A Political Economy Model of Tax-Exemption Standards in a Small Open Economy

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Abstract

This paper is an application of Fredriksson's (1997) framework for environmentally oriented tax rate formation in the political competition among industrial and environmental groups and the government. In contrast to Fredrickson (1997), we analyze the tax-exemption setting. We see that in political equilibrium, the tax-exemption standard deviates from the Pigovian tax standard. We can derive results from the effects of the change in membership of the lobby groups. The tax-exemption standard decreases in the membership of both the environmental groups and the industrial groups.

Keywords: environmentally oriented tax-exemption standard, political competition, environmental group, industrial group, campaign contribution

JEL classification: C72, D72, H23

1. Introduction

The taxation of pollution is among the environmental regulations that have been established to reduce pollutant emissions. For example, coal tax is an environmentally oriented tax that is intended to reduce CO_2 emissions. Many countries impose a coal tax on CO_2-intensive goods such as automobiles. However, industries insist that the technologies to reduce CO_2 requires greater costs for production and that some industries take advantage of the regulations. Exemption terms are included in pollution taxes, which currently aim to ease the opposition of industrial lobby groups. In fact, European countries have adopted exemptions for the use of coal or other factors that effectively relax competition. Governments want to decrease pollutant emissions, but they also want to avoid affecting their industrial competitiveness and increasing unemployment. Governments set the tax-exemption standard for manufacturing industries that might be harmed by severe environmental regulations. As a result of pressure from industries, governments tend to compromise by exempting environmentally oriented taxes for some levels of emissions, and they have the power to impose a high tax rate on industries. In contrast, environmental NGOs continue to press governments to develop more intensive regulations. We consider the pressure by industrial and environmental groups as significant factors in establishing the levels of environmental regulations.

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Barrett（1994）, Rauscher（1994）and Conrad（1994）analyzed environmental policies within the framework of strategic trade policy. These authors identified the strategic behaviors by two countries that led the policy to deviate from the Pigovian standard. However, they did not explicitly address lobbying activities. Fredriksson（1997）analyzed the effects of the political competition between the industrial and environmental lobbies on the environmental tax rate using the Grossman-Helpman（1994）model. He showed that pressure imposed by lobby groups can cause the policy to deviate from the Pigovian level, and increased pressure can cause the policy to become either more intensive or more relaxed.

Fredriksson（1997）, Schleich（1999）and Aidt（1999）analyzed the environmental policy issue with regard to the assumption of a small economy according to the Grossman-Helpman approach. They assumed two lobbying groups: an industrialist group and an environmentalist group. Fredriksson（1997）studied the effect of political pressure from these lobby groups on the pollution tax and subsidies for abatement. Schleich（1999）analyzed the ability of the pollution tax to control the consumption of goods, considering the effectiveness of a combination of domestic environmental policy and trade policy to achieve higher environmental quality than a single policy（i.e., only an environmental policy or only a trade policy）. Finkelshtain et al.（1998）compared two environmental policy tools, price control and quantity control, on the factors of production.

Following Grossman and Helpman（1994）and Fredriksson（1997）, we employ the menu auction game approach. This framework was proposed in Grossman and Helpman's（1994）seminal work in the study of policy formation under political pressure by lobby groups on the incumbent government. This framework allows us to explicitly examine the effects of political campaign contributions on the model. The closest model to this paper is Fredriksson（1997）. The biggest difference between them is that I used the exemption-standard for the major policy variable instead of tax rate itself. By doing so, I created a model that can be equivalent to the model with tax rate as a policy variable but has room for elaborating the emission level with the potential extension to the imperfect and incomplete information problem. Thus the major contribution of this paper is to provide the base model of future research and check how each parameter has impact on the variable in the equilibrium.

In equilibrium, the policy maker chooses the level of the exemption-standard as balancing the social welfare and favor for the two interest groups. The exemption-standard level increases as the size of environmentalist's interest group or the policy maker's weight on the social welfare increases, but it decreases as the size of industrialist's interest group.

The remainder of this paper consists of three sections. In Section 2, we describe the model, and in Section 3, we define the political equilibrium of our model and analyze the properties of tax exemptions within the equilibrium. In Section 4, we present our concluding remarks.

2. The Model

In this section, I provide a simple model of emission tax policy with exemption-standard. In the model, the interest groups of environmentalist and industrialists compete for their favorable level of exemption by making political contribution to the policy maker. In the first subsection, I provide the model without the interest groups and the following subsection I provide the model with the interest groups.

2.1 The Economy

A small, open, competitive economy has two sectors: one sector produces the non-polluting numeraire good z, and the other sector produces the pollution-intensive good x. The economy is populated by N citizens organized into three different groups: workers, industrialists and environmentalists. The variables α^I, α^E and α^W represent the fractions of the population that represent groups of workers, industrialists and environmentalists, respectively, where $\sum_{i\in\{I,E,W\}}\alpha^i=1$. Each citizen owns one unit of labor. All groups of citizens have two common sources of income: (1) labor income l, with an inelastic unit of labor supply to the labor market and (2) the lump-sum transfer financed by the pollution tax. Industrialists have a sector-specific factor to produce good x, and they earn factor income. In contrast, environmentalists are concerned about the environmental pollution associated with the production of good x, and they derive disutility from the pollution. All environmentalists have identical additively separable preferences. We represent the utility of environmentalists by

$$U^E=q_z+u(q_x)-\theta X, \tag{1}$$

where q_z denotes consumption of the numeraire good z. The price of the numeraire good is normalized to unity, and q_x is consumption of the pollution-intensive good x. The world and market price of the good is p^*. In the equation, $u(q_x)$ is a strictly concave and differentiable subutility function. Production of good x is given by X, and $\theta\geq 0$ is an exogenously given damage coefficient of a unit of production of a good x. The variable θ reflects the sector's technology parameter to abate pollution; thus, the sum of disutility to environmentalists is equal to the total pollution in the economy. All industrialists and workers share identical and additively separable preferences, and their utility function is given by

$$U^I=U^W=q_z+u(q_x). \tag{2}$$

We assume that free trade prevails in the markets of both sectors. The government imposes a pollution tax on the pollution-intensive sector. The tax function is given by

$$T(x)=\begin{cases}0, & X\leq e^g/\theta\\ \gamma(\theta X-e^g), & X\geq e^g/\theta\end{cases}, \tag{3}$$

where $e^g\geq 0$ is the tax-exemption standard set by the government. We assume that $\gamma(\cdot)$ is a three-time continuously differentiable function set by the government and that $\gamma'>0$, $\gamma''(\cdot)>0$, and $\gamma'''(\cdot)=0$. Furthermore, we assume

$$\lim_{(X\to\tilde{e}^g/\theta)}\gamma'(\theta X-e^g)=0 \tag{4}$$

$$\lim_{(X\to\infty)}\gamma'(\theta X-e^g)=\infty, \tag{5}$$

where $\tilde{e}^g$ is the tax-exemption standard corresponding to the production level that is not under the regulation. Given the standard e^g, the producer price p is given by

$$p=p^*-T(X)/X. \tag{6}$$

Because the government is assumed to distribute the lump-sum transfer to all of the citizens, and the transfer is financed by the pollution tax revenue, we have

$$\tau(e^g)=T(X), \tag{7}$$

where $\tau(e^g)$ denotes the sum of the distribution of the tax revenue.

The total endowment of labor equals l, and each individual has one unit of labor. The world and domestic wage rate equals one because labor is the only input of producing the numeraire good z. Good x is produced from the labor and the sector-specific factor in an inelastic supply. Both sectors have constant return to scale

technologies. The firms in the pollution-intensive sector solve the following problem:

$$\max \Pi = \begin{cases} p^* - C(X), X^o \le e^g/\theta \\ p^* X - \gamma(\theta X - e^g) - C(X), X^o \ge e^g/\theta, \end{cases} \quad (8)$$

where Π is the profit of the firms or the rent of the sector-specific factor. The term $C(X)$ represents the cost of producing good x. We assume $C(X)=cX^2/2$, where c is the cost coefficient of production. There can be two cases in which the firms achieve maximum profit, satisfying the following conditions:

Case 1: $p^*=c_1X$ and $X_1^o \ge \tilde{X}$

Case 2: $p^* - \theta\gamma'(\theta X - e^g) - c_2X$ and $X_2^o \ge \tilde{X}$,

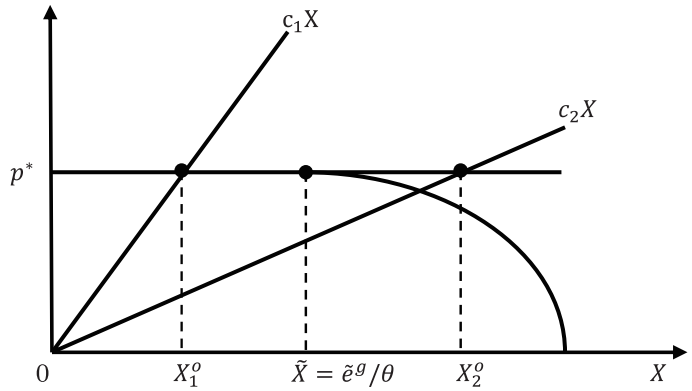

Figure 1 MR curve and the two cases of firms

where X^o is the profit-maximizing production level and $\tilde{X}$ is the level that is not under regulation by the pollution tax. The marginal cost c_iX $(i=1,2)$ is given by the firm's technologies. If the firm has technology that leads the marginal cost c_1X, the government does not levy the tax on the firm. In this paper, we assume that the firms in the sector have identical technology, their cost coefficient is $c=c_2$ in Figure 1, and the government knows the technologies (i.e., cost coefficient) and the production level X^o. Hence, the government sets the tax-exemption standard $\tilde{e}^g$, which is smaller than that for the firms in the sector producing x, as in Case 2. Given the tax-exemption standard e^g, the supply is given by $X(e^g)$.

Parties with similar interests in the x sector (i.e., the industrialists) are assumed to organize a lobby group. The industrialists share the campaign contributions to the incumbent government. However, the citizens who suffer from the pollution organize lobby groups and coordinate the campaign contributions to the government. We assume that workers do not form a lobby group because they have no stake in organizing one. All of the citizens in each group participate in the lobbying activity. Therefore, we can represent the size of the lobby groups exogenously, given by α^I for the industrial lobby group and α^E for the environmental lobby group. Each lobby group offers the government the contribution associated with the tax-exemption standard. The environmental and industrial lobby groups make campaign contributions, denoted by $\Lambda^E(e^g)$ and $\Lambda^I(e^g)$, respectively. The contributions depend on the tax-exemption standard e^g chosen by the government. The worker group does not offer campaign contributions.

Here, we state the individual utility maximization problems. Given the world price of good x and the price of numeraire good z, an environmentalist solves the following problem:

$$\max_{qz,\ qx} U^E = q_z + u(q_x) - \theta X$$
$$\text{s.t.} \quad q_z + p^* q_x + \Lambda^E/\alpha^E = l + \tau(e^g).$$

An industrialist solves

$$\max_{qz,\ qx} U^I = q_z + u(q_x)$$
$$\text{s.t.} \quad q_z + p^* q_x + \Lambda^I/\alpha^I = l + \Pi/\alpha^I + \tau(e^g).$$

A worker solves

$$\max_{qz,\ qx} U^W = q_z + u(q_x)$$
$$\text{s.t.} \quad q_z + p^* q_x = l + \tau(e^g).$$

An individual has income Y for consuming $q_z = d(p^*)$ of non-numeraire good x. The demand function $d(p^*)$ for good x is the inverse of $\partial u(q_x)/\partial q_x$, and the consumption of the numeraire good is equal to $q_z = Y^j - p^* d(p^*)$ ($j \in \{E, I, W\}$). The term Y^j ($j \in \{E, I, W\}$) represents the income of citizens:

$$Y^E = \tau(e^g) + l - \Lambda^E(e^g)/\alpha^E$$
$$Y^I = \tau(e^g) + l + \Pi(X(p(e^g)))/\alpha^I - \Lambda^I(e^g)/\alpha^I$$
$$Y^W = \tau(e^g) + l.$$

We can represent the individual indirect utility function by

$$V^E(p^*, e^g, Y^E) = Y^E + u(d(p^*)) - p^* d(p^*) - \theta X(p(e^g))$$
$$V^I(p^*, e^g, Y^I) = Y^I + u(d(p^*)) - p^* d(p^*)$$
$$V^W(p^*, e^g, Y^W) = Y^W + u(d(p^*)) - p^* d(p^*),$$

where $u(d(p^*)) - p^* d(p^*)$ is the consumer surplus derived from the consumption of good x.

2.2 Utility Functions of the Lobby Groups and the Government

The utilities of the industrial and environmental lobby groups can be derived by summing each member's utility. The consumer surplus and the wage are constant in our analysis, and we omit them from the utility function of the lobby groups. The utilities of the environmental and industrial lobby groups in the absence of campaign contributions are, respectively,

$$\Omega^E(e^g) \equiv \alpha^E\{\tau(e^g) - \theta X(e^g)\}$$

and

$$\Omega^I(e^g) \equiv \alpha^I \tau(e^g) + \Pi(X(p(e^g))).$$

The term $\alpha^i \tau(e^g)$, ($i \in \{I, E\}$) denotes the share of total pollution tax revenue. The term $\alpha^E \theta X(e^g)$ represents the aggregate disutility from environmental pollution. The utility of the workers is given by

$$\Omega^W(e^g) \equiv \alpha^W \tau(e^g).$$

Hence, the gross aggregate social welfare, $\Omega^A(e^g)$, achieved at the given tax-exemption standard, e^g, without campaign contributions is given by

$$\Omega^A(e^g) \equiv \Omega^E(e^g) + \Omega^I(e^g) + \Omega^W(e^g) = \tau(e^g) + \Pi(e^g) - \alpha^E \theta X(e^g). \qquad (9)$$

The worker group has an explicitly political power to influence the choice of the standard, e^g, by the government. However, the aggregate social welfare, $\Omega^A(e^g)$, reflects the worker group's preference. The incumbent government maximizes the weighted sum of the campaign contributions ($\Sigma_{i \in \{I,E\}} \Lambda^i(e^g)$) and aggregate social welfare ($\Omega^A(e^g)$). The incumbent government has concerns about re-election in an upcoming election (the upcoming election is not modeled in this study). Therefore, the government expects campaign

contributions for the election and voting in the election from both the industrialist and the environmentalist groups. The government's payoff function is defined by

$$v^G(e^g) \equiv \sum_{i \in \{I,E\}} \Lambda^i(e^g) + a\Omega^A(e^g), \qquad \text{(a)}$$

where a denotes the weight on the aggregate social welfare. The environmental lobby group has a payoff function given by

$$v^E(e^g) \equiv \Omega^E(e^g) - \Lambda^E(e^g). \qquad \text{(b)}$$

The industrialist lobby group has a payoff function defined by

$$v^I(e^g) \equiv \Omega^I(e^g) - \Lambda^I(e^g). \qquad \text{(c)}$$

2.3 The Game

We solve the menu auction game as in Fredriksson（1997）. The game consists of two stages. It is played among the incumbent government and the industrial and environmental lobby groups. In the first stage, the industrial and environmental lobby groups simultaneously offer the government monetary payments to ensure their favorable tax-exemption standard. These monetary payments are represented by the campaign contribution schedules $\Lambda^I(e^g)$ and $\Lambda^E(e^g)$, which are continuous and differentiable functions. Each lobby group, $i \in \{I,E\}$, determines $\Lambda^i(e^g)$ to maximize its net payoffs, $v^i(e^g)$.

In the second stage, the government determines a tax-exemption standard, e^g, and receives campaign contributions from the industrialist and environmental lobby groups that depend on the tax standard. The government determines the level of tax exemption to maximize $v^G(e^g)$. Both the industrialist and environmental lobby groups accept the monetary payoffs, represented by the continuous and differentiable functions $\Omega^I(e^g)$ and $\Omega^E(e^g)$, respectively. Therefore, each lobby group receives net monetary payoffs of $v^i(e^g)$.

In the next section, we define a political equilibrium of this game, which is the sub-game perfect Nash equilibrium of the game. Before doing so, we provide the definition of the feasibility of the contribution schedule for the industrial and the environmental groups.

Definition: Contribution schedule $\Lambda^I(\cdot)$ for the industrial lobby group is feasible if

$$\Lambda^I(e^g) \leq \alpha^I(\tau(e^g) + l) + \Pi(X(p(e^g))) \quad \text{for any } e^g \geq 0.$$

Contribution schedule $\Lambda^E(\cdot)$ for the environmentalist lobby group is feasible if

$$\Lambda^E(e^g) \leq \alpha^E(\tau(e^g) + l) \quad \text{for any } e^g \geq 0.$$

3. The Political Equilibrium

First, we provide the definition of the political equilibrium of the game using the concept of the sub-game Nash equilibrium.

Definition: A set of contribution schedules of lobby groups, $\{\Lambda^{Ip}(\cdot), \Lambda^{Ep}(\cdot)\}$, and the tax-exemption standard, e^{gp}, is a political equilibrium if the following requirements are satisfied.

（i） For any lobby group $i \in \{I,E\}$, $\Lambda^{ip}(\cdot)$ is a feasible contribution schedule.

（ii） Given $\Lambda^{Ip}(\cdot)$ and $\Lambda^{Ep}(\cdot)$, $e^{gp} \in \operatorname{argmax} \sum_{i \in \{I,E\}} \Lambda^{ip}(e^g) + a\Omega^A(e^g)$.

(iii) For any lobby group $i \in \{I,E\}$, given the contribution schedule $\Lambda^{jp}(\cdot)$ of the opponent lobby group $j \neq i$ and the government's tax-exemption standard e^{gp}, there is no other feasible contribution schedule $\widetilde{\Lambda}^i(\cdot)$ such that

$$\Omega^i(e^{gp}) - \widetilde{\Lambda}^i(e^{gp}) > \Omega^i(e^{gp}) - \Lambda^{ip}(e^{gp}).$$

The structure of the game and the definition of the political equilibrium follow Fredriksson (1997), and his work is an application of Grossman and Helpman (1994). Similar to Fredriksson (1997), the following proposition can be derived straightforwardly by applying Grossman and Helpman's argument.

Proposition 1 (**Grossman & Helpman** (**1994**)). $\{\Lambda^{Io}, \Lambda^{Eo}, e^{gp}\}$ is a subgame perfect Nash equilibrium if and only if

(I) For each lobby group $i \in \{I,E\}$, $\Lambda^{ip}(e^g)$ is feasible.

(II) $e^{gp} \in \text{argmax}_{e^g \geq 0} \sum_{i \in \{I,E\}} \Lambda^{ip}(e^g) + a\Omega^A(e^g)$.

(III) For each lobby group $j \in \{I,E\}$, $e^{gp} \in \text{argmax}_{e^g \geq 0}\, \Omega^j(e^g) - \Lambda^{jp}(e^g) + \sum_{i \in \{I,E\}} \Lambda^{ip}(e^g) + a\Omega^A(e^g)$.

(IV) For each lobby group $j \in \{I,E\}$, there exists a $e^g_{-j} \geq 0$ such that $e^g_{-j} \in \text{argmax} \sum_{i \in \{I,E\}} \Lambda^{io}(e^g) + a\Omega^A(e^g)$ with $\Lambda^{jo}(e^g_{-j}) = 0$.

The intuition of conditions from (I) through (IV) can be explained as follows. The requirement of Condition (II) stipulates that the government sets the tax-exemption standard to maximize its own welfare, given the contribution schedules offered by the lobby groups. Condition (III) means that the tax-exemption standard in equilibrium maximizes the joint welfare of all of the lobby groups and the government, given the equilibrium contribution schedules of each lobby group. This must be true because otherwise some lobby *j* could alter its contribution schedule to induce the government to select the jointly optimal tax-exemption standard and capture most of the surplus from the policy change. Because the government would deviate from the original policy and the lobby *j* would benefit from the change, the original tax-exemption standard could not have been an equilibrium.

3.1 Characterization of the Equilibrium

In this subsection, we characterize the political equilibrium. First, let us derive the marginal effect of the tax-exemption standard on the utilities of the industrialists, the environmentalists and the workers in the political equilibrium. The derivation of Equations 10, 11, and 12 can be found in Appendix A-2.

We can confirm that the environmental group aims to achieve higher environmental quality within their jurisdiction and always supports a decrease in the tax-exemption standard:

$$\Omega^E_{e^g}(e^{gp}) = \alpha^E \tau_{e^g}(e^{gp}) - \theta X_{e^g}(e^{gp}) < 0. \qquad (10)$$

For the environmental group, a marginal increase in the tax-exemption standard leads to a marginal decrease in the transfer of tax revenue and a marginal increase in environmental pollution. Consequently, their utilities always decrease by increasing the tax-exemption standard.

In contrast, the industrial lobby group has an incentive to support the rise of the non-tax standard. We have

$$\Omega^I_{e^g}(e^{gp}) = \alpha^I \tau_{e^g}(e^{gp}) + \Pi_{e^g}(e^{gp}) > 0. \qquad (11)$$

For the industrial group, a marginal increase in the tax-exemption standard causes a marginal decrease in the transfer of the pollution tax and marginal increases in the production level and the rent of the sector-specific factor. A marginal increase in the rent income of the industrial group overwhelms the decrease in tax transfer income. As a result, a rise in the tax-exemption standard leads to a rise in the industrial group's utility.

Workers lose utilities by an increase in the tax-exemption standard:

$$\Omega^{W}_{e^g}(e^{gp})=\alpha^{W}\tau_{e^g}(e^{gp})<0. \tag{12}$$

The industrialists are the winners, whereas the environmentalists and the workers are the losers with the increase in the tax-exemption standard. Furthermore, the effect of the rise of the tax-exemption standard on the aggregate social welfare becomes non-negative:

$$\Omega^{A}_{e^g}(e^{gp})=\tau_{e^g}(e^{gp})+\Pi_{e^g}(e^{gp})-\alpha^{E}\theta X_{e^g}(e^{gp})\geq 0. \tag{13}$$

Next, we derive the contribution schedule function for the industrialist and the environmentalist lobby groups. In the equation, e^{gp} satisfies the following first-order conditions for the problems defined in Condition（II）:

$$\Omega^{j}_{e^g}(e^{gp})-\Lambda^{jp}_{e^g}(e^{gp})+\sum_{i\in\{I,E\}}\Lambda^{ip}_{e^g}(e^{gp})+a\Omega^{A}_{e^g}(e^{gp})=0, \text{ for each } j\in\{I,E\}. \tag{14}$$

In Condition（II）, the first-order condition for e^{go} is

$$\sum_{i\in\{I,E\}}\Lambda^{ip}_{e^g}(e^{gp})+a\Omega^{A}_{e^g}(e^{gp})=0. \tag{15}$$

Therefore, we have

$$\Omega^{j}_{e^g}(e^{gp})=\Lambda^{jp}_{e^g}(e^{gp}), \text{ for each } j\in\{I,E\}. \tag{16}$$

Thus,

$$\sum_{i\in\{I,E\}}\Omega^{i}_{e^g}(e^{gp})+a\Omega^{A}_{e^g}(e^{gp})=0. \tag{17}$$

This implies that, in equilibrium, the government behaves as if it had maximized the weighted sum of the payoffs of the different groups. Accordingly, we redefine the objective function of the government in equilibrium by

$$\sum_{i\in\{I,E\}}\Omega^{i}_{e^g}(e^{gp})+a\Omega^{A}_{e^g}(e^{gp})=0.$$

Using this fact, we can show that the tax-exemption standard in political equilibrium, e^{gp}, is implicitly given by

$$\{\alpha^{E}+\alpha^{I}-1\}\gamma'(\theta X(e^{gp})-e^{gp})\{\theta X'(e^{gp})-1\}$$
$$+(1+a)X'(e^{gp})\{p^{*}-cX(e^{gp})-\alpha^{E}\theta\}=0. \tag{18}$$

In the absence of the lobby groups（i.e., $\Lambda^{i}(e^{g})=0,\ i\in\{I,E\}$）, the incumbent government aims to maximize a payoff that is equivalent to the aggregate social welfare. We define the tax-exemption standard, e^{gs}, in such a case as follows.

Definition. e^{gs} is the tax-exemption standard when no lobby groups exist:

$$e^{gs}\equiv \text{argmax}_{e^g}\Omega^{A}(e^{g}).$$

Because the tax-exemption standard, e^{gs}, must satisfy the first-order necessary condition of the problem above, we have

$$X(e^{gs})=\frac{(p^{*}-\alpha^{E}\theta)}{c}. \tag{19}$$

Using this information, we can derive the following proposition.

Proposition 2. The tax-exemption standard with the presence of the lobby groups, e^{gp}, is more relaxed than that in the absence of the lobby groups, e^{gps}.

Proof of this proposition is given in Appendix A-3. Under the tax rate with the tax-exemption standard, e^{gs}, the quantity of the non-numeraire good x is equal to that under the pollution tax corresponding to the marginal social cost of producing good x. Thus, the tax rate coincides with the Pigovian tax regime. Under the exemption standard, e^{gp}, the quantity of the production of the good x is larger than that under the standard, e^{gs}. Specifically, the pollution tax with the tax-exemption standard set through the political process is more relaxed than the Pigovian tax.

3.2 Comparative Statistics

In this subsection, we analyze the effect of the elements that are exogenously given in the economy.

Proposition 3. In political equilibrium, the tax-exemption standard decreases according to the government's weight on the aggregate social welfare:

$$\frac{de^{gp}}{da}=-\frac{X'(e^{gp})(p^{*}-cX(e^{gp}))}{(\Omega''(e^{gp}))}<0.$$

Proof is given in Appendix A-4. In political equilibrium, the tax-exemption standard is higher than that without political competition among the lobby groups. However, the increase in the weight on the aggregate social welfare makes the deviation of the tax-exemption standard from the social optimal standard smaller. The government considers the voting by the three groups of citizens more significant than the campaign funds offered by the two groups, the industrialist group and the environmentalist group.

The policy, e^{gp}, can be affected by the world and domestic market price of the pollution-intensive good x.

Proposition 4. In political equilibrium, the tax-exemption standard increases in the world market price if some individuals are workers, and total pollution increases in the world market price:

$$\frac{de^{gp}}{dp^{*}}=-\frac{(1+a)X'(e^{gp})}{\Omega''(e^{gp})}>0.$$

Proof is given in Appendix A-4. The intuition of this proposition is as follows. The higher the world price of the good x is, the more profit income the industrial lobby group can gain. The industrial lobby group becomes more active in making political contributions as the world price increases.

Proposition 5. In political equilibrium, the tax-exemption standard decreases in the environmental lobby group:

$$\frac{de^{gp}}{d\alpha^{E}}=-\frac{\alpha^{E}\theta^{2}\gamma''(\theta X^{o}-e^{gp})+c\gamma'(\theta X(e^{g})-e^{gp})}{\Omega''(e^{gp})\{c+\theta^{2}\gamma''(\theta X^{o}-e^{gp})\}}<0.$$

The increase in the membership of the environmental lobby has three effects, as indicated by Fredriksson (1997). First, the total disutility to the environmentalist group stems from the increases in environmental pollution. Second, the effect of pollution on the aggregate social welfare also increases. Third, the pollution tax revenue decreases. The environmentalist group's welfare rises according to the decrease in the tax-exemption standard because it reduces the disutility from emissions and increases the recycled and redistributed environmental tax revenue. The increase in the pressure from the environmentalist group leads the government

to consider the environmentalist group's welfare more important, and thus the tax-exemption standard rises.

Next, we check the property of the tax-exemption standard in terms of the membership of the industrial lobby group.

Proposition 6. In political equilibrium, the tax-exemption standard decreases in the industrial lobby group's membership:

$$\frac{de^{gp}}{d\alpha^I}=\frac{\gamma'(\theta X^o-e^{gp})}{\Omega''(e^{gp})\{c+\theta^2\gamma''(\theta X^o-e^{gp})\}}<0.$$

Although this result seems counterintuitive, the interpretation is simple. Two effects yield to the increase in the tax-exemption standard: (1) the increase in the profit income and (2) the decrease in the tax revenue. Because we assume the market to be perfectly competitive, the profit is zero. Thus, we have only the second effects. As the membership, α^I, increases, the tax revenue redistributed to the group, $\alpha^I\tau(e^g)$, becomes larger. This leads the industrialist lobby group to become more concerned about the income transferred from the tax revenue. Furthermore, in this case, the utility of the government increases according to the reduction in the tax exemption, resulting in less pollution damage for the environmentalist group and more tax redistribution to the citizens in all of the groups. Therefore, the increase in the membership in the industrialist lobby group results in a decrease in the tax-exemption standard in the equilibrium.

4. Concluding Remarks

In this paper, we analyzed the establishment of policies for the tax-exemption standard in the pollution tax. We observe that with the campaign contributions made by the lobby groups, the exemption standard is higher than that achieved through Pigovian taxation. The standard increases in the membership of environmentalist lobby groups and in the government's weight on social welfare. It decreases in the world market price of the polluting goods. Furthermore, the increase in the membership of the industrialist lobby group makes the tax-exemption standard higher. The results derived from the membership of the lobby group stem primarily from the marginal decrease in the pollution tax revenue.

A straightforward extension is to introduce common agency problem with adverse selection by applying Stole (1990) and Martimort (1992, 1996) to this model, in which agencies can choose level of two objects. More concretely, I can set interest groups with unobserved characteristics, such as productivity of abatement technologies. The interest groups can choose both investment level of abetment and level of emission, but the productivity of abatement technologies. As this paper is to found the case where the policy maker can select the exemption-standard level of emission taxation instead of tax level itself, the extension can be a formal theoretical model of Yao (1988)'s analysis with political economy, in which area nobody has explored except it has another problem of moral hazard. Laussel et al. (2005) considered such a case but in more generic situation, an application of their framework can be a reasonable way to go. And after the extension, the possibility lies in adding moral hazard problem to it, which will create a ratchet effect problem, and it will be exact situation of Yao (1988).

Appendix

A-1: The Economic Model.

The profit maximizing production level, X^o, must satisfy the first-order condition:

$$p - cX^o - \theta\gamma'(\theta X^o - e^g) = 0. \qquad (21)$$

Taking the total derivative of Equation (21) gives

$$-cdX^o - \theta^2\gamma''(\theta X^o - e^g)dX^o + \theta\gamma''(\theta X^o - e^g)de^g = 0.$$

$$\Rightarrow X^{o\prime}(e^g) = \frac{\theta\gamma''(\theta X^o - e^g)}{c + \theta^2\gamma''(\theta X^o - e^g)} > 0$$

In the equilibrium, the rise of the tax-exemption standard decreases the total tax revenue:

$$\begin{aligned}\tau'(e^g) &= \frac{d\gamma(\theta X^o(e^g) - e^g)}{de^g} \\ &= \gamma'(\theta X^o(e^g) - e^g)\{\theta X^{o\prime}(e^g) - 1\} \\ &= \gamma'(\theta X^o(e^g) - e^g)\left\{\frac{\theta^2\gamma''(\theta X^o - e^g)}{c + \theta^2\gamma''(\theta X^o - e^g)} - 1\right\} < 0.\end{aligned}$$

A-2: Preferences of the Lobby Groups

The effect of the change in the tax-exemption standard on the utility of the environmental lobby group is negative:

$$\Omega^E_{e^g}(e^g) = \alpha^E\{\tau'(e^g) - \theta X^{o\prime}(e^g)\} < 0.$$

The industrial group gains benefits from the rise in the tax-exemption standard:

$$\begin{aligned}\Omega^I_{e^g}(e^g) &= \alpha^I\tau'(e^g) + p^*X^{o\prime}(e^g) - \gamma'(\theta X^o(e^g) - e^g)(\theta X^{o\prime}(e^g) - 1) - cX^o(e^g)X^{o\prime}(e^g) \\ &= \alpha^I\tau'(e^g) + \gamma'(\theta X^o(e^g) - e^g) + X^{o\prime}(e^g)\{p^* - cX^o(e^g) - \theta\gamma'(\theta X^o(e^g) - e^g)\} \\ &= \alpha^I\gamma'(\theta X^o(e^g) - e^g)\left\{\frac{\theta^2\gamma''(\theta X^o - e^g)}{c + \theta^2\gamma''(\theta X^o - e^g)} - 1\right\} + \gamma'(\theta X^o(e^g) - e^g) \\ &= \gamma'(\theta X^o(e^g) - e^g)\left[\alpha^I\left\{\frac{\theta^2\gamma''(\theta X^o - e^g)}{c + \theta^2\gamma''(\theta X^o - e^g)} - 1\right\} + 1\right] > 0\end{aligned}$$

Finally, the change in the tax-exemption standard negatively affects the utility of workers:

$$\Omega^W_{e^g}(e^g) = \alpha^W\tau'(e^g) < 0$$

A-3: Proof of Proposition 2

A politically optimal tax-exemption standard satisfies

$$(\alpha^I + \alpha^E - 1)\gamma'(\theta X(e^{gp}) - 1) + (1+a)X'(e^{gp})\{p^* - cX(e^{gp}) - \alpha^E\} = 0$$

Without the political process, the first-order condition is given by

$$\Omega^A_{e^g}(e^{gs}) = X'(e^{gs})\{p^* - cX(e^{gs}) - \alpha^E\theta\}$$

For the comparison of e^{gp} and e^{gs}, we need to rearrange Equation 23:

$$\begin{aligned}X(e^{gp}) &= \frac{p^* - \alpha^E\theta}{c} + \frac{(\alpha^I + \alpha^E - 1)\gamma'(\theta X(e^{gp}) - 1)\{\theta X'(e^{gp}) - 1\}}{(1+\alpha)c} \\ &= X(e^{gs}) + \frac{(\alpha^I + \alpha^E - 1)\gamma'(\theta X(e^{gp}) - 1)\{\theta X'(e^{gp}) - 1\}}{(1+\alpha)c}\end{aligned}$$

Because

$$\frac{(\alpha^I+\alpha^E-1)\gamma'(\theta X(e^{gp})-1)\{\theta X'(e^{gp})-1\}}{(1+\alpha)c}>0,$$

we have

$$X(e^{gp})>X(e^{gs}).$$

Furthermore, because

$$X'(e^g)>0,$$

we have

$$e^{gp}>e^{gs}.$$

A-4: Proofs of Proposition 3-6（Comparative Statistics）

The effect of the increase in the weight assigned to social welfare in the tax-exemption standard in the political equilibrium can be derived by

$$d\Omega=\Omega''(e^{gp})de^{gp}+X'(e^{gp})(p^*-cX(e^{gp}))da=0.$$

$$\frac{de^{gp}}{da}=\frac{\dfrac{\theta\gamma''(\theta X^o-e^{gp})}{c+\theta^2\gamma''(\theta X^o-e^{gp})}\{p^*-cX(e^{gp})\}}{\Omega''(e^{gp})}<0.$$

The effect of the increase in the world price of good x, p^*, on the tax-exemption standard in the political equilibrium can be derived by

$$d\Omega=\Omega''(e^{gp})de^{gp}+(1+a)X'(e^{gp})dp^*=0.$$

$$\frac{de^{gp}}{dp^*}=\frac{(1+a)X'(e^{gp})}{\Omega''(e^{gp})}>0.$$

The effect of the increase in the ratio of environmentalists on the tax-exemption standard in the political equilibrium is given by

$$d\Omega=\Omega''(e^{gp})de^{gp}+\{\gamma'(\theta X(e^{gp})-e^{gp})(\theta X'(e^{gp})-1)-\alpha^E\theta X'(e^g)\}d\alpha^E=0.$$

$$\Rightarrow\frac{de^{gp}}{d\alpha^E}=\frac{\gamma'(\theta X(e^{gp})-e^{gp})(\theta X'(e^{gp})-1)-\alpha^E\theta X'(e^{gp})}{\Omega''(e^{gp})}$$

$$=\frac{\alpha^E\theta^2\gamma''(\theta X^o-e^{gp})+c\gamma'(\theta X^o(e^{gp})-e^{gp})}{\Omega''(e^{gp})\{c+\theta^2\gamma''(\theta X^o(e^{gp})-e^{gp})\}}<0.$$

The effect of the increase in the ratio of industrialists on the tax-exemption standard in the political equilibrium is given by

$$d\Omega=\Omega''(e^{gp})de^{gp}+\gamma'(\theta X^o(e^g)-e^g)(\theta X^{o\prime}(e^g)-1)-d\alpha^I=0.$$

$$\Rightarrow\frac{de^{gp}}{d\alpha^I}=\frac{\gamma'(\theta X^o(e^{gp})-e^{gp})(\theta X^{o\prime}(e^{gp})-1)}{\Omega''(e^{gp})}$$

$$=\frac{c\gamma'(\theta X(e^{gp})-e^{gp})}{\Omega''(e^{gp})\{c+\theta^2\gamma''(\theta X^o(e^{gp})-e^{gp})\}}<0.$$

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