Chapter 16
Environmental Policy

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Abstract A variety of policies, direct regulation, economic measure, voluntary action, and information disclosure are applied in environmental problems. Optimal policies differ, depending on the contents of environmental problems and/or the circumstances of social systems. Economic measure, including both pricing policy and target policy, is theoretically effective policy; however, this policy works in condition of high price elasticity of demand and well-developed market. Compensation system for social damage is necessary when environmental damage happens. Policy analysis and assessment are required to assess policy. Tools such as cost-benefit analysis, cost-effectiveness analysis, and risk analysis are used for evaluating policies. However, these analyses can be used in assumption of the trust on the assessment by the general public. The discount rate has a great impact on climate change policy because cost and benefit generally occur at different times. A recycle-based society can be established based on the appropriate assessment of the costs and benefits of recycling and disposal.

Keywords Environmental policy • Direct regulation economic measure • Voluntary actions • Information dissemination • Policy mix • Compensation • Policy assessment • Cost benefit • Risk

16.1 Overview of Environmental Policy and Measures

16.1.1 Classification of Environmental Policies

There are a large number of policies applying in environmental problem, and each policy has its advantage and disadvantage. The environmental problems and the social system will decide which environmental policy should be adopted. Environmental policies include direct regulation, economic measure, voluntary actions, and information disclosure. These are policies to improve the environment; however it has to be noted that it is essential for ensuring the implementation of these policies to establish the pollution-preventing structure of companies which are the main

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Table 16.1 Classification of environmental policies

Means	Features	Incentive	Prerequisite environment	Case example
Direct regulation	Regulator standard, enforcement mechanism	Punishment, penalty	Well-established legal structure, implementation mechanism	Air pollution, water pollution, chemical substances
Economic method	Tax, grant, trading	Economic benefit	Well-developed markets	Emission tax, emissions trading
Voluntary actions	Voluntary statement, voluntary agreement	Social evaluation, avoidance of regulation	Social pressure, trust between society and companies	Pollution prevention agreement with local government, global warming prevention agreement
Information dissemination	Information disclosure	Social assessment	Social pressure, data development	PRTR

execution of environmental protection. Furthermore, damage compensation along with environmental pollution and destruction are also important in environmental policy systems.

Table 16.1 is a summary of each environmental policy. In order for effective implementation of each policy, the incentives and obligations are the key in each policy. The appropriate policy would be selected in accordance with incentive and cost. For example, incentives for business operators are needed to implement measures in avoiding penalties in direct regulation, gaining economic benefit in economic measure, avoiding restriction and improving social reputation in voluntary action, and avoiding risk in informational disclosure. Therefore, it is necessary to design a policy system whereby the incentives of these policies are appropriately exhibited.

16.1.2 Direct Regulation

In direct regulation, the government sets the regulatory standard, while it also monitors compliance situation. Therefore, direct regulation is, in other words, called as "command and control." The regulatory standard is the goal of a desirable environment which needs to be established. Then, emission standard and emission restriction rules are determined to achieve such a goal, thus placing emission restrictions on companies. The direct regulation is widely applicable to various environmental problems where regulatory standard can be scientifically and quantitatively established, for instance, recommended limit of toxins can be decided scientifically for the prevention of health hazard. The advantage of this policy is to make clear the goal of environmental target since the standard and the restriction rules are shared in relevant parties through public announcement.

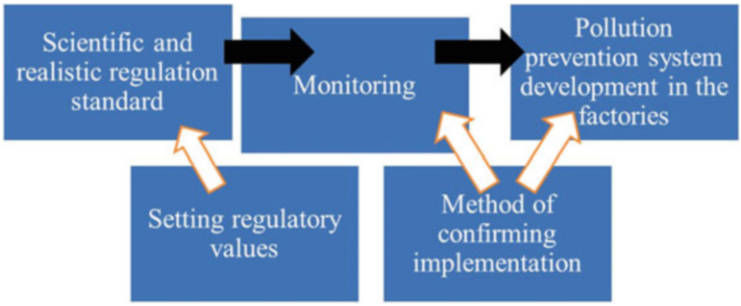

Fig. 16.1 Regulatory means

On the other hand, the government is expected to have information on which accurate regulatory standard can be established in order for this policy to be well enforced. If the government fails or mistakes to establish appropriate regulatory standard, the policy worsens cost performance or deterioration of other environmental situations. This issue is further explained in Sect. 16.4 "Assessment of Environmental Policies."

In addition, this system requires the pollution prevention structure and the monitoring by the government. The relationship between setting appropriate standards and monitoring by the government and system building by the practitioners is shown in Fig. 16.1.

The environmental policy in Japan is explained in the following.

First, the goal of a desirable environment, i.e., the Environmental Quality Standards, is established based on the Basic Environment Law. There are regulatory laws in each environmental field to achieve such an Environmental Quality Standards: the Water Pollution Control Law, Air Pollution Control Law, Noise Regulation Law, Offensive Odor Control Law, Soil Contamination Countermeasures Act, etc. Each law stipulates a set of regulatory standards for companies. To comply with regulations, companies need to establish departments and personnel in the corporation to take pollution-abatement actions. Details of the regulation are prescribed in the Pollution Prevention Managers Act. The Act identifies the environmental knowledge and the expertise with pollution prevention techniques which personnel in charge of environmental issues should have. It also requests that personnel in charge of environmental matters must be certified by the national qualification examination. Such system is very meaningful to develop human resources in charge of pollution abatement at companies to maintain the high level of skill. Recently, besides this legal system, voluntary environmental management standards, such as ISO14001, have been popular, and increasing numbers of companies are voluntarily carrying out system building and receiving certification. Both obligatory system building by the Manager Act and voluntary system building to take environmental certification work hand in hand.

16.1.3 Economic Method: When Are Economic Incentives Effective?

Economic incentives literally induce environmental improvement by using economic benefit. From the economic viewpoint, maintaining the environmental quality can be achieved by internalizing social cost (external cost) which is generated along with economic activities. In principle, companies must appropriately include the cost of pollution abatement in the production cost. If not, the government must take measures, such as subsidies and tax, to compensate social cost for realizing environmental quality in practice. Therefore, it is desirable that the ideal tax is set at the level of meeting the whole external cost (Pigovian tax). However, in reality, the calculation of such a tax level is extremely difficult, and in addition, the design of the tax system and collection system has similar difficulties. If the tax system is not designed to match social systems, the tax burden imposed on those in the social stratum may become disproportionate. This is why the whole notion of tax tends to have low social tolerance despite its theoretical efficiency. Therefore, taxation is implemented in the form of internalizing some part of the necessary external costs rather than covering the entire social cost. This aims the formation of a market that external costs are partly reflected on the product price. The environment is improved by reducing the supply of goods which have a negative influence on the environment.

Moreover, a cost of monitoring the market condition is incurred in order to create an optimal environment by economic measure. The effectiveness is heavily dependent on each market situation and its system design.

Cases of economic measure include the ETS (emissions trading system) of the EU, carbon tax, sulfur oxide allowance trading in the USA, emission trade in China, green tax in China and Taiwan., and taxation on fuel in Japan.

16.1.4 Voluntary Actions

Under the condition where the capability of government and the market system is undeveloped, it is necessary for companies to take voluntary actions. Voluntary actions by companies include a preemptive type where companies voluntarily carry them out, an agreement type where companies and government conclude agreements, and a voluntary program type where companies go along with a government guidance scheme.

Responsible Care, adopted by the chemical industry, is a global preemptive type of voluntary action by companies. Led by the International Council of Chemical Associations (ICCA), Responsible Care aims at reducing the environmental burden of chemical substances. The agreement type includes the agreement on pollution prevention between local governments and companies in Japan. This agreement was implemented prior to settlement of pollution regulations by the government

and worked effectively in developing pollution-abatement measures with consideration for local circumstances. This type is effective as a measure against pollution problems in large cities, which are increasingly the area concentration of pollution. Major cities in China, where pollution became serious, conduct voluntary energy-saving measures led by local governments. Local governments conclude agreements with 100 selected companies as the 100-company project in local communities in addition to the 1,000-company project of the central government. Voluntary actions taken by companies can be seen worldwide, following schemes initiated by governments. Cases of program type include the greenhouse gas emissions reduction program in the USA and the action program to arrest global warming, waste reduction planning, and volatile organic compounds reduction plan in Japan. Large reductions have been achieved in each case, verifying the effectiveness of voluntary actions.

As for the incentive for companies to take voluntary action, social reputation is a strong incentive. The announcement effect is also considered to be the incentive for companies to induce voluntary actions. The announcement effect works in that the company gains positive social evaluation by taking an action and/or making a statement. In fact, it falls within public relations activity, and that means it is desirable to strengthen social appeal in order to increase this effect. Guidance by the government toward the establishment of voluntary actions has an announcement effect. In addition, a major announcement effect can be expected by mass media bestowal of awards to good companies. These methods can achieve a greater level of success by cooperation between government and business organizations. In this regard, the announcement effect works effectively in all policy method and does not apply only to voluntary actions.

16.1.5 Information Disclosure

Information disclosure is the policy to achieve environmental improvement by disclosing relevant information of the environment-related activities of companies. The history of this policy is parallel with the history of social responsibility. The increase of the awareness of corporate social responsibility has triggered the spread of this system. These days, companies are expected to take environment-friendly actions based on a corporate social responsibility in addition to complying with regulations. The most popular method in this policy is to make and disclose a company environmental report. Rating companies according to their environmental performances and disclosing the information are effective methods.

The systems that regularly disclose information on carcinogenic chemical substances (PRTR in Japan, TRI in the USA, and RTR in the EU) are typical government-led information disclosure systems. Four hundred sixty-two chemical substances are designated in Japan (Class 1 Designated Chemical Substances). Reduction is promoted by disclosing the amount of emission and transfer. The total amount of emission and transfer was 450,000 t (FY 2010). The incentive for

reduction is to grasp the accurate amount of toxins by each company, and thus, there is a considerable feeling of social pressure when emission levels are high compared with other rival companies. Therefore, this system will have little effect in a society where such social pressure is not felt by the companies.

16.1.6 Policy Mix

Various policy measures are applied for various environmental problems. Each policy measure has its characteristic advantage, and there is no single mighty policy that is applicable to all problems. An optimal environmental policy is one that differs according to the timeframe and local situation. For example, policy against pollution that causes a health hazard requires fast-acting property and also reliability of standard rather than cost-effectiveness. Direct regulation is necessary in such cases. Cost-effective measures are sought for actions toward creating a more desirable environment even though it does not adversely affect health immediately. For example, there is continuous dispute to select appropriate policy measures for climate change. Cost-effectiveness must be considered for such problems as climate change where the damage is uncertain in near term, but considered in long-term view, and a tremendous level of cost is incurred, if all abatement cost is added up as a total. Therefore, policy mix among direct regulation, economic method, and voluntary actions is assertively used.

In addition, in many cases, multiple policies instead of single policy were adopted for more effective countermeasures. A combination of multiple policies tends to redouble their effect to bring about a better result. Policy against volatile organic compounds in Japan requires different methods from those in traditional direct regulation against toxins to voluntary actions. It is, in fact, a combination of regulation for large companies and voluntary actions for small companies. In addition to the uncertainty regarding the impact of volatile organic compounds on the environment, though they are used in all industries, their emission forms are diverse, and uniform regulation is considered to exhibit poor cost performance. Therefore, voluntary actions have the potential for effective result through a reliable guideline by the government in such cases. On the other hand, uniform regulation is considered to be effective for large companies due to the large volume of emissions and their high social responsibility. Therefore, a complex policy of regulation and voluntary actions is conducted. Measures against air pollution by sulfur oxide in the USA are a combination of two policies: emission regulation and emissions trading. Emission regulation improves the whole air quality, while a system of reduction by more economical measures is introduced by emissions trading with the upper limit of emission from the viewpoint of preventing problems concerning a wider area such as acid rain. Another example is a policy mix of climate change levy and voluntary actions in the UK. The climate change levy in the UK was introduced in 2010. The tax is reduced or exempted for companies which voluntarily reduce emissions for 10 years, promoting more voluntary action.

As has been seen so far, combinations of optimal policies can change depending on the goal of environmental policies.

Complementary policies are also effective. For example, financial assistance for companies would be even if direct regulation is the optimal policy. In Japan, low interest loans and tax deduction for introducing pollution-abatement equipment have been conducted along with the development of pollution control laws in the 1960s. These are effective means for policy implementation.

16.2 Effectiveness of Economic Measures: Theoretical Analysis

Economic measures are theoretically efficient policy to pursue the emission reduction. However, several conditions are prerequisite for their effective function. Such conditions are examined here.

First, let's consider the condition for an effective pricing policy, that is, taxation and subsidiary. The key is the quantitative change of demand responding to a change in price. Observe this in Fig. 16.2. When the marginal benefit curve is an MBb, the reduction effect brought about by tax is b-b′, while an MBa curve proves the emission reduction effect of a-a′. The MBa case is one for low price elasticity that is often observed in case of necessity goods. Pricing policy has limited effect in such cases. For example, it can be observed that energy taxation is effective in developed countries, but is not so effective in developing countries. This is because a certain amount of energy demand can be reduced among with a considerable degree of energy usage in developed countries, while major energy demand is nearly a daily use as necessity goods in developing countries. As a result, demand did not change even if price would change. Taxation has such problems of difficulty in setting levels where no damage is caused, regressive tax, and limited effect when there are no alternatives (Turner et al. 1993).

Next, consider the conditions where emissions trading works effectively. This requires a perfect market, that is, the market has free and open competition and the participating business operators are able to compete without any restriction.

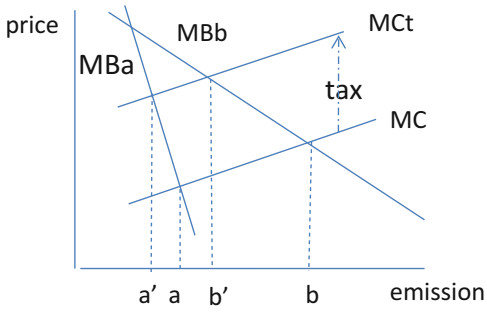

Fig. 16.2 Effect of pricing policy

However in the real world, markets are not perfect. Some markets are monopolized or oligopolistic by a small number of companies. Some markets have large companies who may enjoy a dominant position against other companies, and it may be able to control the prices. For this reason, policymakers are expected to intervene in markets to exclude dominance or secure transparency by distributing information in the market.

Now, let us consider which economic measure is more effective, pricing policy or quantitative target.

Wiseman compared these in a simple way. Under a condition where the effect of emission reduction is uncertain and the marginal cost curve is steeper than the marginal benefit curve of emission, quantitative target is more effective. In the opposite situation, tax policy is preferred when the marginal benefit curve is steeper than marginal cost curve. Observe this in Fig. 16.3. Consider a condition where reduction effect, that is, benefit, is uncertain. Suppose the regulatory agency misunderstand marginal benefit and acknowledged the false curve (MBfalse) as a preferred one instead of the true curve (MBtrue). In such a case, the regulatory agency would establish a false tax instead of a true tax. The tax rate which was correctly at c is moved to wrong point a; accordingly, the benefit area, abc, is lost, which is the social loss accompanying this misunderstanding. On the other hand, in quantitative target, d is acknowledged as the intersection point of MC and MB, instead of true point, c, resulting in moving the quantitative target from E to E′, and an additional cost area, cde, is created. In the upper part of Fig. 16.3, benefit area,

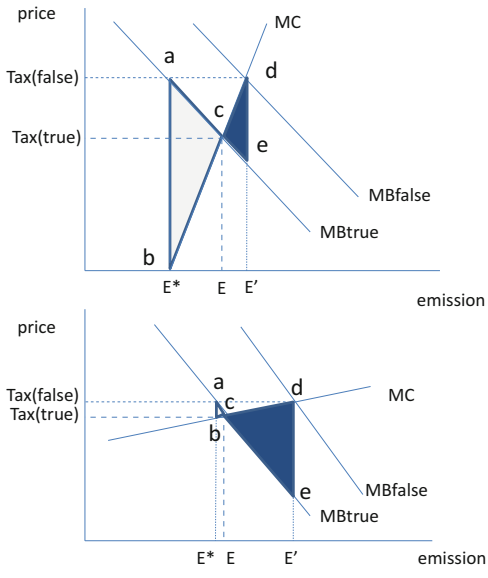

Fig. 16.3 Numerical goals and pricing policy

abc, is larger than loss area, cde; therefore, the quantitative target has less social loss than tax policy. The lower part of Fig. 16.3 shows the reverse case.

To compare pricing policy and target policy, let us examine two systems of renewable energy promotion, RPS (renewable portfolio standard, setting an obligatory amount of introduction and trading) and FIT (feed-in tariff, purchasing at fixed prices). In the RPS system, a target of renewable energy is set, and accordingly, electricity companies are obliged to introduce renewable energy. Renewable energy can be introduced over the whole electricity industry, so trading obligatory amounts among companies is acceptable for minimizing cost. On the other hand, FIT is a system where the purchasing price of renewable energy is set for each type of renewable energy to promote introduction.

A quantitative renewable energy target is set in the RPS system, so the amount to be introduced in the future can be predicted, but there is no guarantee of the purchase price for the generators that bring the financial risk in their business plans. On the other hand, there is a guarantee of purchasing at a fixed price in the FIT system, so it is easier for generators to build business plans, but there is a possibility of the cost remaining at a higher level than rational cost that burdens the consumers. Figure 16.4 shows how the cost reduction effect belongs to these two stakeholders. Here, suppose the marginal cost curve MC was changed to MC′ by price reduction. In such a case, the price is changed from P to P′ in RPS. The benefit accruing to generators is reduced by the area of PP'ZX. On the other hand, in FIT, the introduced amount is changed from Q to Q′ because P is fixed. As a result, the benefit accruing to generators is increased by XYP*. Meanwhile, the cost to consumers increases by the same amount.

There have been lots of discussions on the comparable effectiveness of RPS and FIT. For example, renewable energy is expected to increase by reduction of costs by technology development. Profit is distributed among generators in FIT, so FIT encourages more technology development. However, we can also say that RPS encourages technology development because it promotes competition. In either case, it should be noted that the superiority of one system varies, depending on the circumstances of the local community and business environment.

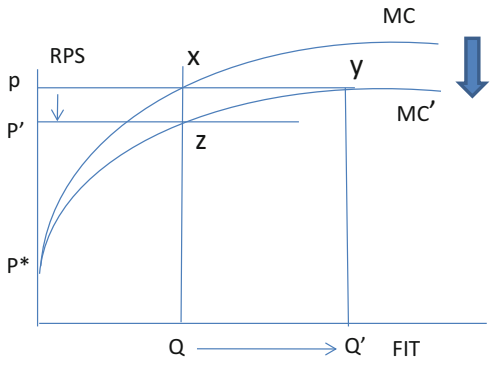

Fig. 16.4 Comparison between RPS and FIT (Source: Menanteau et al. (2003), modified)

16.3 Compensation Policy for Social Damage

As human activities and industrial production have expanded, damage to the environment and harm to people's health are inevitably brought out. A lot of policies are adopted to minimize such damage or harm; at the same time, we have to consider the policies to deal with compensation of social damage. The issue of compensation is who will be responsible and how to compensate the victims when they happened.

The Coase theorem teaches that compensation concerning damage to the environment is smoothly implemented by transactions of compensation money between polluters and victims. However, in reality, it is difficult to implement compensation by direct transaction between polluters and victims. This is because scientific evidences are necessary for establishing the source of the damage and a causal relationship between polluter and damage which is required for compensation responsibility, and a high amount of costs, namely, transaction cost, is inevitably incurred by victims. Coase theorem assumes that transaction cost is zero.

16.3.1 Legal Aspect of Compensation

A legal framework concerning damage compensation becomes necessary in order to decrease transaction cost and allow smooth implementation of compensation for victim. Pollution-Related Health Damage Compensation Act is established in Japan in 1973. The payment system of compensation by polluting companies (a financial burden on companies responsible for a wide range of air pollution is imposed as a levy) is established (Fig. 16.5). Aid for victims based on the Pollution-Related Health Damage Compensation Act is implemented in two categories. Category A is the case where the company causing the damage can be definitely specified, such as the case of Minamata disease (in this case, the polluter is Chisso Corporation) and itai-itai disease (in this case, the polluter is Mitsui Mining and Smelting Corporation). In this case, the polluter company primarily carries out their responsibilities of the compensation. The other is the case where the polluter companies are numerous, and a complex mix of pollutants from those companies causes social damage (category B). In this case, polluter companies discharge their responsibility through contribution to compensation fund.

Figure 16.5 illustrates a compensation scheme when payment is made by the polluters whose causal relationship to the victims is recognized. Next, let us see the case where health damage is actually happening and the victims have a dire need for aid, but there is no clear evidence of causal relationship between polluters and victim. In this case, in viewpoint of social welfare, aid fund was established jointly by governments and related companies. For example, prior to the establishment of the Pollution-Related Health Damage Compensation Act in 1973, the Act on Special Measures Concerning the Relief of Pollution-Related Patient was

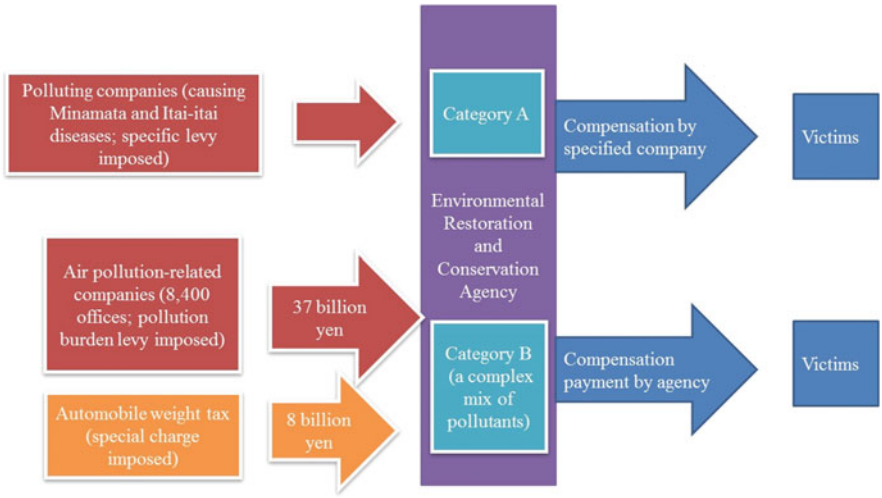

Fig. 16.5 Payment for pollution victims (scheme of the Pollution-Related Health Damage Compensation Act)

established in 1969 by funding from governmental contributions and business donation, providing aid for the victims. These aid systems are effective when related companies are numerous and a causal relationship is unclear. The case of Act on Asbestos Health Damage Relief falls in this category. Aid money is provided to the patients of respiratory diseases due to asbestos (victims of asbestos) as a whole based on this Act. This aid system was adopted because asbestos was used in a very large number of businesses sectors and it was difficult for the victims to make clear causal relationship with which occasion had affected their health.

The following case was pointed out by Yokemoto (2007) as an example of difficulty in applying the concept of polluters providing compensation. (1) The large amount of necessary relief cost is generated by continuing environmental pollution, exceeding the payment capability of the polluters, (2) expansion of industrial activity generated great many pollution-related sectors, and (3) cases of accumulated pollution where polluters cannot be specified. (1) is realized among the cases related to the Pollution-Related Health Damage Compensation Act. For example, Chisso Corporation which caused Minamata disease received assistance from the national government and local governments due to lack of company's payment capability. The same situation can be observed in the Tokyo Electric Power Company in the case of nuclear power plant accident. The compensation cost is over the payment capability of Tokyo Electric Power Co. Asbestos pollution case falls in the cases of (2) and (3).

At last, let us consider the range of responsible companies in charge of damage compensation. When a company directly causes harm to people and/or the environment, such company should bear responsibility (Polluter Pays Principle). However, the definition of polluters is becoming unclear. Let us consider environmental

responsibility in automobile pollution. A direct source of automobile pollution is generated from cars. So any driver who drives a car is expected to be a polluter. However, compensation money cannot be collected from individual drivers. Therefore, part of the automobile weight tax paid by the owners of automobiles is allocated to the fund for pollution damage. What about the responsibility of other stakeholders besides drivers? Automobile pollution occurs around the busy road. The liability for concentrating automobile traffic in the specific road is recognized to be with those entities which build the road (national government, local governments, and highway companies). The social responsibility of automobile manufacturers was also recognized. As is seen here, the range of responsibility of companies has been wider in recent years. This indicates that corporate social responsibility in addition to the legal responsibility is imposed as company's responsibility in the environmental damage.

16.3.2 Economic Aspect of Compensation

Compensation for social damage was explained as internalizing social cost accompanying economic activities in economic theory. Coase explained that environmental damage can be compensated through direct transaction between victims and polluters; however, it is difficult to transact social cost from victims to polluter, due to the difficulty of evaluating social cost. Therefore, victims are generated when such social cost is burden on the part of certain people without internalizing cost. Thus, Kapp said evaluation of social cost of damage was outside the reach of scientific research and responsible for political decision.

16.4 Assessment of Environmental Policies

In the previous chapter, it was explained that there are many policy measures to deal with environmental problems. Then, what criteria shall be applied to choose optimal environmental policies? Policy analysis and assessment method to define the criteria have been developed. Nowadays, analysis and assessment of policies are widely used in an evaluation of government policy. For example, it is mandatory in Japan to conduct policy assessment to evaluate the effectiveness of each policy in all the policies to be introduced. In the USA, assessment of effectiveness of any regulation is requested before introducing a new regulation.

There are numerous methods in policy analysis and assessment. Among them, we will start with cost-benefit analysis first. Here, the cost and benefit of designated policy are compared, and accordingly, the effectiveness of the policy is evaluated. Second, cost-effectiveness analysis is the method to assess the effectiveness of each policy, and thereby the priority of policy set for a certain problem is assessed. Third, risk analysis is used to assess the environmental damage by concept of risks. The

risks for the environment are the uncertainty of a problem caused by pollution. These scientific assessment tools are inevitable to analyze policy effect.

16.4.1 Cost-Benefit Analysis: Case Study of the Policy

Cost and benefit must be considered when introducing environmental regulation. Let's start by the definition of cost and benefit. Cost can be described as compensation cost when environmental destruction is expected or occurred. It can also be described as an alternative cost to endure the environmental deterioration. This is equal to WTA (willingness to accept). Benefit is the value that people gain by maintaining or improving the environment. This is the total of value what individuals consider, so it is a total of payment that individuals are willing to pay. This is shown as WTP (willingness to pay).

Cost-benefit analysis can be thought of as a comparison of cost and benefit. Then, in which policy situation cost-benefit analysis can be applied effectively? The application of policy assessment upon introducing regulations was stipulated by the United States Executive Order in 1981, and it became mandatory to prove that the benefit would surpass cost by introduction of new regulation. This Executive Order was succeeded in the Executive Order in 1993. In the EU, EU Directive in 1996 prescribed cost-benefit analysis of regulations upon introducing air pollution regulations.

However, in fact, it is not easy to assess benefit to the environment. Various problems have been pointed out when such assessment is applied in environmental policies (Kolstad 2011). For example, a question is brought up if WTP and WTA can be assessed accurately in a situation with people only having access to limited information. This problem particularly becomes obvious in case to assess value of nature and biodiversity, or environmental destruction risk, as well as the value of human health. Due to the difficulty in quantifying benefit, assessment measures were changed from quantitative comparison to confirmation of gaining legitimate benefit in the Executive Order in 1993. Furthermore, when those who bear the cost and those who receive the benefit are different, there is a question of how to gain consensus between them. In addition, there is a time problem when there is a time discrepancy between beneficiary and victims. Such a gap in time can occur in major environmental problems. Introducing a discount rate is a tool that will provide an answer. The discount rate will have a key role on evaluation cost and benefit. In other words, cost-benefit ratio can change according to the discount rate.

The discount rate is explained, using formulas (16.1) and (16.2). When there is no discount rate, the ratio of cost and benefit is shown as C/B. Suppose there is a gap of t years between benefit and cost, and annual interest rate is r, the current benefit will take a form of (16.1) in t years. Here, the value in t years is modified to the current value of (16.2).

$$B(1+r)^t \tag{16.1}$$

$$B/(1+r)^t \tag{16.2}$$

How can the discount rate affect the evaluation of problems?

This can be shown by a simple example. For example, ask the question of which is preferred, receiving 1,000 yen today or in 1 year. Most of the people will answer "today." It is because value will decrease in 1 year by the portion of the interest rate. Then what if 1,100 yen can be received in 1 year? What about 1,200 yen? When the amount of receiving money in 1 year is raised, gradually, more and more people will want to receive in 1 year. Those who will be satisfied with 1,100 yen in 1 year understand the discount rate to be 10 %, while those who will be satisfied with 1,200 yen understand the discount rate to be 20 %. That is to say, individual action can change depending on the discount rate which leads to different future values. Whatever the case, it should be noted that overestimation of the discount rate will impose a burden of cost on the future generation (Turner et al. 1993).

16.4.2 Cost-Effectiveness Analysis: Comparison Between Multiple Policies

Cost-effectiveness analysis is used for prioritizing policies. Cost-effectiveness analysis is useful when considering policy options.

Needless to say, the policy measure with the lowest cost should be selected in order to achieve a goal economically. Let's consider the case of carcinogenic substance regulation as this analysis. In this case, the mortality rate of cancer is considered as a cost. The risk of developing cancer is shown as risk of death per capita. The risk is calculated by how much the risk of cancer develops by the exposure to toxins. Additionally, the cost for implementing a measure which can reduce the risks is calculated, and the ratio of cost-effectiveness is calculated. Table 16.2 shows a comparison of the cost-effectiveness of various measures taken in the USA.

Table 16.2 Cost-effectiveness analysis

	Deaths per 1 million people exposed	Cost to avoid 1 death (million USD)
Trihalomethane in drinking water	420	0.2
Benzene fugitive emissions	1470	3.4
Asbestos occupational exposure	3015	8.3
Benzene occupational exposure	39,600	8.9

Source: The Council on Environmental Quality (1991), Turner et al. (1993) modified

16.4.3 Risk Analysis

Risk analysis is a tool to quantitatively measure the predicted impact of a certain environmental problem. The end of environmental policy is improving environmental problems to secure safety for people's health and environmental preservation. Quantitative analyses are necessary to set the goals of safety and environmental preservation. Risk analysis compares and sets priority among relative safety and environmental issues. Uncertainty exists in assessing environmental policy because the environment belongs to the whole nature system. What we can say is that risk analysis measures the degree of this uncertainty. This is represented by the degree of uncertainty of the impact (damage) on the environment and probability of exposure. Without accuracy in this risk analysis, accurate evaluation of environmental policy may not be conducted.

This exact example of risk analysis was applied to set the emission standard for benzene in Japan. The carcinogenicity in benzene is a confirmed fact, but it is not an acutely toxic substance with a threshold, and it is widely used under rigorous regulations. The regulatory value of benzene was estimated as a mortality risk of 10^{-6}. This is the risk of carcinogenicity, and regulation based on this method has been applied to numerous substances ever since.

As is explained here, accurate risk assessment enables choosing an optimal policy with minimum risk. On the other hand, unsound risk assessment may rather lead to environmental deterioration. There was such a case in Peru (Nakanishi 2010). Chlorine sterilization in tap water is known to cause trihalomethane, a known carcinogen. Therefore, the US EPA suspended chlorine sterilization in tap water. The Peruvian government followed the example and ran a similar policy. As a result, Peruvian tap water went without sterilization, which contributed to an outbreak of cholera. It is said that this cholera epidemic killed approx. 7,000. This incident came about by not comparing the carcinogenic risk associated with trihalomethane and the mortality risk of a cholera epidemic. This happened in Peru, but similar incidents have been happening all over the world. The use of ethylene dibromides (EDBs) as a disinfectant is banned in the USA, and its carcinogenic risk was 0.0004 %, while the carcinogenic risk of molds on grain is usually 0.03 %, which can go as high as 1 % in an environment where mold is prone to growth. This poses the question of which is more beneficial for human health – banning EDBs or allowing its use? (Nakanishi 2010).

Next, let us see a case of risk analysis in Japan. Measures against dioxin in Japan began when dioxin was detected in the soil around incinerators. As a result, measures against dioxin progressed focusing mainly on measures for incinerators, that is, by raising the temperature of incineration. Of course, the measure for incinerators is highly effective to reduce dioxin exposure. Measures against dioxin at incinerators are divided into two stages, namely, first measures (emergency measures) and second measures (permanent measures). The cost of extending life expectancy by 1 year in emergency measures is 7.9 million yen/capita/year, while that in permanent measures is 150 million yen. We can see that the

cost-effectiveness of permanent measures is very much lower than that of emergency measures.

16.4.4 Risk Communication

Cost-benefit analysis is used for selecting policy. So it is a social decision tool making a regulatory framework by quantitative assessment as well as a scientific policy assessment. However, cost-benefit analysis, cost-effectiveness analysis, and risk analysis which we have discussed about are not complete by themselves as a social decision tool. Even if such scientific assessment method plays a key role, the trust of the general public in those assessments is prerequisite. In the real world, the amount of information, people have access to, is limited, and as a result, there is a gap between scientific assessment (objective risk) and public awareness (subjective risk) (Fig. 16.6). Kahneman showed in his study of psychology that the awareness and behavior of people are different; that is also different from what is based on rational theory. For example, risk awareness of people tends to assess continuous risks into a lower risk category but large-scale risks into a higher risk category. Risk management is required to fill up such a gap between public awareness and scientific assessment. Accurate analysis and media for transmission of information are the two pillars of risk management. The information dissemination is called risk communication. Without risk communication, accurate risk information is not shared, and accurate policy is not made.

When this trust is lacking, what kind of problem will happen in policy? The safety of mad cow disease is a case where the information announced by researchers and government suffered a loss of credibility. In this case, the

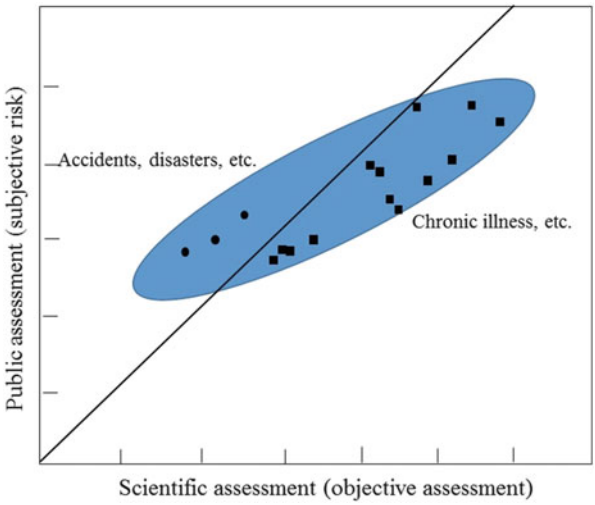

Fig. 16.6 Objective risk and subjective risk (Source: Slovic et al. (1979), Kolstad (2011) modified)

credibility of policies is lost by the delay in appropriate measures and information disclosure, resulting in a demand for unnecessary measures beyond the appropriate risk level.

16.5 Application of Policy Assessment for Some Problems

Policy assessment is useful for drawing up the prescription for the various environmental problems. However, some environmental problems require additional point of attention. Global environmental problems and establishment of a recycle-based society are the most common environmental issues but are hard to deal with. Let's examine those here for the example of policy assessment.

16.5.1 Global Environmental Problems

Some environmental issues are given attention on a global scale. The ozone layer destruction problem and the climate change problem are the two biggest problems in the viewpoint of global issues. All countries must cooperate to tackle global environmental problems where no global government exists. However, there is difficulty for countries to tackle the problem together. In the ozone problem, the victims (beneficiary) and cost-paying countries are almost the same. On the other hand in the latter problem, the victims and payers are different, which makes the climate change problem more difficult to reach appropriate policy agreement. In addition, cost-effectiveness in the ozone layer problem is 1:11, while it is 1:0.5 in the climate change problem (Nordhaus and Boyer 2000). We can see that the solution for the ozone layer destruction problem is going smoothly, while the solution for the climate change problem is anything but simple.

There is another difficult issue in the climate change problem; that is the gap between the generation bearing the cost of measures and the generation receiving the benefit. Traditional cost-effectiveness analysis is made on the premise that cost and benefit occur simultaneously. However, global environmental problems are not so easy. In particular, the climate change problem will require 100–300 years to stabilize the concentration of carbon dioxide, several hundred years to stabilize the temperature, and another several hundred years at least to stabilize the sea level. Even if the current generation takes appropriate measures, it will take a very long time for their effects to appear. Therefore, we cannot compare the measures (cost) and profit (benefit) unless we convert them at the same point in time. The discount rate is required to deal with the issue.

The discount rate brings about major differences in ideas for climate change measures. Sir Stern analyzed policy of climate change at the request of the UK government and compiled the report, so-called Stern Review (Stern 2006). According to the conclusion of this Stern Review, early actions for climate change

lower the cost and increase the benefit. Stern assessed the cost-benefit ratio at 1:10. This figure is much higher than the one suggested by Nordhaus. Why such a difference? Stern uses a discount rate of 0.001, while Nordhaus uses the rather hefty 0.015. That is, the difference between the current value and future value is smaller in the figure of Stern than the one of Nordhaus. This indicates that the future value is higher evaluated in Stern Review. As a result, Stern concluded that emission control would rise to 53 % by 2015, while Nordhaus concluded that it would rise to merely 15 %.

Another important point in a dispute of climate change problem is the fairness of cost burden among countries. Let's consider this issue by viewpoint of nature of climate change. The climate change problem was prescribed by the United Nations Framework Convention on Climate Change in 1992 and the Kyoto Protocol in 1997. Constructing a new framework of climate change targeting at 2015 was agreed on at COP17 in Durban in 2011, and it was decided at COP19 in Warsaw in 2013 that new framework includes three points; namely, all the nations should join; each nation should voluntarily make their contributions toward reduction of GHG; and a review scheme should be established to confirm the fairness and accuracy of contributions. Policy and measure of reduction activity in developing countries is one of the controversial issues in the next framework. Developing countries are exempted from obligation in the Kyoto Protocol, but are requested to join in the next framework. The comparison of the marginal abatement cost of measures in various countries shows us that the cost-effectiveness of measures is higher in developing countries than in developed countries. Therefore, taking more measures in developing countries is economically rational when only the marginal abatement cost is considered. However, the priority of actions for the climate change is not solely judged by the marginal abatement cost. There is a viewpoint that social damage by climate change is caused by accumulated GHG emissions in the past. If this idea is adopted, the cost of measures in each country should be a fair burden in accordance with their past contribution to pollution, not merely cost-effectiveness of current measures. This is a complex case of how to allocate the responsibility when an accumulated environmental damage occurs (or is expected to occur).

16.5.2 Waste and Recycling

Next, let's consider the waste and recycling issue. Waste and recycling seem to be the local issues; however, waste is the common problem occurring all over the world. In addition, waste is transferred beyond the border. So, reducing waste and promoting recycling is one of the major issues in the global environmental context. Recycling issue became serious worldwide that the economic development as citizen life becomes affluent with home products and the large amount of waste fill in the society. It is desirable to reduce the amount of waste and promote recycling toward a recycle-based society. In Japan, waste is divided into two

categories: general waste consisting of waste produced from households and small and middle enterprises that is collected and treated by local municipalities and industrial waste which is produced and treated by the big companies. The amount of general waste is 43.39 million tons (2011) with a recycling rate of 20 %, while industrial waste amounts to 385.99 million tons with a recycling rate of 53 %. Industrial waste has a higher amount and higher recycling rate than general waste. This is because general waste is a mixture of diverse kinds of waste, which make separation for recycling difficult.

Regarding to a policy measures toward a recycle-based society, various policies are examined. By law, a certain rate of recycling in waste is set for obligation of big companies producing a large volume of waste. There are several specific laws regulating certain sectors: recycling for home appliances by the Law for the Recycling of Specified Kinds of Home Appliances, automobiles by the Law for the Recycling of End-of-Life Vehicles, waste generated during construction by the Construction Material Recycling Law, and waste food by the Law for Promotion of Recycling and Related Activities for Treatment of Cyclical Food Resources.

In the case of general waste where a great many parties are involved in producing waste, there is difficulty in enforcing people by regulatory measures. Instead, economic measure is more applicable. When the recycling cost becomes lower than the incineration cost, it should encourage recycling. However, in reality, incineration cost is lower; as a result, the recycling rate remains low.

The reason for the slow spreading of general waste recycling is attributed to the fact that collection and treatment of general waste are considered to be the responsibility of local governments where the market mechanism is distorted. As a result, the incineration fee charged by municipalities is far lower than the recycling fee. In other words, official subsidiary is provided for incineration services which discourages recycling. It means that the treatment fee at incinerators does not reflect the actual cost, and municipalities offer incineration by fees not covering the cost. In the future, such a situation will need to be improved so that recycling should be handled according to the market mechanism.

Furthermore, it is pointed out that benefit is not accurately assessed in cost-benefit assessment of recycling. Recycling does not only reduce the incineration cost but also offers a wide range of benefits such as saving natural resources by recycling, reducing the environmental burden, and returning profit to the local community by the "locally produced, locally consumed" system. Such an assessment of policy including the value of social benefit is not well conducted. The lack of assessing social benefit is one of the reasons for the underperformance of recycling.

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