

Chapter 6

Regulation, Government Expenditure and Firms' Investment: Indispensable Elements for Environmental Protection

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1. Introduction

Environmental issues in Asia including Japan share very distinguishable characteristics as “adjacent to human activities”. Exhaust air and polluted water from firms degrade environment of life space near by the firms. Substances absorbed from landfill of industrial waste contaminate underground water and harms health of people lives nearby. This can happen in Europe and United State, however it is more likely to happen in Asia where population density is high and people stick to firming.

Furthermore, many Asian countries have experienced rapid economic growth and resulted in unprecedented environmental problems. They could enhance their production capacities rapidly through importation of capital and technologies from industrial countries, however, they did not successfully acquire technologies for environmental protection. Needless to say that it is required to have an accumulation of knowledge that could bring production enhancement in order to develop pollution suppressing technologies. Unfortunately, many Asian countries do not share this situation.

On the other hand, developed countries have been successfully reducing burden to environment as their economies grew. Peoples awareness toward environmental protection, regulation and firms investment for environmental facilities, and development of service sectors have contributed for the reduction of pollution originated from industrial production. Namely per capita income and burden to environment took inverted-U shape (so called Environmental Kuznets Curve).

Seminal work by Grossman and Krueger (1993) on suspended particulate matter (SPM), sulfur dioxide (SO₂), and Hettige et al (1992) on toxic intensity found inverted-U relation (Kuznets curve) between emission of pollutant and per capita GDP.

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Selden and Song (1994) also confirmed that this inverted-U relationship in suspended particulate matter (SPM), sulfur dioxide (SO₂), oxides of nitrogen (NOX) and carbon monoxide (CO) followed same pattern along economic growth. It is important to recognize that increase in per capita income did not bring about the inverted-U relations. Innovation in pollution suppressing technologies and investment into equipments for environmental protection along with productivity growth contributed to this reduction in burden to the environment.

The purpose of this paper is to reveal the economic mechanism behind this Environmental Kuznets Curve. This paper is organized as follows. Section 2 summarizes standard analysis of Pigovian tax, and introduce new private marginal cost curve when firms adopt pollution-suppressing technology that can remove 100 % of pollution. Section 3 analyzes firms' responses to environmental policies such as surcharges like Pigovian tax or quantity limitation for emission. Environmental policies and government expenditure in Japan that has successfully brought about reasonable amenity level of environment will be overviewed in section 4. Final session beliefs cooperation between established industrial countries and newly industrialized countries.

2. Externality and Technology

Economics has been related environmental issues with externality. The concept of social marginal costs (SMC) is utilized to indicate true cost of production including damages caused by pollution distinguished from private marginal costs (PMC). Diagram 1 indicates for different states: 1) no pollution is involved in production (Case 1), 2) pollution exists, however, no policies taken by government and no prevention effort by firms (Case 2), 3) government imposes Pigovian tax, but firms take no positive action (Case 3), and 4) firms introduced technology which can remove pollution by 100%, therefore government regulation is not activated (Case 4)¹.

When production activities do not result in any pollution, SMC coincides with PMC as is indicated by Case 1. Competition can guarantee maximization of social surplus (triangle age). Case 2 indicates the situation no government policies taken while pollution exists in the process of production. SMC is higher than PMC by the magnitude of environmental costs. Private firms equate their PMC with demand curve (marginal evaluation) to maximize their producer's surplus. Case 2 bears a loss of social

¹ Perfect knowledge on environment cost is required to impose Pigovian tax, but there is no way to know this. Baumol and Oates (1988) are proposing tax system applicable to actual situation.

surplus by the triangle area $a-c-b$. As a result, social surplus of this economy shrank to area $e-f-n-m$. It must be noted that firms are actually polluting the environment. Social surplus indicated by the area $a-b-f-g$ is devoted to compensate the damage in this economy. The government imposes Pigovian tax equivalent to environmental cost in Case 3. Pigovian tax can save a loss of social welfare by the area of $a-d-c$ ($=c-m-n$) since SMC and marginal evaluation for the consumption of the commodity are now equated. As a result, social surplus is extended to area $c-f-e$. Environmental cost is reduced by area $a-d-c-b$ due to a reduction of production by $i-h$, however this economy is paying environmental cost indicated by the area $d-g-f-c$. Needless to say, government receives tax revenue by the area $c-d-r-q$, which is immediately transferred back to private sector.

This can be summarized as follows. Social surplus ($m-n-f-e$) is smallest and environmental cost ($a-g-f-b$) is largest when government does not regulate pollution at all. Pigovian tax can save social surplus only by the area $c-n-m$ since there still exists environmental cost indicated by the area of $c-d-g-f$. Economic policy can contribute to environmental problems by the magnitude of this triangle so far as firms do not take any positive action such as innovation of environmental technology, introducing pollution suppressing equipment, and so on.

Now we consider that firms start positive action to reduce the level of pollution while government keeps regulation active. Case 4 assumes that firms have introduced environment protection equipments that could remove pollution by 100% at their expenses. Firms have to pay the cost shown by the area $k-m-g-l$ for the equipment, but are free from Pigovian tax. Obviously, there is no pollution due to the equipments. Government policies such as Pigovian tax did not bring about this directly, but positive action by firms induces by government regulation realized this pollution-free situation.

3. Maximizations of Firm Profit and Regulation

This section analyses firms' profit maximization under government regulation. Diagram 2 explains a mechanism which firms start internalizing the negative externalities. Demand curve is drawn horizontal here for explanatory simplicity². $PMC(100\%)$ indicates private marginal cost curve when firms facilitate 100% pollution free equipment. Since there remained no pollution, private marginal cost and social marginal cost are coinciding. $PMC(100\%)$ shift upward by the magnitude of increment of cost for pollution suppressing equipment. SMC is remained for a reference that can

² Firms, which export commodities in developing countries, are often confronted to horizontal demand curve, international price.

indicate the magnitude of environmental cost when firms do not take any positive actions and remain paying Pigovian tax.

Costs to remove pollution by 100% are assumed lower compared with the value of damages incurred to pollution in the upper diagram. On the other hand, costs to remove pollution by 100% exceed the value of damages incurred to pollution in the lower diagram. The increment of producer's surplus (area d-i-e) after avoiding paying Pigovian tax by internalizing externalities is larger than that (area c-f-h) when firms are imposed Pigovian tax without facilitating any pollution suppressing equipments for former case. On the other hand, in the latter case producer's surplus when firms internalize externalities (area d-i-e) is smaller than otherwise. Therefore, firms do not have incentive to internalize externalities.

Whether firms initiate internalization of negative externality strictly depends on producer's surplus. Once we admit this, we can derive two major implications: 1) transfer of tax revenue to firms make firms to reduce their incentive to facilitate pollution reduction equipments, and 2) Any factor which reduce PMC(100%) can reinforce firms incentive to internalize negative externality to avoid imposition of Pigovian tax.

Environmental regulation is often imposed in terms of emission control, rather than surcharge such as Pigovian tax. It is well known that surcharge and emission control are equivalent in its effect to attain social efficiency in a static framework. Contrary to this equivalence, emission control and surcharge can give different incentive for firm when it determines whether to internalize its externality since tax revenue under surcharge scheme belongs to firm under emission control scheme. Firm can get larger producer's surplus when emission control that is equivalent in terms of its effect on output is imposed by the amount of tax revenue under surcharge scheme. Consequently, firms have less incentive to take positive measures to reduce pollution emission under the emission control scheme. Diagram 3 provides an economic analysis of emission control through imposing output ceiling. Similar to the case for Pigovian tax, costs to remove pollution by 100% are assumed lower compared with the value of damages incurred to pollution in the upper diagram. On the other hand, costs to remove pollution by 100% exceed the value of damages incurred to pollution in the lower diagram. Producer's surplus in both cases is indicated by the area b-c-f-e. In the former case introduction of environmental facility that can remove pollution by 100% results in reduction of producer's surplus by the area ob I-j-c-f and increment by the area of d-i-b at the same time. Therefore, firms have incentive to facilitate environmental protection measures when increment in producer's surplus exceeds reduction in the producer's

surplus. Contrary to this, producer's surplus decreases by the area of $d-i-e$ when firm inactivate internalization of externality in latter case.

The following implications are derived from the above analysis: 1) When costs to remove pollution is lower compared with the value of damages incurred to pollution, firms are going to internalize externalities under the surcharge scheme, however, emission control through imposing output ceiling cannot guarantee the internalization of negative externality, 2) Firms have no incentive to internalize negative externality when costs to remove pollution is higher compared with the value of damages incurred to pollution under the both surcharge and emission control schemes, 3) The lower is the private marginal cost that could attain environmental standard which can avoid surcharge or imposition on output, the stronger is the incentive to internalize externality for firms, and 4) When costs to remove pollution is lower compared with the value of damages incurred to pollution, internalization externality increase not only producer's surplus but also social welfare.

4. Environment Policies during High Economic Growth

Japan experienced rapid economic growth from 1960's to early 1970's. The growth rate of GNP was exceeded 10%. Environmental policies could not catch-up to this speed of high growth. Along this high growth, Japan started suffering from serious pollution problems, such as Yokkaichi Asthma, Minamata Disease in Kumamoto and Niigata area, and Itai-itai Disease³.

There were no sufficient environmental policies to protect against the environmental pollution problems until above four major pollution cases were taken into lawsuit in 1968. The verdict made not only firms but also government was responsible for the results, since government neglected to enforce necessary regulations.

³ Yokkaichi Asthma was first discovered in 1960. The people lived in Northwest part of Yokkaichi city suffered from the serious asthma because of the sulfur dioxide emitted from the factories. Minamata Disease was first discovered in 1956 in certain village around Minamata Bay, in Kumamoto prefecture. Another similar epidemic occurred along the Agano River, in Niigata prefecture. The people, who took fish and shellfish contaminated by methyl mercury compound discharged from a chemical plant, started suffering from the several signs and symptoms such as sensory disturbances of extremities, loss of coordination, and bilateral concentric contraction of visual field, etc. Itai-itai Disease was occurred along the Zintsu River, in Toyama prefecture. The heavy metals such as cadmium discharged under the operation of mining, dressing and smelt during early 1900's to 1945 polluted the river and soil of the rice fields, etc. Then cadmium was accumulated into the peoples' body through the contaminated water, fishes, vegetables and rice.

Basic Law for Environmental Pollution Control was firstly inactivated in 1967. This made clear the target of pollution control were air pollution, water pollution, noise, vibration, ground subsidence, and odor. This law was revised in 1970 to put first priority into environment instead of "harmony between environment and economic growth." Furthermore, soil contamination was added to the above six targets of pollution control. The *Air Pollution Control Law*, *The Offensive Odor Control Law*, and *The Water Pollution Control Law* were succeeding and inactivated between 1971 and 1976. Furthermore, environmental standards on air pollution, noise from airplane, and noises from Shinkansen were set up and target level to keep environment were clarified. In 1971, Environmental Protection Agency was finally established to cope with regulations and standard related to environmental protection. Major environmental policies are summarized in Table 1.

Fiscal expenditure on environment grew rapidly along with reinforcement of laws and regulations. Expenditure on environmental conservation consists of 1) establishment of various quality standards, 2) reinforcement of monitoring and control, 3) aid to private organizations engaged in works for pollution prevention, 4) promotion of public works for pollution prevention, 5) promotion of research for pollution prevention, 6) reinforcement of protective measures for pollution victims, and 7) promotion of nature conservation measures. The share of promotion of public works for pollution prevention occupied 80% and that of sewage works reached half of expenditure on environmental conservation budget. Government put emphasize on sewage works to ensure "national minimum for living" as is shown in Diagram 4.

Firms have also started considering facilitating environmental protection equipment to their production lines in accordance with public opinion. Firms, i.e., polluter, took responsibility for environmental protection based on standards and regulation since "Polluter Pays Principle (PPP)" was established based on OECD committee's proposal in 1972. Government supported firms to promote facilitating environmental equipments by means of fiscal investment and loan to private sector, special tax allowance for depreciation reserve, and so on.

Diagram 5 indicates expenditure related to environmental among central government, local government, and private firms. Share of government expenditure in GDP has soared from .62 in 1970 to 1.65 in 1979. Private firms also expanded investment for pollution control facilities since 1973. Private firms intended mainly to save energy cost due to energy crisis, however, this effort has resulted in environmental conservation since reduction in fossil energy itself is an essential part of environmental

protection.

5. Prescription for NIEs: Conclusion

The four economic imprecations described in section 3, evolution in environmental policies summarized in section 4, and characteristics of fiscal expenditure on environmental conservation can be combined to explain mechanism that promoted environmental conservation in Japan during her high economic growth period. Fiscal expenditures that were devoted into 1) invention, innovation and transfer of pollution suppressing (including energy saving technology), 2) public sewage, 3) industrial waste management, and 4) fiscal investment and loan to Local government and private firms contributed to lowering private marginal cost curve when firms facilitate 100% pollution free equipment (PMC(100%)), therefore to induce positive action of firms.

Based on the above interpretation, government expenditure contributed directly for environment conservation and to reduce private marginal cost curve when firms facilitate 100% pollution free equipment. It became more plausible for firms to facilitate environmental protection as this private marginal cost decreased.

Japan and many developed countries (DCs) enhanced their environmental protection technologies along innovation of their production technologies at the later stage of their development. Government had played important roles to support firms to promote environmental protection. On the other hand, developing countries and newly industrialized economies (NIEs) possess production technology to large extent, however, they are extremely short of environment protection technology. This could happen mainly because NIEs launched mass production of industrial products without (or with very few) own process of invention and innovation for their own products. As a result, they do not possess enough know-how to establish their own environmental protection technology by themselves within limited time horizon. Under these situation, realizing private marginal cost curve when firms facilitate 100% pollution free equipment (PMC(100%)) at reasonable price is far beyond the reach of NIEs. At the same time, many NIEs are suffering from shortage of government budget. This could limit the government to play roles for environmental conservation.

Furthermore, NIEs have been also required to accommodate global environmental issues at the very early stage of their development. This should be a secondary burden for them. Due to this secondary burden, it is also very difficult to get unanimous consensus to the global environmental issues.

If it is really crucial to realize private marginal cost curve when firms facilitate 100% pollution free equipment (PMC(100%)) at reasonable price to promote self-sustaining effort for improving environment, we have to somehow break through this tri-lemma.

Prescriptions for this tri-lemma are; 1) transfer of pollution suppressing technology, 2) supporting government expenditure to promote innovation of pollution suppressing technology and facilitating pollution suppressing equipment, and 3) mitigating environmental standard to keep private marginal cost curve when firms facilitate 100% pollution free equipment (PMC(100%)) within reasonable price range for NIEs.

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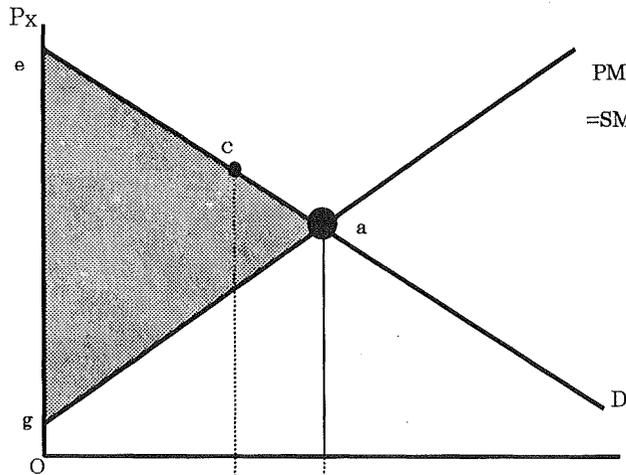
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Table1 Laws and Regulations for Environment Standard and Conservation in Japan

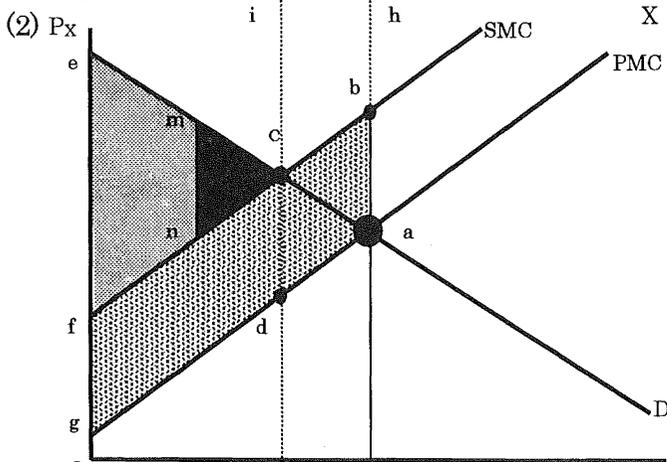
	Basic Environment Law	Environmental Quality Standards	Law and Regulations					Settlement of Disputes and Damages Compensation etc.
			Air Pollution	Water Pollution	Noise, Vibration & Offensive Odor	Grand Subsidence & Soil Pollution	Others	
			-Law concerning the Regulation, etc. on the Emission of Smoke and Soot (June 1962)	-Enact the Law concerning the Water Quality Conservation for the Public Water Bodies (December 1958)		-Enact Industrial Water Law (June 1956) -Law concerning Regulation of Pumping-up of Ground Water for Use in Building (May 1962)		
1967	-Enact Basic Law for Environmental Pollution Control (August 1967)	-Environmental Quality Standards for Sox (February 1969)	-Enact Air Pollution Control Law (June 1968)		-Enact Noise Regulation Law (June 1968)			-Enact the Law concerning Compensation and Prevention of Pollution-related Health Damage(December 1969)
1970		-Environmental Quality Standards for CO (February 1970) -Environmental Quality						-Enact the Law for the Settlement of Environmental Pollution Disputes (June 1970)
1970.12	-Amend Basic Law for Environmental Pollution Control (Eliminate Harmonized Article)		-Amend Air Pollution Control Law (Stricter Standards)	-Enact Water Pollution Control Law -Enact Marine Pollution Control Law -Amend Sewerage Law	-Amend Noise Regulation Law	-Enact Agricultural Land Pollution Prevention Law -Amend Industrial Water Law -Amend the Law concerning Regulation of Pumping-up of Ground Water for Use in Building	-Enact the Law for the Punishment of Environmental Pollution Crimes relating to Human Health -Enact Waste Disposal and Public Cleansing Law -Amend Agricultural Chemicals Regulation Law -Amend Poisonous and Deleterious Substances Control Law -Amend the Road Traffic Law	-Enact the Law concerning Entrepreneurs' Bearing of the Cost of Public Pollution Control Works
	-Enact Nature Conservation Law (June 1972)	-Environmental Quality Standards for Noise (May 1971) -Environmental Quality Standards for Suspended Particulate Matters (January 1972)			-Enact Offensive Odor Control Law (June 1971)			-Enact the Law concerning the Improvement of Pollution Prevention Systems in Specific Factories (June 1971) -No-fault liability for compensation (June 1972)
1973	-Enact National Land Use Planning Law (June 1974)	-Environmental Quality Standards for Air Pollution (May 1973) -Environmental Quality Standards for So2 (May 1973) -Environmental Quality Standards for Aircraft Noise (December 1973) -Environmental Quality Standards for Water Pollution (September 1974) -Amend the Environmental Quality Standards for Mercury -Environmental Quality Standards for Shinkansen Superexpress Railway Noise (July 1975)	-Amend Air Pollution Control Law (June 1974) Established the Emission Standard				-Enact the Law concerning the Examination and Regulation of Manufacture, etc. of Chemical Substances (October 1973) -Enact the Law concerning the Conservation of the Environment of the Seto Inland Sea (October 1973)	-Enact Pollution Related Health Damage Compensation Law (October 1973)
1976				-Amend Sewerage Law (May 1976) -Amend Marine Pollution Control Law (June 1976) -Amend to the Law Relating to the Prevention of Marine Pollution and Maritime Disaster	-Enact Vibration Regulation Law (June 1976)		-Amend Waste Disposal and Public Cleansing Law (June 1976)	

This is a list of the law relating to the environmental quality standard and preservation as thinking as important (Environmental Quality of Japan 1978)

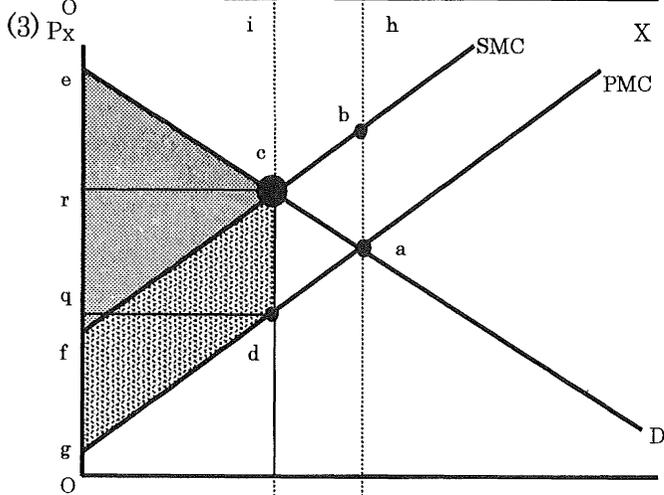
(1) Diagram 1 Economic Analysis of Externality



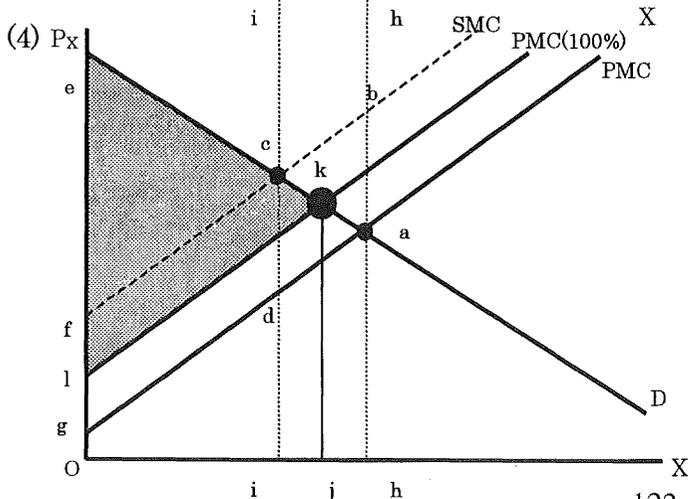
CASE1:
 No Environmental Pollution
 Government: No Action
 Firms: No Action



CASE2: Pollution Exists
 Government: No Action
 Firms: No Action

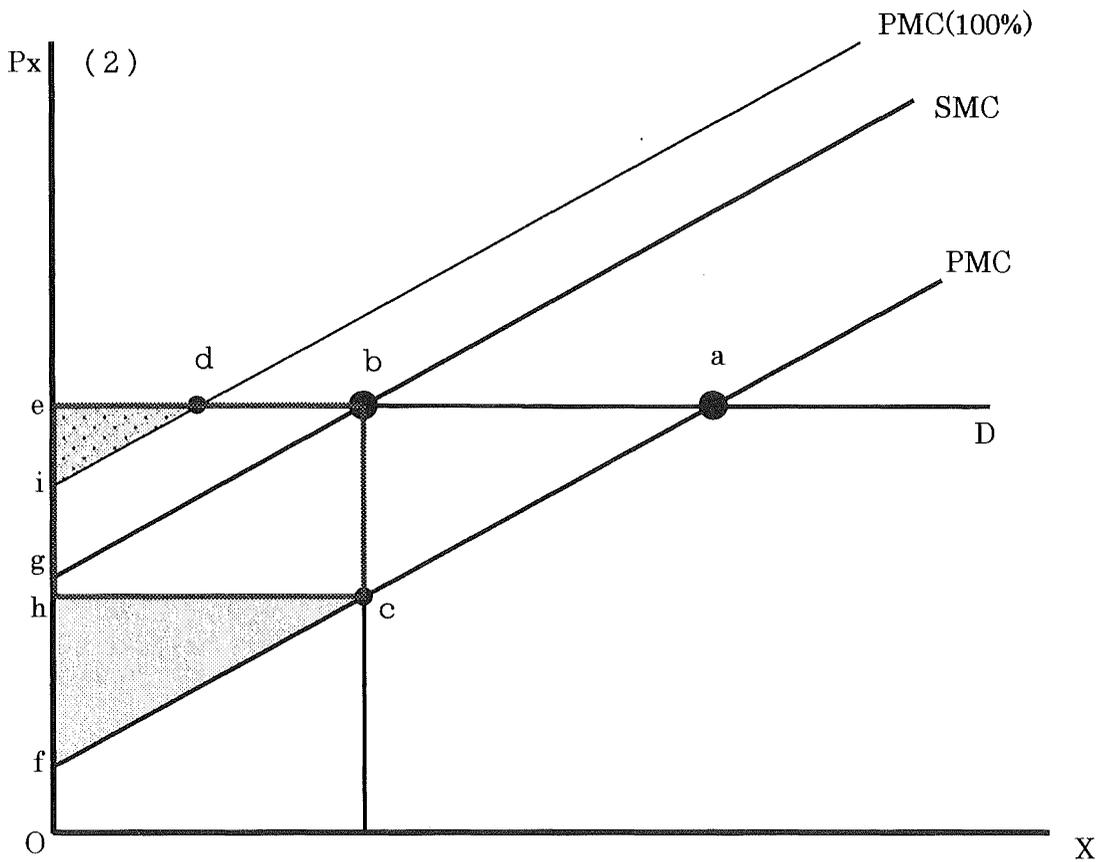
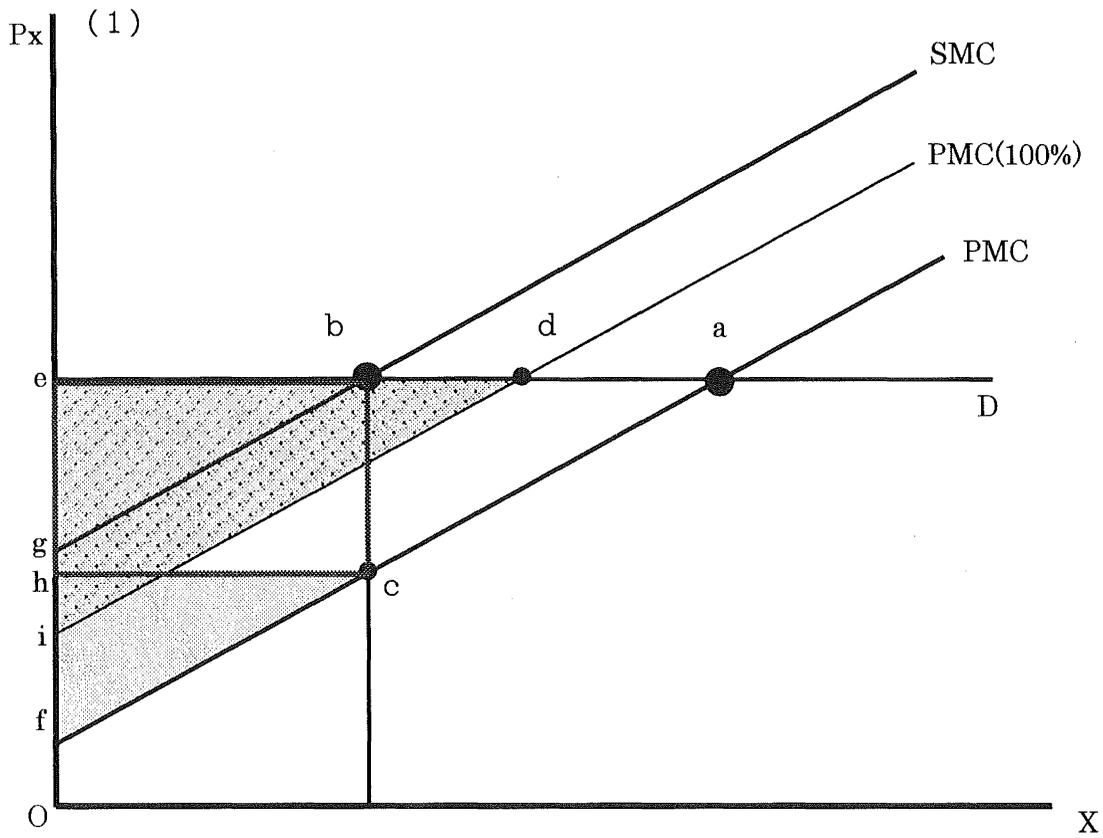


CASE3: Pollution Exists
 Government: Environmental Action Exists
 (Pigou Tax)
 Firms: No Action



CASE4: Pollution Exists
 Government: No Action
 Firms: Emission Control (100%)
 (Internalization)

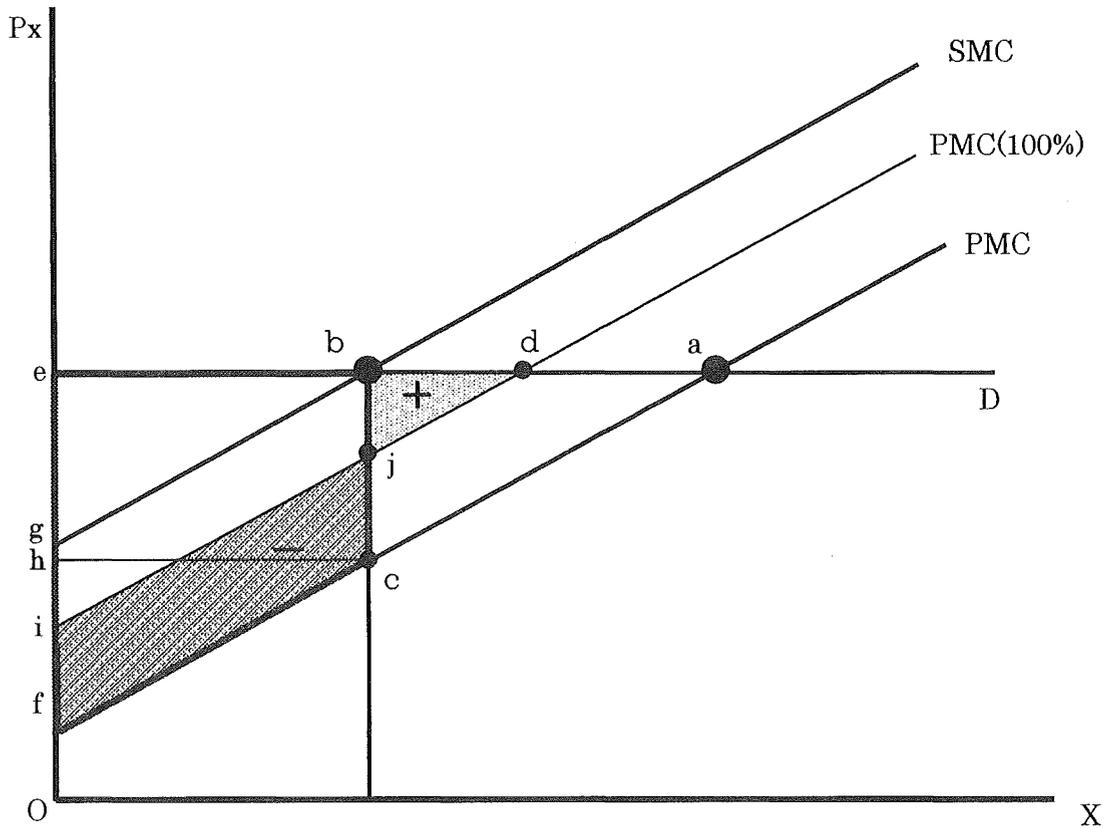
Diagram 2 Pigouvian Tax and Firms' Action (Fixed External Case)



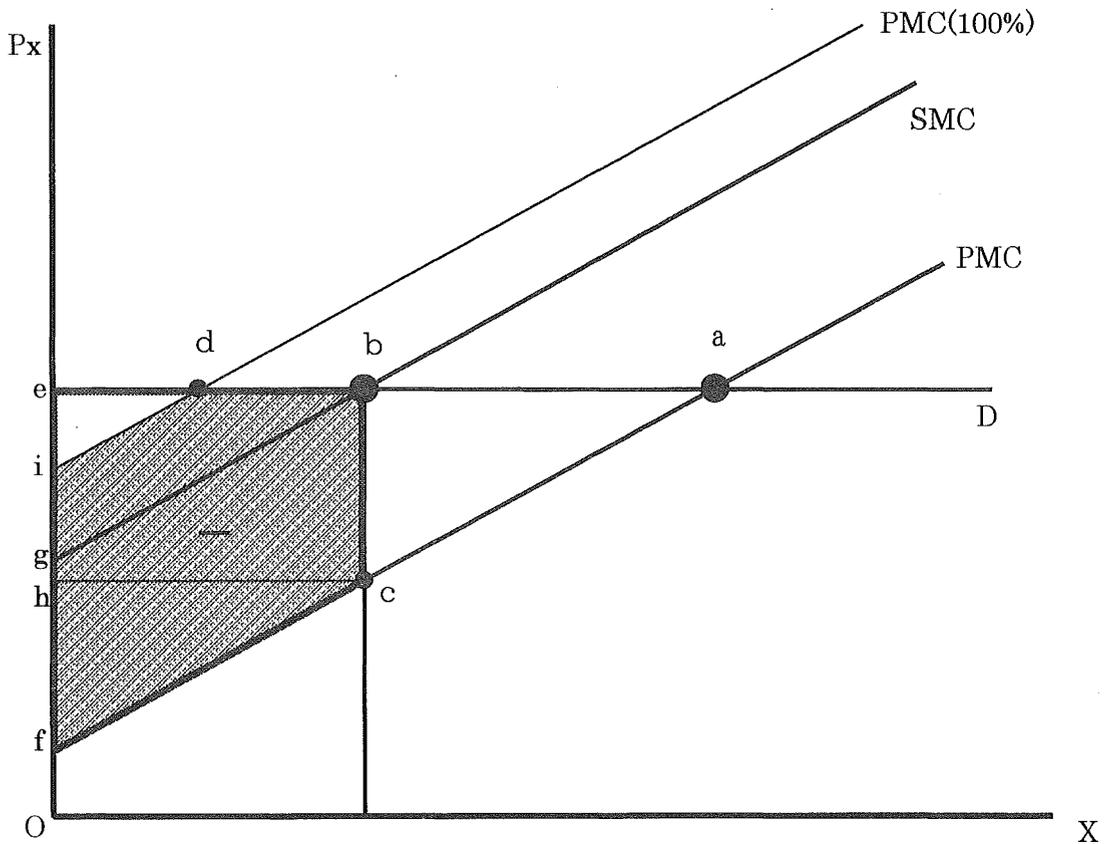
Notes : $PMC(100\%)$ — Private marginal cost curve in case remove pollution 100%

Diagram 3 The Emission Restriction and Firms' Action (Fixed External Case)

(1) When environmental protection cost decreases cost incurred from externality



(2) When environmental protection cost exceeds cost incurred from externality

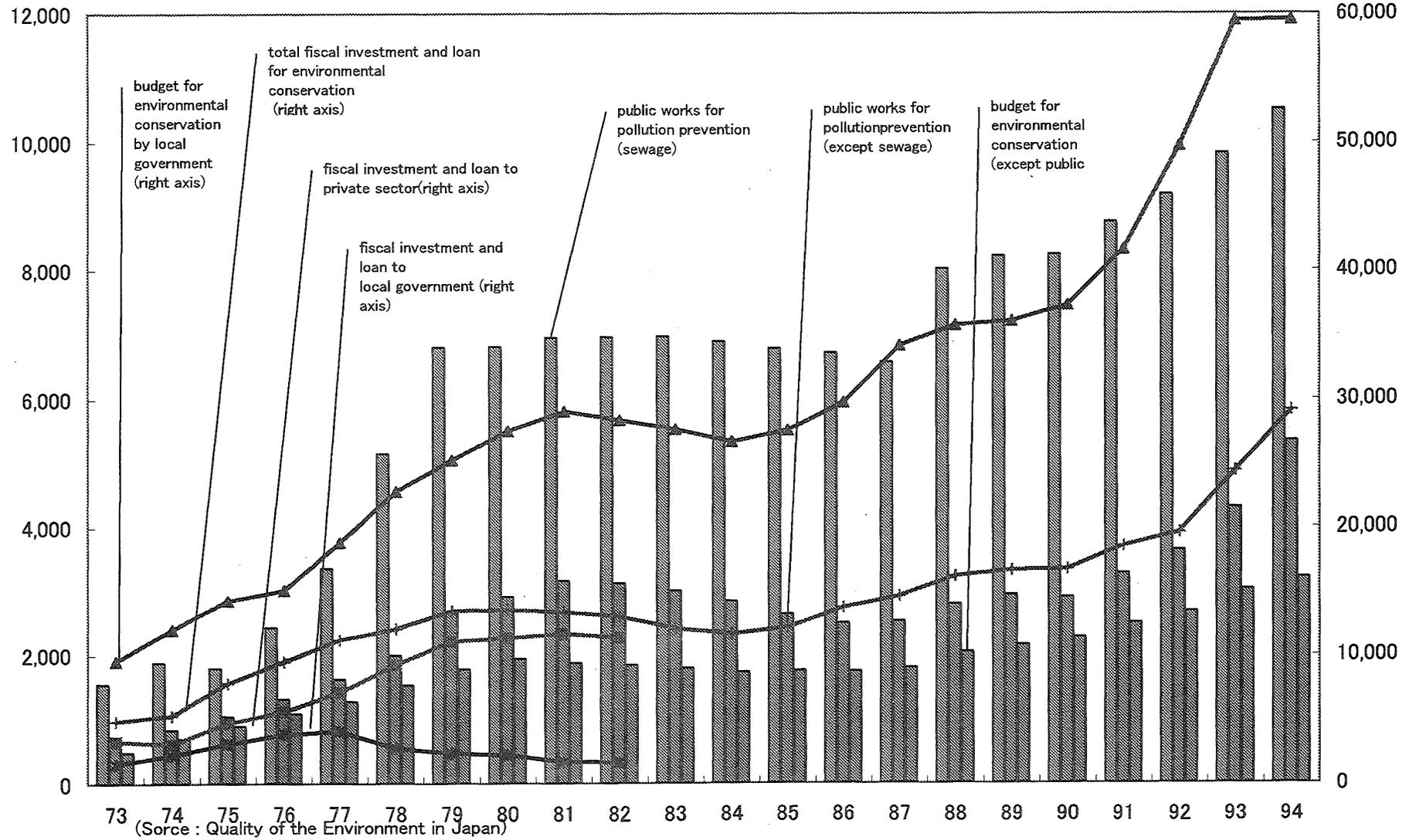


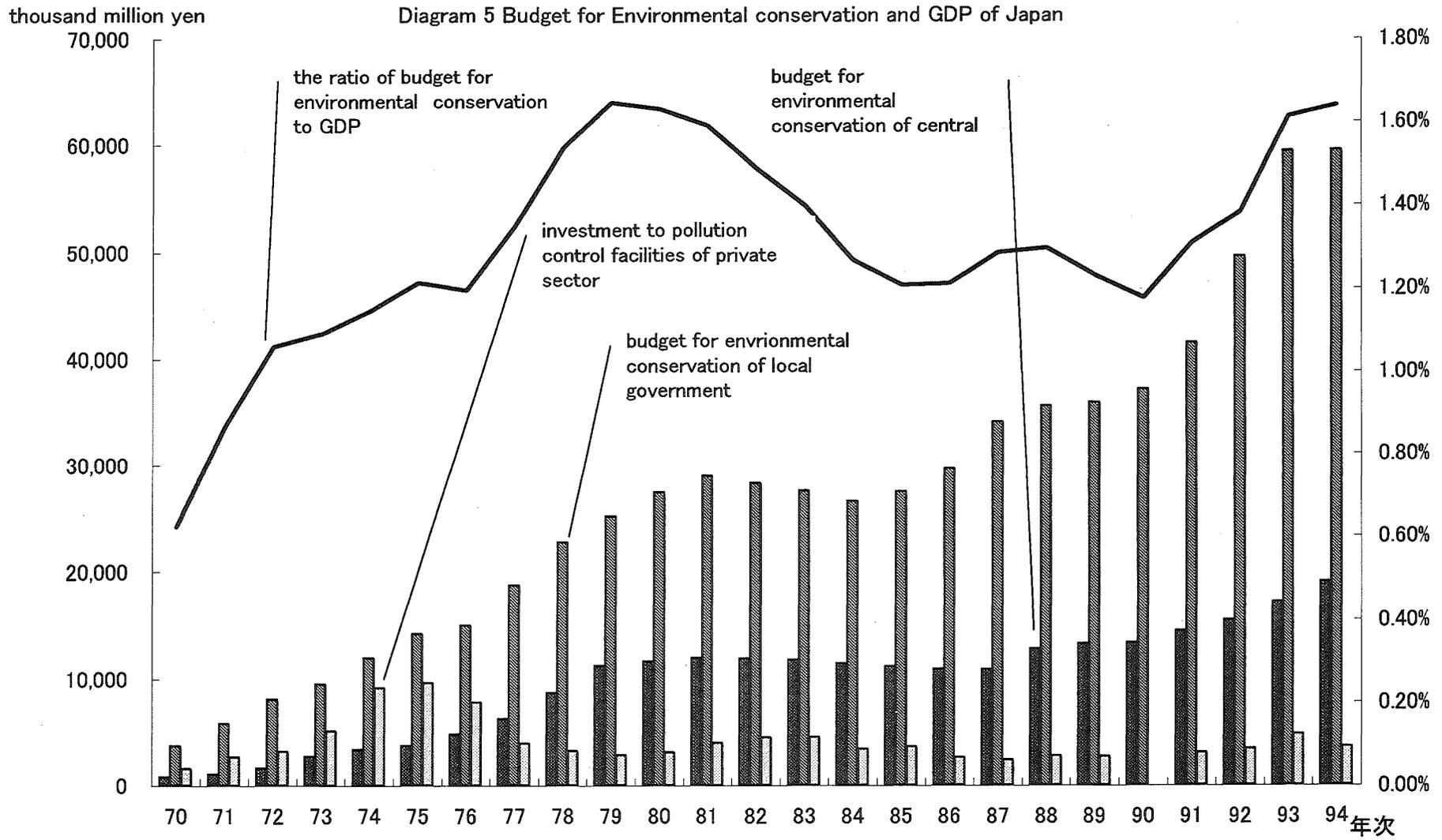
Notes : PMC(100%)—Private marginal cost curve in case remove pollution 100%

thousand million

Diagram 4 Budget and Fiscal Investment and Loan for environmental conservation

thousand million





(Source : Quality of the Environment in Japan Economic Planing Agency "Economic Outlook 1996")