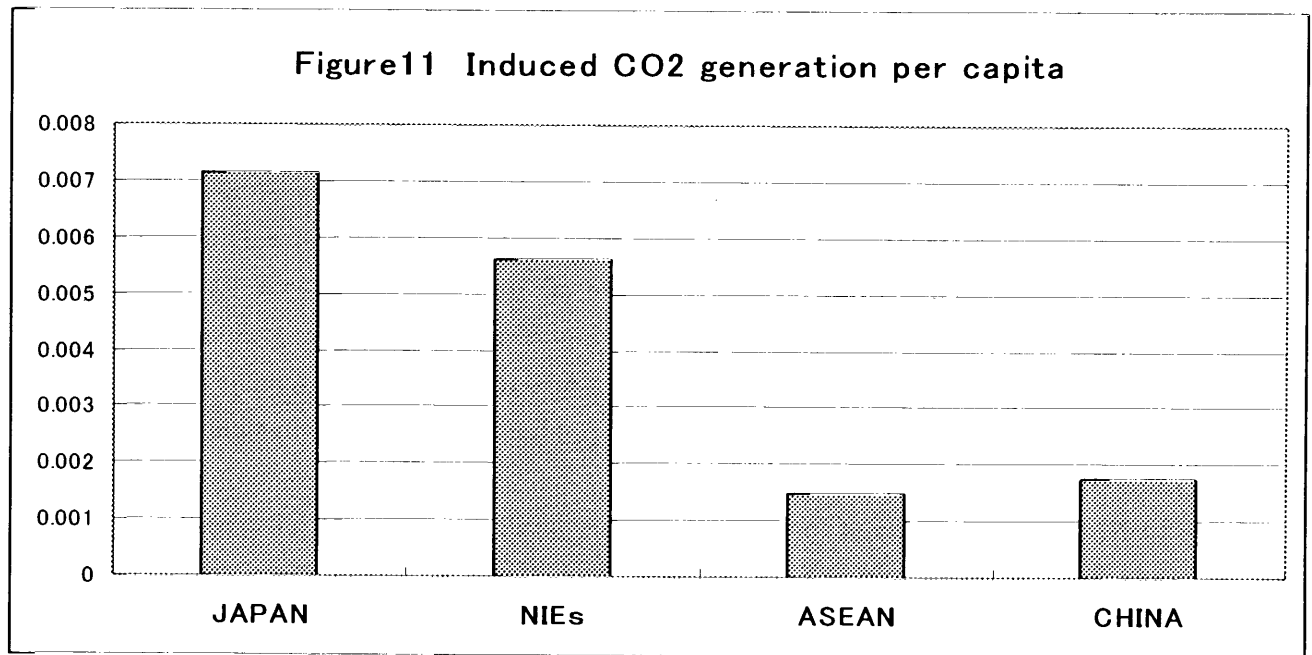


Figure 10 shows the ratio that whose final demand induces CO₂ generation to each group. Every group induced CO₂ mainly cause by final demand of own. Especially, it is JAPAN that the rate of own group is the highest(97.33%) . On the other hand, the rate of it is the lowest is NIEs about 89.95%.

<Induced CO₂ generation per capita>

Figure 11 shows induced CO₂ generation per population in 1990* in each group.



As to per capita, top is JAPAN, the second is NIEs, the third is CHINA, and the worst is ASEAN. JAPAN is 5.06 times of ASEAN which is the worst group and 4.08 times of CHINA, and 1.23 times of NIEs. But the quantity of induced CO₂ generation per capita in CHINA is very small because it is the leading population country in the world, while it is the biggest induced CO₂ generation group. The cause of JAPAN and NIE s may be comes from its high income. Properly speaking, it should line up in order of the scale of income, but CHINA is bigger than ASEAN which is higher income than CHINA. So one likely reason of this is that CHINA does not get technologies to control environmental destruction.

* Reference[7]

<Factor resolution as each demand place>

Table 6 shows top ten industries as induced CO₂ generation in each group. According to table 6, industry of “electricity, gas and water” is commonly the biggest quantity of induced CO₂ generation in four groups and above all, the rate is 43.73% in JAPAN and 53.90% in ASEAN. Type of service industry such as “other services” or “commerce” ranking top ten industry in three groups JAPAN, NIEs, and ASEAN, by contrast, it has a feature that “non-metallic ores mining (coal)” ranked top ten but the rate is not high in CHINA.

In JAPAN, three top industries that “electricity, gas and water”, “transport”, and “iron” occupy about 70% of whole. The order and the quantity of induced CO₂ generation in JAPAN by own final demand is almost same as those of by total final demand. On the other hand, “iron” occupies a lot about 25.18% of whole by final demand of NIEs. Moreover it has a feature that “nonferrous metal” and “general machinery” ranked within top ten. The rate of “iron” occupies about 29.9% by final demand of ASEAN and “motor vehicle” is high-ranking industry. The rate of “iron” occupies about 34% by final demand of CHINA so its rate is the highest. And it has a feature that “fertilizer”, “non-ferrous metal products”, and “glass and glass products” ranked within top ten industry.

In NIEs the quantity of “petroleum refinery and coal products” is big comparatively, and the tertiary industry such as “other services”, “commerce”, and “public administration” is high-ranking industry. And the industry of “spinning and weaving”, “wearing apparel and fabricated textile products” by final demand of JAPAN and “commerce”, “public administration” by final demand of NIEs own are stand out. And, it has a feature of that the main industry is “petroleum refinery and coal products”, and “spinning and weaving”, and “fertilizer” are high ranking by final demand of ASEAN. And it has a feature that two top industries “electricity, gas, and water” and “petroleum refinery and coal products” occupy about 50% of all and “spinning and weaving”, “glass and glass products”, “fertilizer” are high-ranking industry by final demand of CHINA.

In ASEAN “crude oil natural gas” ranking within top ten in every final demand. Especially, its rate is very high 29.76% in final demand of JAPAN, and 27.21% in that of NIEs. And it has common feature that “foods”, “forestry”, and “fishing” are ranking within top ten factors.

In CHINA “crude oil and natural gas” or “non-metallic ores mining (coal)” is high-ranking industry by every final demand.

Table6 CO2 induced generation top ten each demand place

JAPAN															
TOTAL		JAPANFD			NIEsFD			ASEANFD			CHINAFD				
1	electricity·gas·water	385371	43.734%	electricity·gas·water	346888	45.436%	electricity·gas·water	3372	33.888%	electricity·gas·water	2590	33.226%	Iron	1093	34.826%
2	transport	139864	15.873%	transport	114725	15.027%	Iron	2506	25.181%	Iron	2331	29.909%	electricity·gas·water	995	31.719%
3	Iron	72149	8.188%	Iron	51386	6.731%	transport	920	9.248%	transport	736	9.447%	transport	231	7.372%
4	other services	44924	5.098%	other services	43128	5.649%	other chemical products	662	6.651%	other chemical products	482	6.189%	other chemical products	219	6.982%
5	pulp·paper·paper products	31291	3.551%	cement·non-fabricated metal	27554	3.609%	petroleum refinery·coal prod.	433	4.347%	pulp·paper·paper products	264	3.393%	petroleum refinery·coal prod.	105	3.354%
6	petroleum refinery·coal prod.	30951	3.513%	petroleum refinery·coal prod.	27180	3.560%	pulp·paper·paper products	414	4.159%	petroleum refinery·coal prod.	235	3.021%	pulp·paper·paper products	103	3.269%
7	cement·non-fabricated metal	30068	3.412%	pulp·paper·paper products	26922	3.526%	non-ferrous metal	296	2.971%	non-ferrous metal	170	2.185%	fertilizer	66	2.105%
8	other chemical products	21652	2.457%	other chemical products	15158	1.985%	cement·non-fabricated metal	232	2.328%	cement·non-fabricated metal	157	2.012%	non-ferrous metal	48	1.526%
9	commerce	14511	1.647%	fishing	14043	1.839%	general machinery	161	1.616%	general machinery	117	1.496%	cement·non-fabricated metal	43	1.374%
10	fishing	14474	1.643%	commerce	13405	1.756%	other services	128	1.286%	motor vehicle	93	1.196%	glass·glass products	36	1.143%

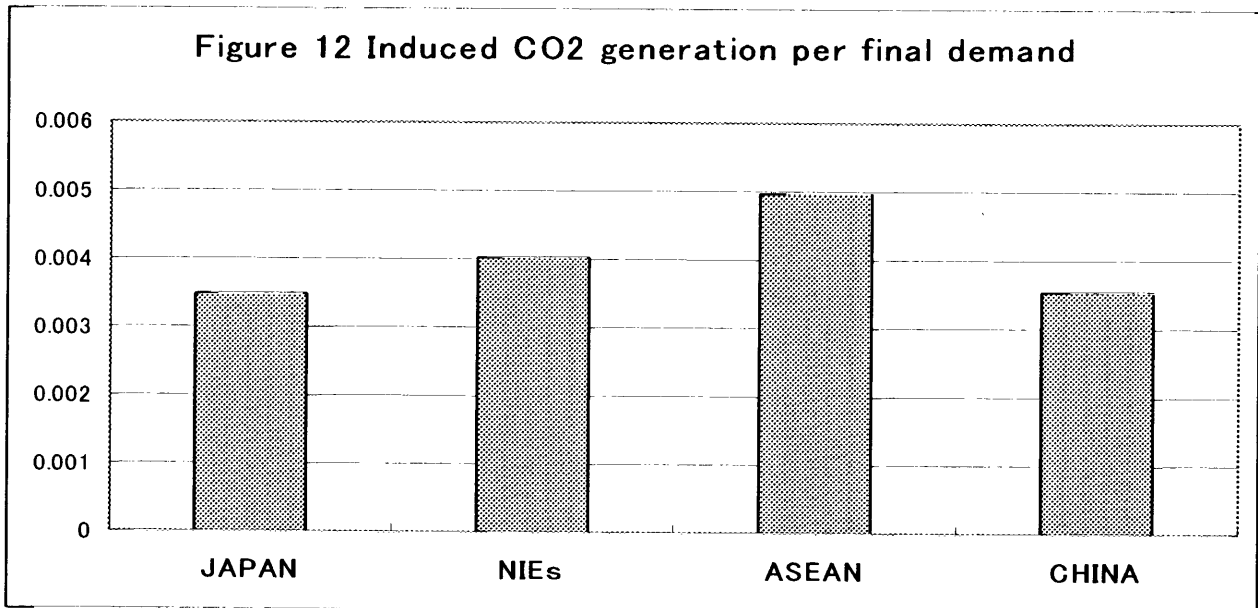
NIEs															
TOTAL		JAPANFD			NIEsFD			ASEANFD			CHINAFD				
1	electricity·gas·water	95091	26.807%	electricity·gas·water	3463	22.384%	electricity·gas·water	67349	30.142%	petroleum refinery·coal prod.	3441	39.694%	electricity·gas·water	625	25.75%
2	transport	79864	22.515%	petroleum refinery·coal prod.	3063	19.801%	transport	43167	19.320%	electricity·gas·water	1665	19.208%	petroleum refinery·coal prod.	595	24.53%
3	petroleum refinery·coal prod.	32773	9.239%	Iron	1880	12.152%	cement·non-fabricated metal	19049	8.525%	Iron	1084	12.501%	other chemical products	377	15.51%
4	Iron	25381	7.155%	transport	1393	9.005%	Iron	14326	6.412%	transport	709	8.173%	Iron	315	12.99%
5	cement·non-fabricated metal	22871	6.448%	other chemical products	869	5.616%	petroleum refinery·coal prod.	12474	5.593%	other chemical products	521	6.014%	transport	144	5.93%
6	other chemical products	12524	3.531%	cement·non-fabricated metal	843	5.450%	other services	10618	4.752%	cement·non-fabricated metal	183	2.110%	pulp·paper·paper products	90	3.72%
7	other services	12051	3.397%	fishing	834	5.390%	commerce	8035	3.596%	spinning·weaving	141	1.625%	spinning·weaving	49	2.01%
8	commerce	11374	3.206%	spinning·weaving	376	2.433%	public administration	7528	3.399%	pulp·paper·paper products	128	1.477%	cement·non-fabricated metal	44	1.80%
9	fishing	7688	2.167%	wearing apparel·fabricated te	363	2.346%	fishing	6127	2.742%	commerce	125	1.441%	glass·glass products	30	1.22%
10	public administration	7557	2.131%	commerce	360	2.328%	other chemical products	4715	2.110%	fertilizer	64	0.737%	fertilizer	24	0.97%

ASEAN															
TOTAL		JAPANFD			NIEsFD			ASEANFD			CHINAFD				
1	electricity·gas·water	253225	53.901%	electricity·gas·water	6300	33.080%	electricity·gas·water	2115	30.863%	electricity·gas·water	213465	57.281%	electricity·gas·water	755	44.616%
2	cement·non-fabricated metal	51029	10.862%	crude oil·natural gas	5669	29.764%	crude oil·natural gas	1864	27.210%	cement·non-fabricated metal	46431	12.459%	crude oil·natural gas	334	19.712%
3	transport	49278	10.489%	Iron	1648	8.652%	cement·non-fabricated metal	718	10.477%	transport	34882	9.360%	transport	107	6.348%
4	Iron	35355	7.526%	transport	1297	6.813%	transport	516	7.534%	Iron	30006	8.052%	Iron	102	6.021%
5	crude oil·natural gas	20375	4.337%	foods	651	3.420%	Iron	471	6.869%	pulp·paper·paper products	5102	1.369%	timber·wooden products	79	4.695%
6	foods	7926	1.687%	metal ores mining	530	2.782%	foods	158	2.305%	foods	4851	1.302%	pulp·paper·paper products	52	3.042%
7	pulp·paper·paper products	6510	1.386%	cement·non-fabricated metal	514	2.697%	pulp·paper·paper products	144	2.106%	crude oil·natural gas	4688	1.258%	cement·non-fabricated metal	45	2.640%
8	fishing	5308	1.130%	forestry	368	1.930%	forestry	112	1.641%	other services	4381	1.176%	foods	43	2.518%
9	other services	5148	1.096%	timber·wooden products	321	1.683%	metal ores mining	109	1.595%	fishing	4319	1.159%	metal ores mining	33	1.922%
10	commerce	3205	0.682%	fishing	245	1.287%	commerce	92	1.340%	civil engineering	2774	0.744%	forestry	29	1.683%

CHINA															
TOTAL		JAPANFD			NIEsFD			ASEANFD			CHINAFD				
1	electricity·gas·water	1199351	31.62%	electricity·gas·water	16610	30.15%	electricity·gas·water	1655	28.96%	electricity·gas·water	4849	28.20%	electricity·gas·water	534390	31.93%
2	Iron	416658	10.99%	Iron	5552	10.08%	Iron	740	12.95%	Iron	4095	24.84%	Iron	184540	11.03%
3	cement·non-fabricated metal	38088	10.10%	other chemical products	4251	7.72%	petroleum refinery·coal prod.	630	11.02%	other chemical products	1413	8.57%	cement·non-fabricated metal	180092	10.76%
4	other chemical products	191126	5.04%	petroleum refinery·coal prod.	3599	6.53%	cement·non-fabricated metal	392	6.86%	petroleum refinery·coal prod.	1016	6.16%	other chemical products	74556	4.46%
5	transport	152443	4.02%	cement·non-fabricated metal	2738	4.97%	other chemical products	364	6.37%	cement·non-fabricated metal	886	5.38%	fertilizer	67526	4.04%
6	fertilizer	148253	3.91%	transport	2729	4.95%	transport	204	3.57%	fertilizer	571	3.46%	transport	65581	3.92%
7	petroleum refinery·coal prod.	139625	3.68%	spinning·weaving	2322	4.22%	fertilizer	197	3.44%	transport	511	3.10%	petroleum refinery·coal prod.	58476	3.49%
8	foods	88126	2.27%	crude oil·natural gas	2196	3.99%	crude oil·natural gas	158	2.77%	non-metallic ores mining	373	2.26%	foods	38481	2.30%
9	spinning·weaving	78262	2.06%	fertilizer	1856	3.37%	foods	141	2.48%	spinning·weaving	332	2.02%	non-metallic ores mining	32952	1.97%
10	non-metallic ores mining	76520	2.02%	non-metallic ores mining	1700	3.09%	transport equipment	137	2.39%	foods	287	1.74%	other services	32592	1.95%

2 – 4 Interdependency as induced CO₂ generation in 4 group

Figure 12 shows induced CO₂ generation per unit of final demand.



According to figure 12, it is ASEAN that the most induced CO₂ generation per unit of final demand and the second is NIEs, the third is JAPAN, and the worst group is CHINA. CHINA which is the lowest income in four groups is the lowest induced CO₂ generation country because of the demand structure does not depend on goods and services induced a lot of CO₂. But ASEAN which is more higher incomes and more industrialization than CHINA is the most induced CO₂ generation in four groups, because of its structure of demand depends on goods and services induced a lot of CO₂ and late of measures of environment. And NIEs which is higher income is smaller than that of ASEAN, because it depends on soft environment goods by progress of industrialization and service. Finally, JAPAN which is the highest income in 4 groups is the worst induced CO₂ generation group, because of the progress of service industry and technology and the system of environmental regulate are arranged to some extent. According to “white paper on environment*”, the path of CHINA→ASEAN→NIEs→JAPAN as induced CO₂ generation is the reverse U-shaped distribution, that is to say, that call “Kuzunets curve as environment”. So, if the income in CHINA increased steadily, it would experience the type of ASEAN which is the biggest induced CO₂ generation, and next is the type of NIEs, finally it would experience the type of JAPAN in the future. That is to say, figure 12 shows the path not only CHINA but also ASEAN and NIEs would follow in the future by increase of income and economic growth. In

* Reference[4]

other words, we can imagine the future of CHINA, ASEAN, and NIE s from this figure. This figure tells us we have to down the absolute quantity of induced CO₂ generation that is to say, down “Kuzunets curve” to make circumstance of soft environment in East Asia, by expand to change of industry structure ,effort of environmental safeguard by each country and enterprise, and cyclical society.

Figure 13 Induced CO₂ generation per unit of final demand

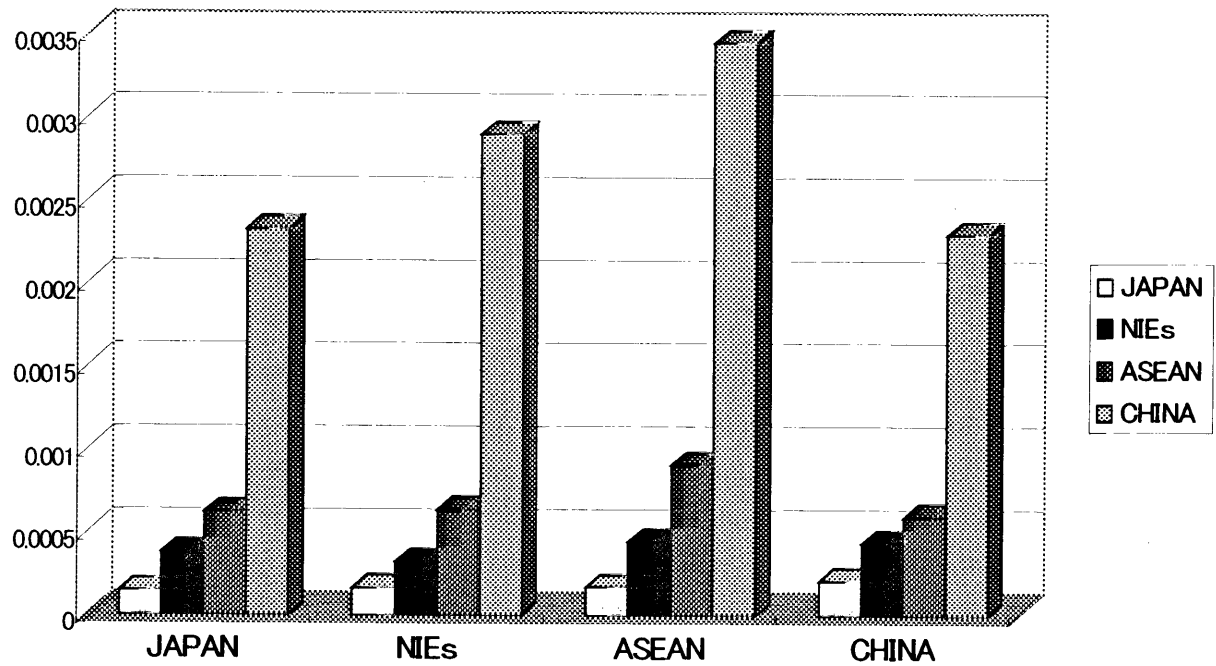
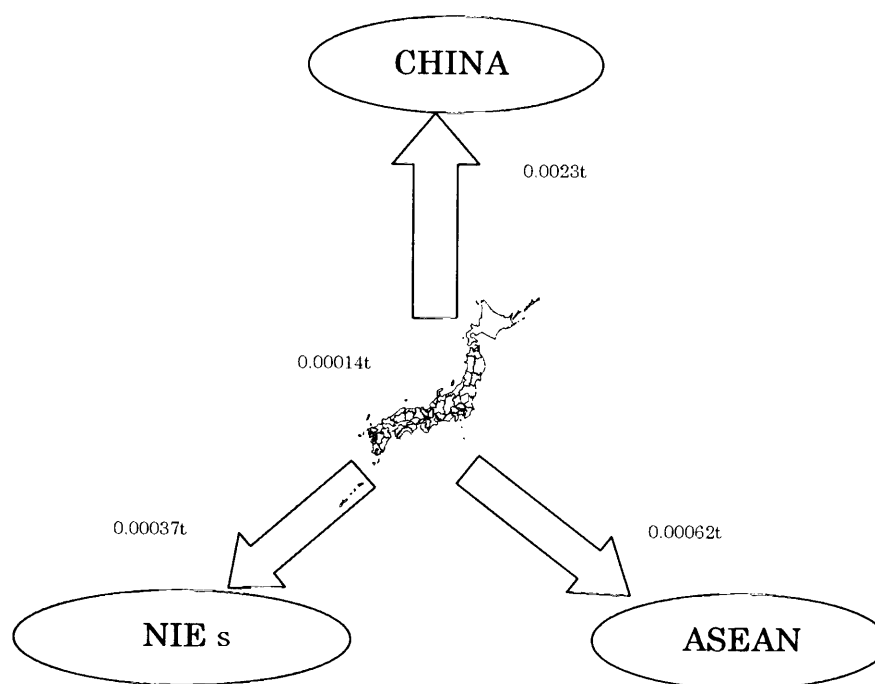


Figure 13 is more detail about figure 12 and shows where each group induce CO₂ per unit of final demand (=1000\$) both direct and indirect by people in 4 groups buy goods and services. Then figure13 shows the structure of goods and services per unit of final demand in every 4 group and this means that whether the demand structure in each country depends on goods and services which induced a lot of CO₂. In other words, this figure shows baskets which means whether it is induced much CO₂ or not per unit of final demand in four groups. For example, we will see another figure as to JAPAN.



This figure shows that induced CO₂ generation per unit of final demand to the other groups both direct and indirect by people in JAPAN buy goods and services. From this figure, it is CHINA in four groups that JAPAN induced to the biggest the quantity of CO₂, the second is ASEAN, and the third is NIEs, and the worse is JAPAN.

Now back to figure 13, as to JAPAN, it is the smallest groups as quantity of induced CO₂ generation per unit of final demand by own, but it has a structure of demand that more induced CO₂ goods depend on the other groups, especially CHINA. To put it concretely, the industry of “fertilizer”, “fishing”, “non-edible crops”, “forestry”, and “rubber products” are high-ranking to JAPAN own, but on the contrary, “iron”, “cement and other non-fabricated metal products”, and “petroleum refinery and coal products” are high-ranking to CHINA. As to NIEs, the rate which depends on the goods induced much CO₂ is lower to JAPAN than to NIEs own, but NIEs depends on goods more induced CO₂ to ASEAN and CHINA comparatively. That is to say, NIEs has a structure of demand that it relatively depends on soft environmental goods to JAPAN, but not soft goods to ASEAN and CHINA. As well, ASEAN, which is considered the most depends on not soft environmental goods as mentioned above, has a demand structure that depends on soft goods to JAPAN and NIEs, on the other hands, not soft goods to CHINA. As to CHINA as well, it has a demand structure that depends on not soft goods to CHINA own, but depends on soft goods to the other three groups.

So it has a common feature that JAPAN is relatively depend on soft goods from the other three groups, on the contrary, CHINA is depended on not soft goods from the

other three groups. And viewed from another perspective, only as to both Chinese goods that means made in CHINA and ASEAN goods that means made in ASEAN, we can find “Kuznets curve” mentioned above, so we understand how important to change industry structure and get in some technology.

2 -- 5 Finally

The problem of the global environmental warming is ultimate environment problem of human beings because it changes the stability climate system of globe and furthermore, it is fundamental problem because it influences to formation of today's economic society caused by daily behavior to use energy, so it is very difficult to find means of settlement. And moreover, it is difficult to have common image about environmental problem in every country because each county has a different background and a sense of values, so it is impossible to take equal measurement in global. In the future, we have to think about how get on well the relation to the world with each country, moreover this problem has a feature that it is not clear who is an assailant or a sufferer, so people have to live one by one to consider about what we will do influence to own from now.

Now look at the East Asia, the total emission of the East Asian countries* except Taiwan occupies 14.87% in 1980, 16.9% in 1985, 19.37% in 1990, 24.04% in 1995 of that of the world, so the rate grows year by year. For 15 years from 1980 to 1995, the total CO₂ emission of the world grows 1.2 times. On the other hand, the rate of the East Asia grows 1.9 times, so it grows earlier than that of world. The circumstance of the East Asia is previously described as analysis of EDEN, especially we think about what happened to China from now, it needs to take measurements for environmental protection urgent.

The economic action of human beings follows with CO₂ generation and the economic development follows with increase of CO₂ generation inevitable. It will not happened to stop economic growth in the East Asian countries but it will be possible to control increase of energy consumption and CO₂ generation with economic development by use some knowledge and technology. This means that “Kuznets curve” which mentioned above can shifts below label. We will find the sustainable climate system by developing new technology and make an effort to attain “Sustainable development”. Japan is now most expected country to contribute that of technology and fund.

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