Chapter 7

The Economic Evaluation of the Environmental Policies in Japan: Learning from Past Experience

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1. An Overview of Pollution-Related Damage and Pollution Control Costs during the Process of Economic Growth in Japan

In Japan, we experienced high economic growth and serious pollution-related damage after WWII. The high rate of heavy and chemical industries in Japanese industries caused this circumstance.

The amount of pollutants produced per unit of production is higher in the heavy and chemical industries than in any other industry. Consequently, the amount of pollutants produced throughout Japan grew faster than GNP growth rate. The other cause of the pollution is the low investment for pollution control by companies. Even in 1965, the percentage of total capital investment that businesses allocated toward pollution control was only 3%.

The pollution caused serious health damage and damages to assets.

There is many type of pollution—air pollution, water pollution, etc. The problems arising from the pollution are also many and varied.

But they can be divided roughly into four kinds of damages.

1) Illness and other injury to peoples' health caused by the absorption into the body of harmful substances,
2) Damages to property—metal corrosion, laundry contamination, drops in land value, increased difficulty in growing crops, decrease in fish catch, etc.,
3) Disruption of the ecosystem or other damage to the environment,
4) Loss of amenities—loss of beaches, spoiling of the scenery, etc.

Japan has suffered every conceivable kind of pollution-related damage.

Environment Agency estimated the expenses incurred by the damage and the costs of preventive measures in two reports. One is "Pollution in Japan-Our Tragic

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Experience". The other is "Japan's Experience in the Battle against Air Pollution".

In this paper, I will introduce the essence of the reports.

1.1 The financial Assessment of Pollution-Related Damage and the Relationship between Damage and Pollution Control Costs.

1.1.1 Expenses incurred by pollution-Related Damage

First let us consider how to approach incurred by pollution-related damage.
While some components of the pollution-related damage may easily be assessed financially—damage to assets, for instance—in general, damage caused by pollution does not lend itself to financial assessment. Injury to people's health, for instance, is often irreparable, and is something which can never be fully compensated by financial means. Furthermore, the amount of compensation has to do with people's perception of value of life in each country. When translating pollution-related damage into financial terms it is easy to neglect those parts that are difficult to assess economically, and as a result, the assessed amount tends to be too small.

In this report, we have not tried to translate damage completely into financial term. We have represented the full financial assessment of expenses incurred by all pollution-related damage by the actual expenditures—for instance, the amounts already paid in compensation or the amounts already paid to clean up polluted fields or water.

The amounts cited as damage expenses in this report are clearly nothing more than provisional estimates of amounts paid out to correct some of the damage caused by pollution.

1.2 Costs Incurred by pollution Control Measures

By around 1970, at the height of era of high economic growth, pollution had spread drastically and become recognized as a major socioeconomic problem in Japan.

To cope with this problem, the framework for dealing with pollution is established and the pollution control measure was implemented.

Pollution control measures can be divided into as follows.

1) Measures to prevent the production of pollutants in the first place, such as changes in manufacturing methods and changes in raw materials of fuel,
2) Measures to prevent pollutants from spreading from their place of origin

into the environment, such as the installment of dust collectors and sedimentation ponds,

3) Measures to prevent released pollutants from affecting the living conditions of area residents, such as the establishment of green buffer zones,
4) Measures in the public sector such as the monitoring of pollutants in the environment and at the sources, and the use of that data to establish regulations or purpose laws.

The money required to implement these kinds of pollution control measures can be broken down into equipment investment (equipment purchase, including interest payments, and installation costs) and running costs (the personnel, chemical, electrical, and tax costs required to run the equipment).

Data is available mostly from large companies, on equipment investment costs for item 1. However, there is insufficient data on investment cost for item 2, as well as running costs for both items 1 and 2. Precise figures are available for the activities covered in items 3 and 4, since central and local government bodies handle these; however, these figures are mostly in the area of equipment investment.

In principle, the estimates given for pollution control costs in this report are the sum of depreciation costs for the equipment investment outlined in items 1-4 above and the running costs, and are based on a time series of equipment investment cost data.

Also, general yearly running costs are assumed to be in a proportional relation to equipment investment costs.

1.3 Expenses Incurred by Pollution-Related Damage versus Pollution Control Measures

In this report, we will compare the costs incurred by pollution-related damage versus pollution control measures using concrete examples of air and water pollution.

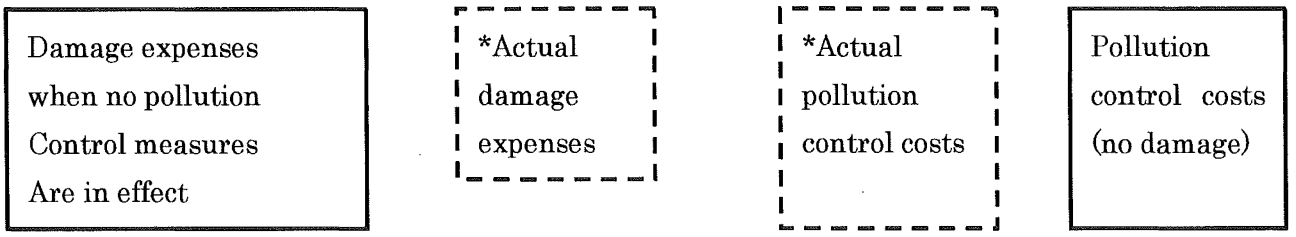
We attempt to compare the amount of money incurred by damage expenses when no pollution control measures are in place versus the amount of money necessary to fund measures which will arrest pollution before damage occurs.

However, it is important to note that the estimated expenditure on damage based on actual amounts spent tends to be less than the amount of money incurred by damage expenses when no pollution control measures are in place. On the other hand, the actual pollution control costs in each case are the costs of corrective measures taken after damage had already arisen, and in many cases these measures proceeded by trial

and error. Thus the figures tend to be larger than amounts for pollution control measures that arrest pollution before damage can occur.

For the reasons listed above, we must assume that the damage expenses being compared are lower than they should be, and pollution control costs are higher than they should be. However, in the interests of making the economic significance of these pollution control measures clearer, we have felt it safer and more persuasive to proceed with this assumption. (In other words, we are comparing damage expenses which are probably higher than they should be—see Chart 1 below.)

Chart 1.



Note: The underlined amounts are those which this report is attempting to compare. In actually, however, the amounts marked with an asterisk * are used to represent the underlined amounts.

At first, we made a comparison for the year 1976 of the costs for measures taken at factories and other pollution sources to control sulfur oxide, versus estimates of pollution damage expenses that would have been incurred had no measures been taken at all (Figure 1).

The projected measures been in place (approximately ¥6 trillion per year, 1976 values) far exceed the amount which was estimated to have been actually spent on pollution control (approximately ¥480 billion, 1976 values.)

2. Case studies 1: (health damage caused by organic mercury)

2.1 Background

In 1908, a manufacture of nitrogenous fertilizers, now called Chisso Corporation, located itself in Minamata City. At that time, Minamata was a small scenic town of 12,000, producing wood products and oranges. Numbers of fishermen made their living in the Shiranui Sea between Minamata City and Amakusa Islands.

In 1956, the Chisso corporation had become one of the largest chemical manufacturers in Japan.

By the 1920's, compensation for fishing damage due to the effluent from the Minamata factory was already an issue.

2.2 Pollution and Pollution-Related Health Damage

Minamata disease is a neurological affliction caused by the ingestion of seafood with high concentrations of a methyl mercury compound. The Chisso factory discharged this compound, a by-product of the acetaldehyde manufacturing process, into the Minamata Bay Area of Kumamoto Prefecture.

The appearance of Minamata disease has been traced to May 1956 repots of patients with symptoms of a brain-related ailment, but later investigations confirmed that such patients first appeared around 1953.

But it took long time to investigate the mechanism of the Disease. In 1968, 12 years after the first recorded appearance of Minamata patients, the government announced its opinion that the cause of Minamata disease was the methylmercury compound in the factory's effluent.

Until the cause of Minamata disease had been disappeared, the number of the patients had increased. In 1959, Chisso signed a contract for compensation to the injured parties. Since the cause of the disease had not yet been conclusively determined, the contract did not hold Chisso responsible for the damage, and thus exacted only a small indemnity from the company.

After the government announced its opinion on the cause of Minamata disease, the Minamata victims resumed moves towards obtaining a larger indemnity, and in June 1969 brought a suit against the company claiming compensation for damages.

In December of the same year, certified patients in the Minamata area were declared eligible for coverage of medical and other expenses under the Law Concerning Special Measures for the Relief of the Pollution-Related Patients.

In March 1973, the Kumamoto district court confirmed a court decision that the Chisso Corporation was responsible for compensation for damages. Furthermore, in July, the Chisso Corporation and a group representing the Minamata patients signed a compensation agreement requiring Chisso to pay compensation for damages directory to people legally certified to have Minamata disease.

As of the end of March 1991, there are currently 2,248 people who are certified patients of Minamata disease by the above-mentioned framework; Chisso up to this period has paid about ¥9.08 billion in compensation, and current annual payment is in the order of ¥3 bullion per year.

In addition to this, ¥48.5 billion were spent from fiscal 1974 t fiscal 1989 in order to treat 1.5 million cubic meters of bay floor with a mercury concentration. Also, Chisso paid a lot of money in compensation to the fishing industry.

2.3 Pollution control

In the 1950s, Chisso began instituting pollution controls by collecting mercury in sedimentation tanks and installing other equipment to treat waste water. In 1966 the factory adopted a method for completely recycling waste water within the plant. There are no accurate records of how much was paid, but including the periphery equipment the improvements are estimated to have cost about ¥400 million at the time. Furthermore, in 1968, the factory stopped producing acetaldehyde.

2.4 Pollution Related Damage v.s. Pollution Control Costs

2.4.1 Extent of Damage without Pollution Controls

The financial assessment of the damage caused by Minamata disease consists of three parts: health related damage, damage from the polluted bay bottom, and damage to the fishing industry. What follows is a calculation of the average yearly payments for damage by Minamata disease if the spillage of mercury had continued without any pollution control.

If we define health compensation as the sum of the average yearly indemnity after FY 1974, a year after the 1973 compensation agreement between Chisso and the patients' association, the ¥1,184 bullion Chisso was forced to pay after the 1973 trial, arranged as payments of principle and interest (7%) in equal yearly installments over a thirty year period; and FY 1973 payment of ¥11.15 bullion which was paid to the existing patients as a lump-sum compensation equivalent to the amount set by the compensation agreement, then total health damage costs come to ¥7.671 billion yearly (at 1989 values).

Then, if we define bay pollution damage as the average yearly cost of the sludge dredging projects, then total bay pollution costs reach ¥4.271 billion per year (at 1989 values).

Finally, if we define fishing industry compensation as the indemnity to the fishing industry arranged as payments of principle and interest (7%) in equal yearly installments over a thirty year period, the total damage to the fishing industry costs

¥690 million yearly (at 1989 values).

The total yearly cost of damages would thus be ¥12.632 billion (1989 values).

2.4.2 Pollution Control Costs

Pollution control costs were calculated by totaling the yearly average corporate investment in pollution control equipment, which was interpreted as average depreciation costs since 1955, plus additional operating costs and interest payment which was assumed to be fixed proportions of the annual investment. Their total amounted to ¥125 million (FY 1989 values).

2.4.3 Assessment

The comparison of yearly payments for pollution damage of ¥12.632 billion (1989 value) and that for pollution control of ¥125 million (1989 value) makes it very clear that pollution control undertaken at the early stages would have been good policy in terms of monetary cost-effectiveness.

Regardless of why it took so long to elucidate the cause of Minamata disease, there is no way to reclaim the lives, health, and environment lost during that time.

3. Case studies 2 (air pollution caused by sulfur oxide)

3.1 Background

The location of Yokkaichi city combined large areas of land suitable for factory use with excellent harbor facilities. Under this condition, large petrochemical complexes were constructed on the site. When the Number 3 Complexes was completed in 1973, it had a petroleum refining capacity of 505,000 barrels, and an ethylene production capacity of 701,000 tons, making it one of the largest in Japan at that time.

3.2 Pollution and pollution-related health damage

Soon after the start of plant operations, area residents began to suffer from asthma and other complaints. This became widespread problem.

According to measurements taken between November 1963 and October 1964, the average concentration of sulfur dioxide in the worst district was eight times that of

unaffected districts, with 3% average one-hour measurements exceeding 0.5 ppm, and at times even exceeding 1ppm—ten times the current environmental standard of 0.1 ppm.

In September of 1967, the residents filed a damage suit against six companies of the industrial complex. The suit ended in July of 1972 with the Tsu district court, Yokkaichi branch handing down a decision in favor of the plaintiffs which found all the defendant companies guilty of illegal actions.

From 1970, medical costs for the patients had been supported by private donations from industry and by central as well as funds of local government under the Law concerning Special Measures or the Relief of Pollution – related Patients. However, with the decision of 1972 placing responsibility for pollution damage firmly on the polluting companies, the public became aware of the need for the system which could provide patients with support for living expenses as well as medical expenses. Thus 1974 saw the Implementation of the Pollution-related Health Damage Compensation Law, a law which directed that polluting companies bear victims' medical expenses and pay compensation for lost income.

Yokkaichi qualified to receive aid, and the number of patients certified in the Yokkaichi area under this Law reached a peak of 1,231 in 1975.

3.3 Pollution control measures

In 1962 the government passed the Soot and Dust Regulation Law. From 1964, Yokkaichi City became a regulated area under the Law, and reforms such as the translocation of housing, the institution of buffer zones, the high smoke stacks installed to promote dispersion of air pollutants merely caused the pollution to spread over a larger area.

To cope with this problem, the supply low sulfur heavy oil and development a flue gas desulfurization apparatus were going.

In 1976, Area-wide Total Pollutant Load Reduction Plan and Area-Wide Total Pollutant Load Control Standards stipulated by the Air Pollution Control Law were introduced and by the end of FY 1976, the level of SO_2 in Yokkaichi had reached conformity with the Ambient Air Quality Standard for Sox.

3.4 Damage expenses versus pollution control costs

3.4.1 Damage expenses

For damage expenses we have used the average single-year compensation amounts since the implementation of the Pollution-Related Health Damage Compensation Law in FY 1974 which provided for the payment of medical expenses and compensation for such things as loss of income.
They amounted to ¥1.331 billion per year (1989 value).

3.4.2 Pollution control costs

Pollution control costs were calculated by totaling the yearly average corporate investment costs for pollution control facilities, interpreted through average depreciation costs, since implementation of the Regional Environment Pollution Control Program in 1971. ; plus operating costs and interest payment which we estimated to be fixed proportions of the annual investment, as well as expenses borne by the public sector for such measures as monitoring systems including operating costs and environmental improvements such as green buffer zones. Their total, which we define as air pollution control costs, amount to ¥14.795 billion per year (1989 value).

3.4.3 Assessment

As a result, we see that ¥14.795 billion (1989 values) is spent yearly on air pollution control measures in Yokkaichi. With sufficient pollution control investment of this magnitude, the industrial complex since then has not had problems with regard to pollution. Damage expenses, which resulted from the lack of sufficient pollution control measures at early stages, amounted to ¥1.331 billion (1989 values).

In order to calculate how much money would have been incurred by damage expenses had no proper measures been in place, we have hypothesized a patient certification rate (percentage of certified patients among the total population) for all of Yokkaichi equaling that of the worst-hit district in 1975, although is reality worst consequence was avoided by corrective pollution control measures. In this hypothetical case, the " projected one-year damage expenses" would amount to ¥21.007 billion (1989 values), an amount greatly in excess of the air pollution control costs.

Therefore, we can say that providing sufficient investment to prevent health damage is a logical choice in terms of monetary cost-effectiveness as well.

4. Reproduction of Japan's History of Air Pollution Measures using an Economic model

It is necessary to analyze the total cost and effect of pollution control in Japan in addition to the case studies. Environment Agency re-enacted Japan's history of air pollution measures using an economic model based on the MERGE model. MERGE is a dynamic optimization model which focuses on the balance of energy supply and demand.

Based on this model, we are able to simulate the following three conditions of sulfur oxide emission volume reductions.

1) Reduction in sulfur dioxide exhaust by flue-gas desulfurization
2) Reduction in sulfur dioxide emissions through sulfur reductions in fuel
3) Reduction in sulfur dioxide emissions by energy conservation and structural conversion of industry

Through the use of this economic model, we have simulated the following:

1) Results of absolutely no implementation of Japan's response policies;
2) Timing for enactment of measures generating maximum economic efficiently;
3) Revenue/expanding associated with loss and gain when the implementation of measures in delayed.

4.1 Results of absolutely no implementation of Japan's response policies

Factors of Japan's reduction in sulfur dioxide emissions were analyzed by reproducing the actual effect of Japan's sulfur dioxide reduction measures.

Figure2 indicates the results of this simulation. If no sulfur dioxide reduction measures had been carried out in Japan, it is estimated that emission volumes would have increased rapidly to more than seven times the actual peak. We understand that actual emission volumes were suppressed to a much lower level as a result of various measures.

Continuously healthy market competition in Japan was also a main factor in the effective introduction of such measures. Additionally, oil's dramatic price rise after the oil shock inspired investments in energy conservation, which is seen to have had an effect on subsequent pollution measures. Further, fuel convention to low-sulfur resources was influenced by the price of low-sulfur crude oil on the international market. However, Japan's market competition was sustained by so-called "convoy fleet method"

policies, which take as their principal object the promotion of domestic industry and avoidance of the creation of definitive losers.

4.2 Timing for enactment of measures generating maximum economic efficiently

Generally speaking, Japan's pollution control investment peaked in the 1970's, before the economy stabilized. Air pollution control investment in particular achieved an all-time high in 1975 and sharply decreased beginning in 1977. What would have been the result had the timing of such investment been delayed? Further, taking pollution-related damage into consideration, should investment have been timed earlier had economically rational policies been carried out? To answer such questions, two types of simulations were conducted.

The first simulation calculates results according to a model where timing for sulfur dioxide emission restrictions is delayed at ten years. Another is delayed at six years. The last one builds damages incurred as a result of sulfur dioxide emissions into national economic accounts under the economic model. It estimates the optimal timing for sulfur dioxide reduction measures.

Figure 3 contrasts sulfur dioxide emissions generated by three case. It is clear that delayed timing results in a rise in sulfur dioxide emissions. When considering damages as well, we see that the most economical timing for response was much earlier than the actual case. Examining the situation in terms of economic gain and loss, Japan's air pollution response should have been timed much earlier.

In order to analyze the extent to which response timing should have been accelerated, a comparison of timing in flue-gas desulfurization investment was conducted. Its results indicate that the economically rational timing for investment would have been approximately 8 years earlier than the actual case.

In Figure 4, each case products significant differences in estimates for damages resulting from air pollution. In the case of optimal timing for the introduction of response measures, damages were suppressed to an extremely low level throughout all periods.

4.3 Revenue / expanding associated with loss and gain when the implementation of measures in delayed

Figure 5 adjusts response timing compared with Japan's actual history of response timing, estimating differences in GDP and damage as well as resulting differences in

net profits. GDP, damages and net profit are calculated at 1990 prices, with conversion rate at approximately 1 dollar per 140 yen.

It can be said that this loss/gain calculation is integrated in that it considers such factors as long-term influences upon economic growth and prevailing effects on energy consumption. However, this calculation does not consider two important factors. The first is irreversible, cumulative damage caused by air pollution to human health. The second factor excluded is the effect of air pollution response on boosting GDP.

Even considering the limitation of such models, Japan's air pollution responses is nevertheless shown to come out on the positive side of a loss/gain calculation in economic terms.

4.4 Analysis conclusion

As a result of this analysis, the following conclusions were reached.
When we take the year 1974 as a standard year and consider the theoretical effect of response timing, it is estimated that damages resulting from air pollution would have exceeded an estimated cumulative amount of 12 trillion yen had response been delayed by 10 years. The rise of GDP over this period would have stopped short of 6 trillion yen indicating an overall loss of approximately 6 trillions yen.

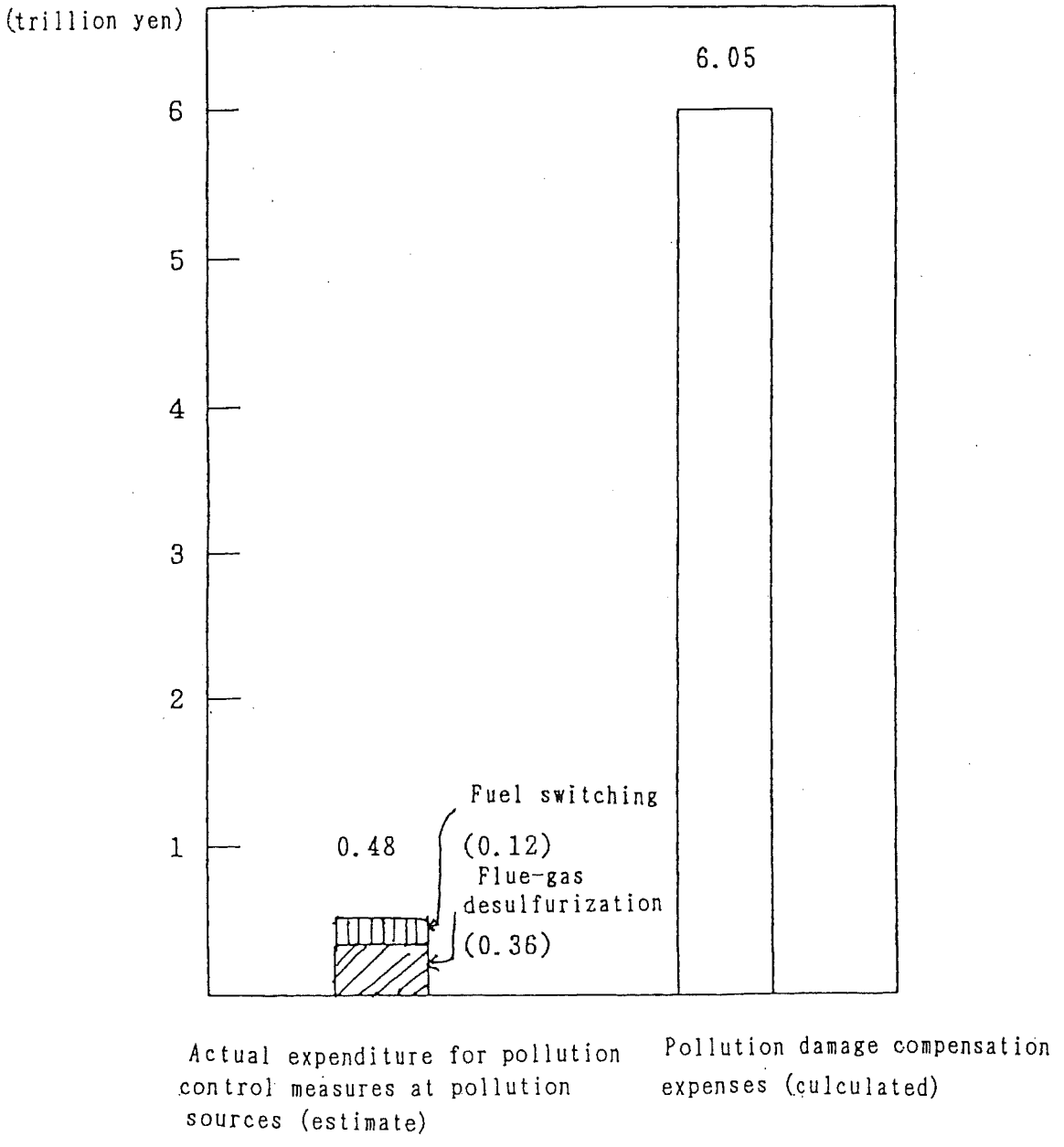
On the other hand, had response timing been accelerate by about eight years, it is highly likely that resultant decline in damages would have exceed a resultant decline in GDP, making this more economically profitable than the actual case.

Although Japan's air pollution response was somewhat late, the dramatic rise in air pollution prevention investment during the 1970s eased and eliminated previous pollution damage. We can say that consequently, an anticipated subsequent rise in damages was pre-empted. In the end, Japan's air pollution response was economically profitable.

References

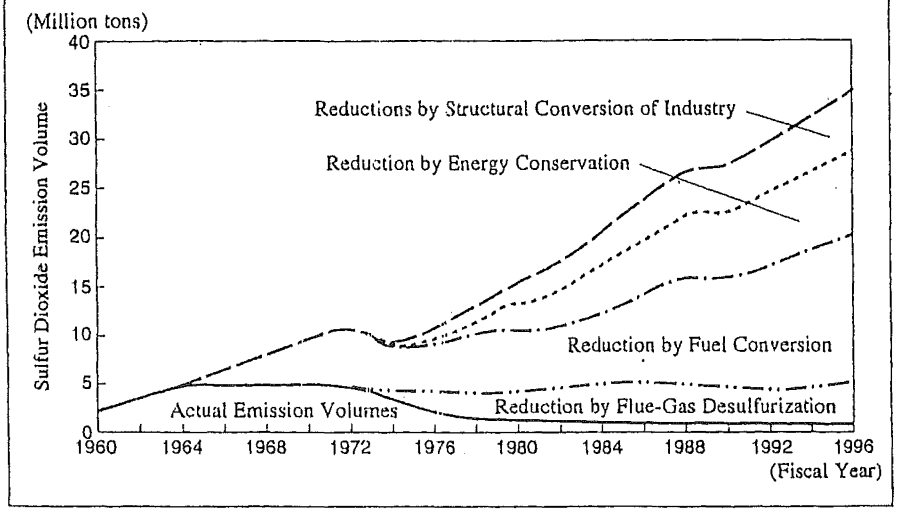
"Japan's Experience in the Battle against Air pollution." The Japan Times, 1997.

Figure 1 Comparison of the annual costs for sulfur oxide pollution control measures at sources, versus estimates of annual pollution damage expenses that would have been incurred had no measures been taken at all (1976 value).



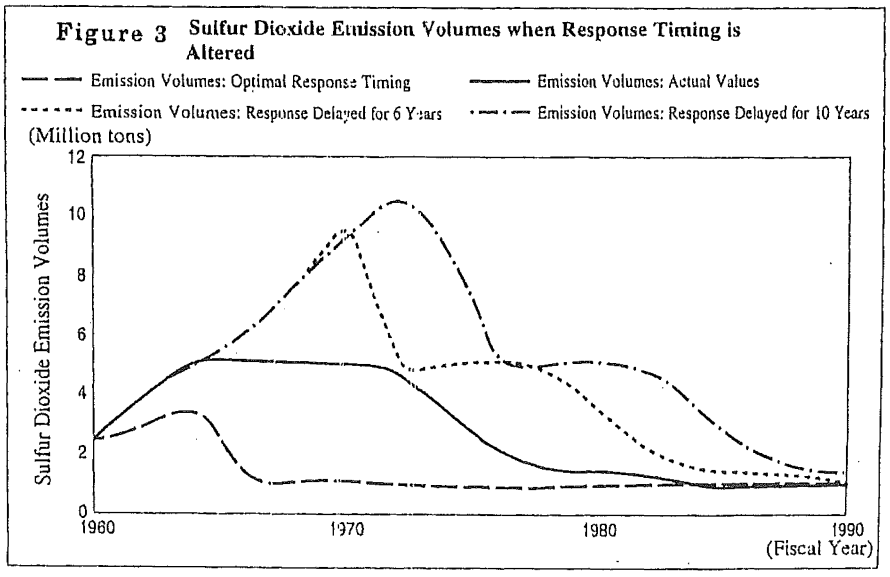
(Note) From the thesis by Youichi Kaya, presented to the Tokyo meeting of the Club of Rome

Figure 2 Factor Analysis for Sulfur Dioxide Emission Volume Reductions in Japan



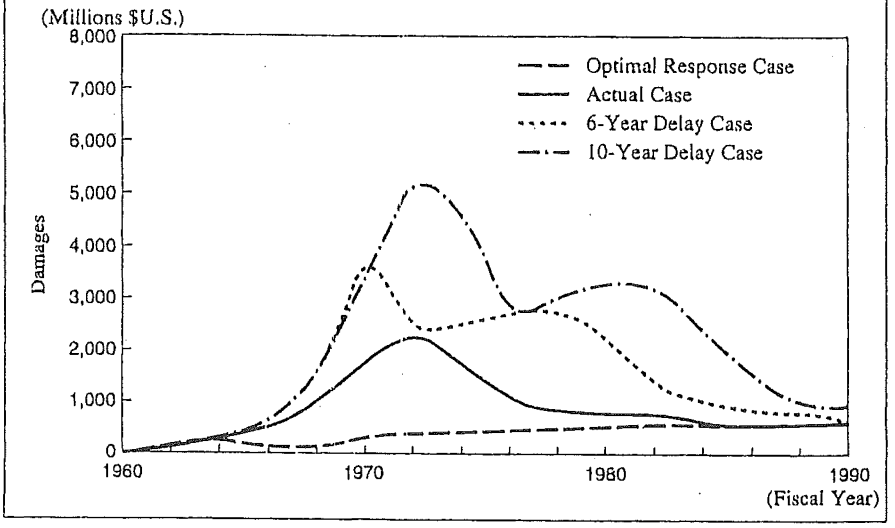
The Figure is from "Japan's Experience in the Battle against Air Pollution", The Japan Times, 1997.

Figure 3 Sulfur Dioxide Emission Volumes when Response Timing is Altered



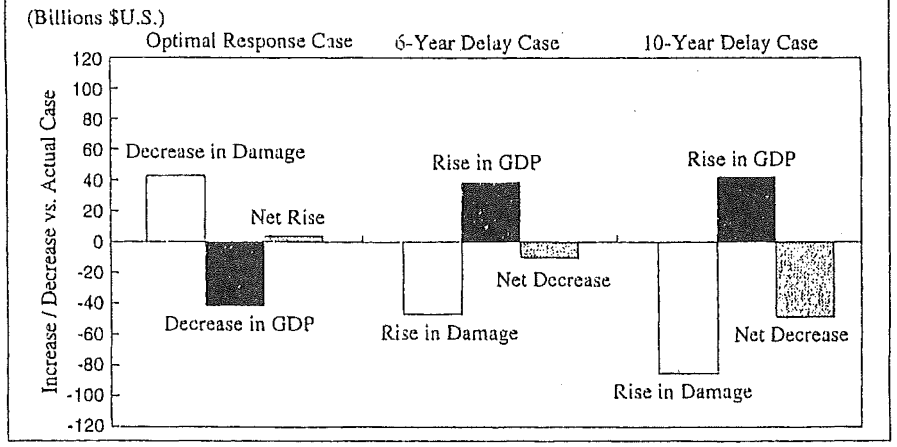
The Figure is from "Japan's Experience in the Battle against Air Pollution", The Japan Times, 1997.

Figure 4 Damages when Response Timing is Altered



The Figure is from "Japan's Experience in the Battle against Air Pollution", The Japan Times, 1997.

Figure 5 Damages and GDP Variation when Response Timing is Altered (compared to the actual case)



The Figure is from "Japan's Experience in the Battle against Air Pollution", The Japan Times, 1997.