자원 · 환경경제연구 제 27 권 제 4 호
Environmental and Resource Economics Review
Volume 27, Number 4, December 2018 : pp. 725~743
DOI: https://doi.org/10.15266/KEREA.2018.27.4.725

Environmental Policy and the Political Economy of Energy Subsidies[†]

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ABSTRACT : Industrial groups (representing the polluters) and environmental non-governmental organizations (representing the victims) respond differently to various environmental policy instruments. As the affected group's power is large either politically or economically, it is unlikely that a single instrument will be actually selected despite being effective or efficient because of the high political costs associated with it. In this paper, we focus on the political role that energy subsidies play in creating a compromise between energy consuming polluters and victims of pollution. The use of a Dolbear (1967)'s triangle Edgeworth box model makes it possible to examine how policy selection affects the income distribution and welfare levels of two groups. The effects of a single policy instrument of either direct regulation or tax are compared with those of a policy mix that includes energy subsidies. We found that the addition of energy subsidies would increase the chance of compromise between polluters and victims.

Keywords : Polluters/Victims, Political Power, Energy Subsidies, Triangle Edgeworth Box

JEL 분류 : D62, Q58

Received: December 8, 2017. Revised: April 6, 2018. Accepted: June 27, 2018.

[†] We are grateful to Professor T. Morotomi at Kyoto University and Professor H. Kibune at Nagoyagakuin University for their valuable comments; This research was supported by Korea Electric Power Corporation (Grant number: R18XA01) and a part of the project titled 'Manpower training program for ocean energy', funded by the Ministry of Oceans and Fisheries, Korea (Grant number: 20140505).

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환경정책과 에너지보조금의 정치경제

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요 약 : 어느 한 집단이 정치적, 혹은 경제적으로 영향력이 클 경우 정책수단이 비록 효과적 혹은 효율적이라도 선택될 가능성은 현실적으로 낮다. 왜냐하면 그 과정에서 높은 정치적 비용이 수반되기 때문이다. 본 논문에서는 에너지를 소비하는 공해발생자와 공해피해자 간 타협을 도출하는 데 있어서 에너지보조금의 정치적 역할을 분석한다. Dolbear(1967)의 삼각 에즈워즈 상자 모형을 이용하여 정책선택이 두 집단의 소득분배와 후생수준에 미치는 영향을 중심으로 직접규제와 조세의 단일 정책수단 도입 효과와 에너지보조금을 포함한 정책조합의 효과를 비교한다. 분석결과, 에너지보조금이 사용됨으로써 공해발생자와 피해자 간의 타협 가능성은 증가하는 것으로 나타났다.

주제어 : 공해가해자/피해자, 정치파워, 에너지보조금, 삼각 에즈워즈 상자

접수일(2017년 12월 8일), 수정일(2018년 4월 6일), 게재확정일(2018년 6월 27일)

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I. Introduction

Most studies of public choice involving environmental policy take a theoretical approach, in which policy instruments are assessed in terms of their efficiency in attaining the target level of environmental quality. Since Pigou (1920) proposed using taxation of polluting activities as a way to correct negative externalities, market-incentive instruments (charges/taxes) have been considered superior to direct regulation (setting environmental standards) in achieving environmental goals with minimum social costs (Baumol, Oates, and Blackman, 1979; Baumol and Oates, 1988; OECD, 2010).

However, choices are often not made this way during the policy-making process. Some policy instruments have an unfavorable impact on specific interest groups, leading to the groups' resistance to the policy's implementation. If the affected group is politically, economically powerful, policy makers are unlikely to use the most economically efficient instruments. Turner, Pearce, and Bateman (1993) find that governmental authorities and industry both favor command and control approaches to environmental policy. Existing firms tend to pursue 'rent-seeking behavior', which involves persuading regulators to raise barriers to entry and to provide subsidies in order to meet environmental standards.[1] Firms with more market power are able to exercise more political power. Authorities tend to favor command and control instruments because not only less information is required to design environmental policies, but also the degree of acceptance is higher politically and administratively (Young, 1992).

Several studies examine political influences on environmental policy choice. Buchanan and Tullok (1975) conclude that direct regulations have an effect similar to forming a cartel; the regulations prevent new entrants from entering the market. Hahn (1989, 1990) suggests that authorities will select an environmental policy that

1) Despite belonging to the category of economic-incentive instruments, subsidies may not be relevant because they violate the PPP (Polluter Pays Principle). Yet, in most cases, subsidies have been used with direct regulation to offer a stimulus for industry to invest in pollution abatement facilities (Lee, 2004).

maximizes the weighted average value of the preference functions of the polluter group and the environmental protection group. Keohane, Revesz, and Stavins (1999) use a model that indicates that environmental policies are chosen where the supply and demand are in equilibrium in the political market.

As demonstrated in the Coase (1960) theorem, the success of specific policy instruments depends on whether agreement can be reached between polluters and victims. In this paper, we focus on the political role that energy subsidies play in creating a compromise between polluters and victims, a topic that previous studies have not dealt with sufficiently. We examine the extent to which policy selection will affect social welfare and income distribution between polluters and victims, and we compare the effects of a single policy instrument, such as direct regulation or energy taxation, with a policy mix that includes energy subsidies.

This paper is organized as follows. The environmental policy choice by major countries is reviewed in section II and the analytical framework is described in section III. The political economy of energy subsidies is discussed in section IV. Section V contains concluding remarks.

II. Environmental Policy Choice in Selected Countries

Not surprisingly, the polluters and victims respond differently to different policy instruments. In general, the polluters do not favor taxes, while victims do not favor environmental subsidies financed by taxes. The effects of direct regulations are somewhat complicated. In general, the more stringent the direct regulation is, the stronger polluters' resistance is. The choice of policy instruments is highly influenced by the political power of each interest group. In the real world, as a result of competing power interests of these groups, several instruments are often adopted simultaneously.

In Japan, industrial groups (representing the polluters) have had a stronger political influence on environmental policy instruments than environmental non-governmental

organizations (NGOs representing the victims) have had (Lee, 2014, pp.1-18). The environmental NGOs have had not many chances to take part in decision making on major policies because they lacked both funds and specialists. Meanwhile, industrial groups maintained a close relationship with the government and the ruling party.[2] The industrial interests were protected in exchange for donations to the political parties. Moreover, following what they call *administrative guidance*, the central and local governments took pollution prevention measures in consultation with the industrial groups. Hamamoto (1998, 2008) discusses the role of Japanese administrations in the process of environmental policy decision making. As a result, the policy instrument that industrial groups opposed most vociferously−taxation−was hardly ever used in Japan.

Serious pollution-related epidemics, such as the *Minamata* and *Itaiitai* outbreaks, put pressure on the Japanese government and industrial groups to implement more stringent pollution prevention measures. The government chose strict direct regulations, including total emission load control that had an immediate effect on drastically reducing industrial pollution. On the other hand, to ease the financial burden on industrial groups that were required, as a result of the regulations, to invest in pollution-control equipment, the government provided subsidies, such as government-subsidized loans (soft loans) and special tax exemption or breaks.

In the United States, there are many environmental NGOs whose political power is much stronger than NGOs in Japan. U.S. environmental NGOs in the U.S.A. actively participate in and influence the policy decision-making process by lobbying or through litigation.[3] Nonetheless, U.S. industrial groups engage in similar activities and form a strong counterpart to the NGOs, particularly in the petroleum, electric power, steel, and automobile industries. These industrial groups systematically resist the introduction of a carbon-base tax by organizing the “Earth Climate Union”. In some cases, they can even

2) Politicians, bureaucrats, and industrial groups have been called *The Triangle of Powers*.

3) The number of full time lobbyists employed by environmental NGOs has increased substantially: only two lobbyists in 1965, 40 in 1975, and 88 in 1985 (Dunlap and Mertig, 1992).

exert some control directly on environmental NGOs through donating money to them.

As in Japan, the power of industrial groups makes it difficult for the U.S. government to choose pollution-related taxes as an environmental policy instrument. In the field of wild life protection programs, which is less likely to pit environmental interests against industrial interests, strict regulation is often introduced. However, in the field of industrial pollution control, such as reducing SOx, NOx, and CO_2 emissions, where industrial interests are directly involved, environmental policy tends to be a compromise between direct regulation and emission trading lenient to industrial circle.

Since the early 2000s, Japanese government has promoted the introduction of carbon tax by organizing the climate change task force. However, it faced strong opposition from industrial groups including Japan Business Federation. There has been an increase in the public opinion on the supply expansion of low-carbon energy (led mainly by the environmental NGO) since 2011 Fukushima nuclear disaster. It was not until October of 2012 that the carbon tax was implemented. The great part of carbon tax revenues was used to subsidize firms' energy efficiency investment to negotiate with the opposition.[4)]

In Europe, environmental movements, often led by environmental NGOs, have a long history and strong support among the citizenry.[5)] European environmental NGOs have strengthened their political influence by developing relationship with, and sometimes funding, political parties. Especially since the beginning of the green party movement, the political influence of environmental NGOs has become stronger, leading to the institution of environmental taxes, like the carbon tax.[6)] The political influence of the industrial groups in Europe, however, cannot be rated as weak. They actively opposed the European Union's adoption of the carbon tax at the beginning of the 1990s. Their influence was felt in the implementation of the carbon tax, as other industrial-related

4) In 2016, the carbon tax rate was set at ¥289 per one ton of CO_2 and tax revenue was estimated to be ¥260 billion.

5) For instance, the *Friend of Nature* organization in Denmark, established in 1911, has 270,000 members with 210 local organizations, equivalent to 12% of all Danish household members.

6) Opschoor (1986) finds that industrial groups favor direct regulations, while environmental NGOs favor taxes in the Netherlands.

taxes, such as the energy tax, were reduced and subsidies were offered under the principle of *revenue neutrality* (Green Fiscal Commission, 2009).[7] As a result, the carbon tax did not create an excessive burden for the European industrial groups.

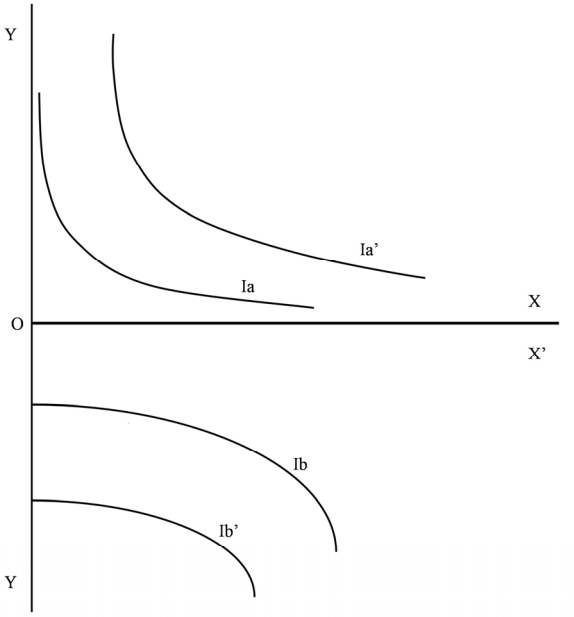
III. Analytical Framework

First of all, consider a case in which the externality of diseconomy is generated between two utility-maximizing individuals: A and B. Individual A consumes two goods, energy (X) and other goods (Y), which produces pollution (X') in proportion to the consumption of energy. Individual B consumes good Y only but is still affected by pollution. We assume that the authority is responsible for controlling this externality through policy instruments. As shown in Figure 1, the indifference curves of A and B can be depicted in the upper and lower sides labeled as Ia and Ib, respectively.[8] Note that pollution corresponds to energy in the proportion of one-to-one and Ib' indicates a higher utility than Ib. Presuming that more Y will be traded for abatement of a unit of X' in comparison with X, B's indifference curves are steeper than those of A.

7) In 1998, for example, the "red-green" German government undertook the revenue-neutral green tax reform, which included an increase in the existing energy tax rates and the introduction of new electricity tax. These taxes were not imposed on the basis of CO_2 emissions, but energy consumption. In 2014, the gasoline tax rate, in CO_2 terms, was equivalent to approximately €67 per one ton of CO_2. Total tax revenue amounted to approximately €19.6 billion; 90% of tax revenue was used to ease the burden of pension on firms. This policy mix combining energy tax and subsidy would make it possible for interested parties to negotiate with each other.

8) This is the way Dolbear (1967) and Oyama (1998) introduce the indifference curves of two individuals involved in negative externalities. Dolbear (1967) demonstrates that a proper combination of per-unit tax and lump-sum subsidies makes it possible to achieve the Pareto optimum.

〈Figure 1〉 Indifference curves of A and B



In order to examine the effect of environmental policy instruments on income distribution and welfare (or utility), we use Dolbear (1967)'s triangle Edgeworth box model, as presented in Figure 2. B's indifference curves are placed on A's goods bundle space in Figure 1 and B's origin is located at the intersection of budget line FF and the Y axis. The slope of the budget line is the ratio at which X can be traded for Y.[9] GG is the budget line A faces; thus income OG is given to A in terms of Y and income FG belongs to B. The tangency points between the indifference curves of A and B represent Pareto optimum in the society. The optimal behaviors of A and B, subject to budget constraints, are specified by:

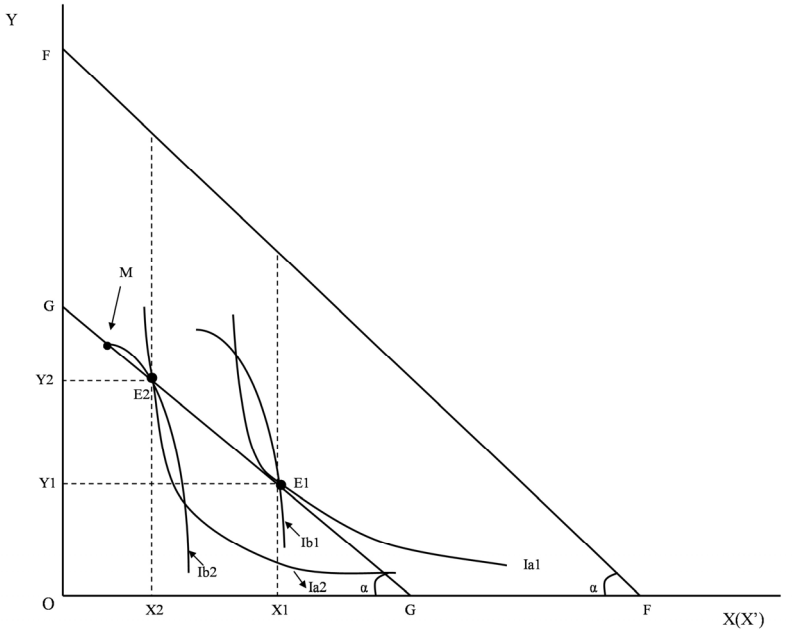
9) This can be interpreted as the marginal rate of transformation reflecting the society's opportunity cost of producing an additional unit of Y in terms of forgone X, which is assumed to be constant over the budget line.

$$\text{Max } U_A(X, Y) \quad \text{s.t. } OG \geq P_X \cdot X + P_Y \cdot Y \qquad (1)$$
$$U_{AX} > 0,\ U_{AY} > 0$$

$$\text{Max } U_B(X', Y) \quad \text{s.t. } FG \geq P_Y \cdot Y \qquad (2)$$
$$U_{BX'} < 0,\ U_{BY} > 0,$$

where U_i is the utility function of individual $i = A, B$; $U_{ij} \equiv \partial U_i / \partial j$, $j = X(X'), Y$, and P_k is the price of goods $k = X, Y$.

〈Figure 2〉 Effects of direct regulation



Given the budget line GG, A attempts utility maximization by selecting X1 and Y1 at E1, where indifference curve Ia1 is tangent to the budget line. B's indifference curve also goes through E1 with Ib1, because B is enforced to have pollution equivalent to OX1' due to negative externality caused by A's consumption of energy. B spends all income

on the consumption of Y at E1 (as indicated by the vertical distance from E1 to the budget line FF). Let E1 be the initial point before the policy to correct the externality is executed.

First, let us take a look at the case where a single policy instrument is selected: either direct regulation or taxation. Assume that the policy authority directly restricts A's consumption of energy from OX1 to OX2 in order to control the externality as shown in Figure 2. Then the consumption points for A and B both move from E1 to E2, where indifference curves Ia2 and Ib2 cross each other, meaning that the utility of B (A) improves (deteriorates). Direct regulation would not influence the income distribution between A and B, because the budget lines for A and B do not change. B consumes the same amount of Y as before, which is measured as the vertical distance from E2 to FF, but A experiences alteration in the consumption combination from (X1, Y1) to (X2, Y2).

If the policy authority prohibited the consumption of B, the consumption pattern of A and B would move to point G on the vertical axis, where A and B both consume Y only. The income distribution between A and B remains unchanged, while the utility of A (B) greatly decreases (increases). Therefore, it can be said that direct regulation has no impact on income distribution, but does affect the utility levels of both A and B. Also, the Pareto optimum cannot be reached because the tangency point of the indifference curves would not fall within the scope of direct regulation.

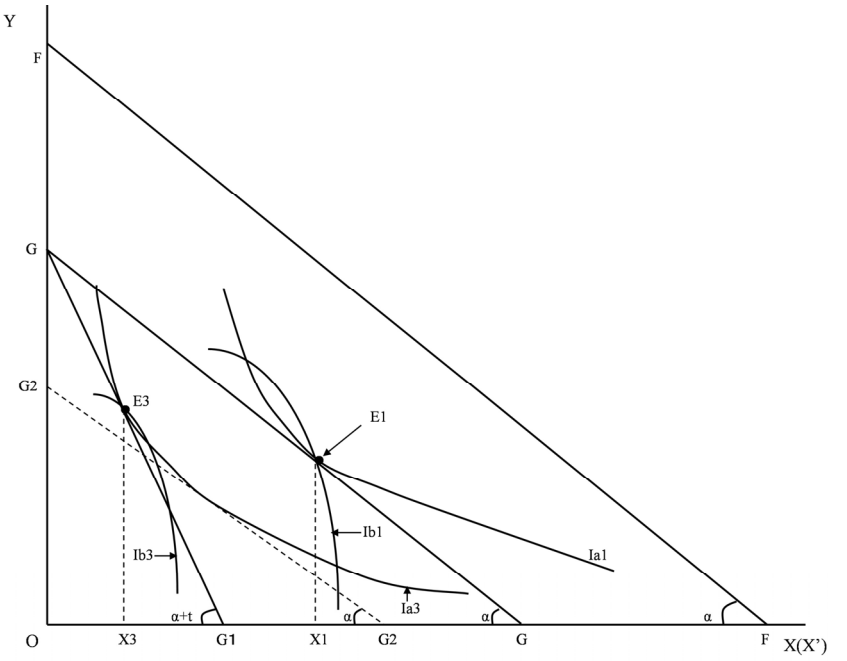
Now, assume that the authority levies a tax rate t per consumption of a unit of energy, as seen in Figure 3. All tax revenues are assumed to be transferred to B in the form of lump-sum subsidies (s) to compensate the victims of pollution. Taxation on the consumption of energy causes A's budget line to move from GG to GG1, that is, the effective price of energy will be its market price plus the per unit tax on pollution. Under the taxation policy, the optimal behaviors of A and B are described as follows:

$$\text{Max } U_A(X, Y) \quad \text{s.t. } OG \geq (P_X + t) \cdot X + P_Y \cdot Y \tag{3}$$

$$\text{Max } U_B(X', Y) \quad \text{s.t. } FG + s \geq P_Y \cdot Y, \tag{4}$$

where $t\,X = s$.

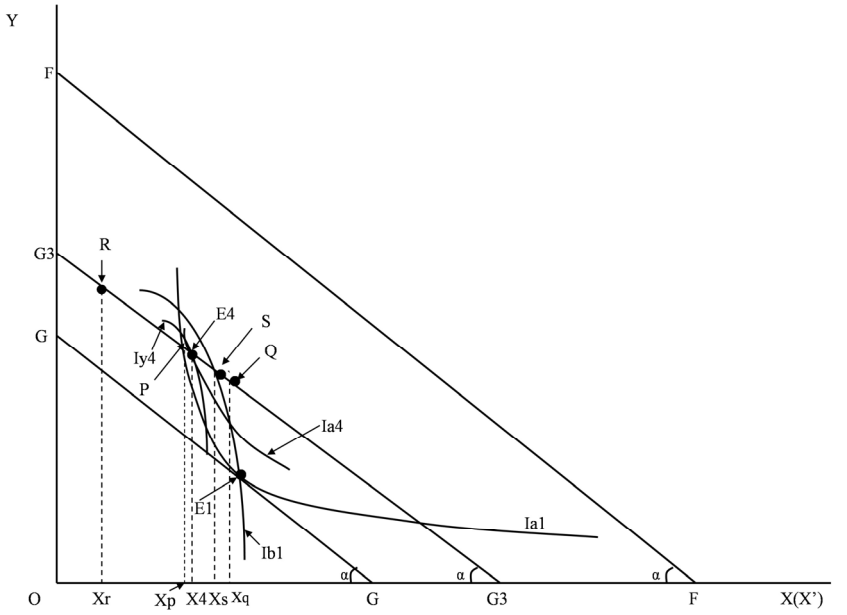
〈Figure 3〉 Effects of energy taxation



A's utility is maximized at E3, where the indifference curve Ia3 is tangent to the budget line GG1. The consumption point for B also shifts from E1 to E3 along with the indifference curve Ib3. As A's consumption of energy is reduced to OX3, the extent of externality B suffers decreases, implying that the utility of B (A) gets higher (lower) in comparison with E1. Energy taxation also affects income distribution. The budget line G2G2 can be drawn by sliding budget line GG1 along the indifference curve Ia3 until paralleling budget line GG. As taxation is imposed on the consumption of energy at a rate of t, A's income decreases from OG to OG2, while B's income increases from FG to FG2.

Turning to the case where energy subsidies are used in a mixed policy environment, first, consider the policy mix of direct regulation and subsidies, in which an amount of income GG3 is transferred from B to A in the form of lump-sum energy subsidies along with a restriction on the consumption of energy from OX1 to OX4, as shown in Figure 4.[10] A's budget constraint shifts in a parallel manner from GG to G3G3, and A and B consume at E4 on the G3G3 line. Let us denote the two points where budget constraint G3G3 intersects with the indifference curves Ia1 and Ib1 that both go through E1 by P and S, respectively. Xp and Xs represent the consumption for energy corresponding to P and S.

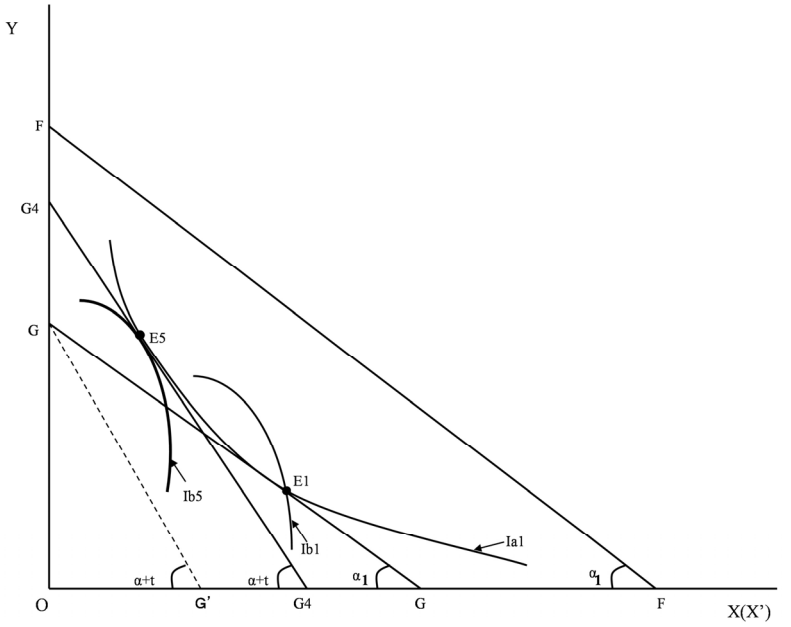
〈Figure 4〉 Effects of policy mix of direct regulation and energy subsidies



10) Subsidies will be implemented by subsidizing energy efficient and clean energy technologies. Alternatively, subsidies can be offered in proportion to the reduction in pollution or the investment in pollution control facilities.

The welfare levels of A and B vary considerably, depending upon the extent to which regulation constrains consumption of energy. If energy is restricted so that the consumption point falls inside the area limited by P and S, the welfare of A and B is improved: for instance, at E4, Ia4> Ia1 and Ib4> Ib1. If energy is restricted further, such as up to Xr in Figure 4, the consumption point ends up with R, resulting in B's welfare increasing and A's welfare decreasing. Even if the polluter A receives the energy subsidies, A' welfare deteriorates when the strictness of regulation goes beyond Xp. This time, suppose that consumption for energy is loosely restricted compared to Xs, for instance to Xq. Then B's welfare deteriorates, while A's welfare improves.

〈Figure 5〉 Effects of policy mix of energy tax and subsidies



Next, let us consider a policy mix of a per-unit energy tax and lump-sum subsidies by GG4 as indicated in Figure 5. The source of the energy subsidies is the revenue collected from the taxation at t rate per consumption of energy. The budget line is rotated from GG to GG' by taxation, and then parallel shifted to G4G4 due to energy subsidies. A's

welfare is maximized at E5 under new budget line G4G4. The optimal behavior of A and B is characterized as follows:

$$\text{Max } U_A(X, Y) \quad \text{s.t. } OG + s \geq (P_X + t) \cdot X + P_Y \cdot Y \tag{5}$$

$$\text{Max } U_B(X', Y) \quad \text{s.t. } FG \geq P_Y \cdot Y, \tag{6}$$

where $t\,X = s$.

This policy mix does not change the income distribution between the two agents because energy taxes levied on A are the source of the subsidies offered to A. However, welfare levels are affected: at the new equilibrium point E5, B's welfare is improved because Ib5> Ib1, while A's welfare does not change because E5 and E1 are on the same indifference curve. This finding suggests that use of mixed policy instruments makes it possible to improve B's welfare without decreasing A's welfare. Moreover, a tangency point between the two indifference curves Ia1 and Ib5 can be obtained, implying that, in contrast to the single-instrument case, a Pareto optimum is attainable using the policy mix of energy taxes and subsidies.

IV. Political Economy of Energy Subsidies

Table 1 summarizes the effects of different policy instruments on the income and welfare of the polluters and victims. Since energy taxation faces strong opposition from polluters who exercise political power, this policy instrument is unlikely to be used by itself. Since energy subsidies to polluters are unacceptable to victims, this instrument is also unlikely to be used by itself.

〈Table 1〉 Effects by environmental policy instruments

Policy Instruments \ Effects		Income		Welfare	
		Polluters	Victims	Polluters	Victims
Single Instrument	Direct Regulation	n.e.	n.e.	(-)	(+)
	Taxes	(-)	(+)	(-)	(+)
Policy Mix with Energy Subsidies	Direct Regulation	(+)	(-)	?	?
	Taxes	n.e.	n.e.	n.e.	(+)

Note: n.e. stands for no effect.

On the other hand, it is relatively easy to introduce direct regulation, because polluters are less likely to oppose it when their income is unaffected, and victims are likely to support it because it improves their welfare without decreasing their income. That is one of the reasons why direct regulation is so widely used by many countries and has a political significance. However, the stricter regulation becomes, the more the welfare of polluters deteriorates. Thus, the use of strict regulation sparks polluters' resistance, which makes it more difficult to implement the regulation because of the polluters' powerful political influence.

Since the victims feel unfairly treated under a policy mix of direct regulation and energy subsidies, increasing victims' welfare is imperative for the success of this policy mix, which depends on how much regulation constrains the polluters. If regulation becomes strict enough to improve victims' welfare, polluters are likely to push for compromise with victims to forestall even stricter regulations, as happened in the Japanese case.

The imposition of energy taxes and subsidies helps to lessen the polluters' resistance to taxation alone, because the addition of energy subsidies helps to mitigate the impact on polluters' welfare, as well as the impact on the income distribution between the polluters and victims. Energy subsidies compensate the polluters for the distortion on

income distribution caused by taxation. With the policy mix of energy taxes and subsidies, victims whose welfare is improved are more likely to compromise with polluters, as happened in the European case.

Therefore, we conclude that a policy using energy subsidies along with direct regulation and taxation would increase the chance of compromise between polluters and victims as compared with a policy using a single instrument alone. This demonstrates why energy subsidies are frequently used by governments as a supplemental policy instrument (IEA, 2015).

V. Concluding Remarks

In this paper, we examined how various environmental policy instruments affect the income distribution and welfare levels of polluters and victims. We noted that, when making policy decisions, authorities tend to consider the political aspects of the issue, i.e., distribution, more than the functional aspects, i.e., efficiency. Because political considerations are dominant in policy decision, using a single policy instrument, such as direct regulation or energy taxation, is difficult because of the high political costs associated with them. Energy subsidies can be used as supplemental instruments to mitigate political resistance while increasing environmental quality. Pareto optimum is attainable using a policy mix of energy taxes and subsidies to achieve environmental policy objectives, but not attainable using a single policy instrument.

Which policy instruments authorities use in conjunction with energy subsidies depends on which group has more political power in a particular country. In Japan, for example, where the political influence of polluters (mainly industrial groups) is strong, a policy mix using direct regulation and energy subsidies is usually chosen.[11] Increasing

11) After Fukushima nuclear accident in 2011, however, there were civic movements for environment and energy security and since then environmental NGO have made a stronger influence on establishment of environmental policy than before. As a result, carbon tax was introduced in October of 2012 for the first time in Asia. As the influence of industrial groups including Federation of Economic

victims' welfare is imperative for the success of the policy mix of direct regulation and energy subsidies. If regulation becomes strict enough to improve victims' welfare, polluters are likely to demand for compromise with victims to forestall even stricter regulations.

In Europe, a policy mix of energy taxes and subsidies is the preferred option, because the political cost of using taxes is not as high as it is in the United States and Japan. The addition of energy subsidies helps to mitigate the impacts on the income distribution and polluters' welfare. Victims whose welfare is improved are more likely to compromise with polluters, In the United States, where the political influence of both polluters and victims (mainly environmental NGOs) is strong, a policy mix protecting the interests of existing polluters while penalizing new polluters is often chosen.

Future study might consider using a more comprehensive analytical framework. In this paper, we considered the limited case of the diseconomy externality generated between two consumers. However, for a more comprehensive assessment of the diseconomy externality generated by environmental policy, it might be worthwhile addressing the relationship between producers and consumers. If firms have enough market power at least partially to offload the additional costs of regulation or taxation on to consumers through price increases, this dimension of the distributional issue can be also dealt with.

[References]

Baumol, W.J. and W.E. Oates, *The Theory of Environmental Policy*, Cambridge: Cambridge University Press, 1988.

Baumol, W.J., W.E Oates, and S.A.B. Blackman, *Economics, Environmental Policy, and*

Organization was too great to ignore, a compromise was reached that its rate is determined at relatively low at 289 yen per a ton of CO_2, and some tax revenues are provided to subsidize the low-carbon investment (Lee, Pollitt, and Ueta, 2012).

the Quality of Life, NJ: Prentice-Hall, 1979.

Buchanan, J. and G. Tullok, "Polluters Profits and Political Response: Direct Controls versus Taxes," *American Economic Review*, Vol. 65, 1975, pp. 139~147.

Coase, R., "The Problem of Social Cost," *Journal of Law and Economics*, Vol. 3, 1960, pp. 1~44.

Dolbear, F.T., "On the Theory of Optimum Externality," *American Economic Review*, Vol. 57, 1967, pp. 90~103.

Dunlap, R.E. and A.G. Mertig, *American Environmentalism: The US Environmental Movement*, 1970-1990, Abingdon: Taylor and Francis, 1992.

Green Fiscal Commission, *The Case for Green Fiscal Reform-Final Report of the UK*, 2009. http://www.greenfiscalcommission.org.uk/images/uploads/GFC_FinalReport.pdf.

Hahn, R.W., "Economic Prescriptions for Environmental Problems: How the Patient Followed the Doctor's Orders," *Journal of Economic Perspectives*, Vol. 3, 1989, pp. 95~114.

Hahn, R.W., "The Political Economy of Environmental Regulation: Towards a Unifying Framework," *Public Choice*, Vol. 65, 1990, pp. 21~47.

Hamamoto, M., "Process of Environmental Policy Determination," *International Public Economy Studies*, Vol. 8, 1998, pp. 26~33.

Hamamoto, M., *Political Economy of Emission Trading Scheme* (in Japanese), Tokyo: Yuhikaku, 2008.

IEA, *World Energy Outlook 2015 Special Report: Energy and Climate Change/ on the Case Studies of Energy Subsidies for Some Selected Countries of the World*, 2015. http://www.iea.org/publications/freepublications/publication/WEO2015SpecialReportonEnergyandClimateChange.pdf.

Keohane, N.O., R.L. Revesz, and R.N. Stavins, "The Positive Political Economy of Instrument Choice in Environmental Policy," in A. Panagariya, P. Portney, and R. Schwab (eds.), *Environmental and public economics: Essays in honor of Wallace E. Oates*, pp. 89~125, Cheltenham: Edward Elgar, 1999.

Lee, S., "Comparative Analysis of Institutional Designs and Policy Processes toward the Introduction of Emissions Trading Systems in Japan and Korea," in T. Morotomi (ed.),

Low Carbon Development and Low Carbon Society, Tokyo: United Nations University Press, 2014.

Lee, S., "Environmental Subsidies by Fiscal Investment and Loan in Japan," *The Research and Studies* (in Japanese), Vol. 18, 1998. pp. 15~31.

Lee, S., H. Pollitt, and K. Ueta, "An Assessment of Japanese Carbon Tax Reform Using the E3MG Econometric Model," *Scientific World Journal*, 835917, 2012, pp. 1~9.

Lee, S., *Theory and Practice of Environmental Subsidy* (in Japanese), Nagoya: Nagoya University Press, 2004.

OECD, *Taxation, Innovation and the Environment, Policy Brief*, 2010. http://www.oecd.org/environment/tools-evaluation/48178034.pdf.

Opschoor, J., *Economic Instruments for Environmental Protection in the Netherlands*, OECD, 1986.

Oyama, A., "Internality and Existence of Third Party,"*Economic Magazine* (in Japanese), 1998, pp. 129~143.

Pigou, A.C., *The Economics of Welfare*, London: Macmillan, 1920.

Turner, R.K., D. Pearce, and I. Bateman, *Environmental Economics: An Elementary Introduction*, Baltimore, MD: Johns Hopkins University Press, 1993.

Young, M.D., *Sustainable Investment and Resource Use*, UNESCO, 1992.