Increasing worldwide environmental consciousness and environmental policy adjustment

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Abstract

Increasing worldwide environmental consciousness has been driving countries in the world to adjust their environmental policies. Conventional wisdom often suggests tightening environmental policy. This paper challenges the wisdom. By using an oligopoly model, we show that, in a local pollution case, a country that confronts the increasing environmental consciousness may tighten or slacken her environmental policy depending on her relative cost competitiveness to her rivals. However, in a global pollution case, all countries in the world always tighten their environmental policies as worldwide environmental consciousness rises.

1. Introduction

The public concerns with environmental degradation are growing domestically and internationally. However, most existing literature, from the strategic trade policy views, on the linkage between trade and environment has concentrated on how governments can help domestic firms to gain advantages in imperfectly competitive international markets.[1] Little attention has been paid on the effects of environmental consciousness from the economic aspects. The purpose of this paper is to investigate how governments adjust their environmental policies when worldwide environmental consciousness increases.

Two studies are exceptional to explore this issue. Endres (1997) considers a model of two identical countries suffering from pollution to examine the relationship between environmental consciousness and the deviation of the Nash equilibrium emissions from the social optimum levels. Vogel (1999) constructs a political economy model to analyze the effects of interest group activities (such as campaigning and lobbying) on the quality of the environment. Both articles conclude that governments will tighten their environmental policies if environmental consciousness goes up.

Although tighten environmental policies to meet increasing environmental consciousness is intuitive, some instances that may be purposefully designed to deviated from this wisdom. One of examples is that the U.S. environmental policy advised by the Environmental Protection Agency (EPA) has in some instances been modified to accommodate concerns expressed by the White House Council on Competitiveness.[2] As a result, the following question may be raised: Why and what factors to cause the governments that confront increasing environmental consciousness to slacken their environmental policies?

Compared to previous research, this paper differs from those of Endres (1997) and Vogel (1999) in two key respects. First, it models the strategic interactions between two large heterogeneous firms (countries) with different cost competitiveness. Second, it explores the environmental policy adjustment for both local pollution and

[1] The literature on so-called "strategic environmental policy" is large, and growing. It is argued that, in the absence of trade policy to protect domestic industries, governments might seek to relax environmental policies to give their domestic producers an advantage. See Barrett (1994), Kennedy (1994), Ulph (1996), among others, and, for a survey, Ulph (1994).

[2] See the Wall Street Journal (8 July 1991), European edition.

global pollution. This paper shows that government that faces increasing environmental consciousness may tighten or slacken her environmental policy depending on her relative cost competitiveness to her rival.

The rest of this paper is organized as follows. Section 2 presents the model. Sections 3 and 4 discuss the environmental policy adjustment for local pollution and global pollution, respectively. Some concluding remarks are contained in section 5.

2. The model

Two firms, A and B, located in different countries, A and B, export a homogeneous good to a third market with the linear inverse demand $P = \alpha - (Q^A + Q^B)$, $\alpha > 0$. Pollution emissions associated with output levels cause damage either to the local economy (denoted as local pollution) or to all countries in the world (denoted as global pollution). By considering firms' profits and environmental impacts, both governments set emission standards (E^i, $i = A, B$) as their own environmental policies.[3] Let the emission-output ratio be one for both firms.[4] The cost of abating a level of emissions $(Q^i - E^i)$ is $(Q^i - E^i)^2/2$ which reflects the existence of the diminishing marginal returns in the abatement technology. If the pollution is local, country i suffers the environmental damage $(E^i)^2/2$ resulted from its firm's emissions E^i.[5] If the pollution is global, countries in the world suffer the environmental damage $(E^A + E^B)^2/2$ resulted from global emissions $(E^A + E^B)$. The model is a two-stage game, where each government chooses the level of emission standard in stage one, and each firm sets its output in stage two. The game is solved by backward induction to obtain a subgame perfect Nash equilibrium.

Firm i maximizes its profit,

$$\pi^i = (P - C^i)Q^i - (Q^i - E^i)^2/2, \quad i = A, B \qquad (1)$$

where C^i is constant marginal cost of firm i. Solving $\frac{d\pi^A}{dQ^A} = 0$ and $\frac{d\pi^B}{dQ^B} = 0$

[3] Lax (Weak) environmental policy represents that governments allow firms to emit more pollution.
[4] The units are chosen such that each unit of output produces a unit of pollution. Furthermore, the consideration is confined to production-related pollution rather than consumption-related pollution.
[5] The quadratic environmental damage function implies that the emissions affect the environment at an increasing scale, that is, every unit of emission causes a greater damage than the previous unit.

simultaneously, the Cournot-Nash equilibrium output levels at the second stage are

$$Q^A = \frac{1}{8}[2\alpha - 3(C^A - E^A) + (C^B - E^B)], \quad (2)$$

$$Q^B = \frac{1}{8}[2\alpha + (C^A - E^A) - 3(C^B - E^B)]. \quad (3)$$

Equations (3) and (4) show that stricter environmental policy (lower E^A) will cut the equilibrium output of firm A and raise the output of firm B.

While the solution to the second stage of the game as a function of environmental policies (E^A and E^B) is obtained, it can now be used to analyze the first stage where both governments simultaneously set their emission standards (E^A and E^B) to maximize their own welfare functions. In the following two sections, we will derive the optimal emission standards and evaluate how they are affected when worldwide environmental consciousness changes under two cases: local pollution and global pollution.

3. Environmental policy adjustment under local pollution case

Let ϕ be a subjective nonnegative indicator showing the worldwide consciousness (or concern) about environmental damage. As ϕ increases, people in the world are more concerned about environmental damage, which results in more reduction in welfare. Therefore we define perceived environmental damage, i.e., environmental damage as it is perceived by the country i ($i = A, B$), as the product of physical (or effective) environmental damage $(E^i)^2/2$ and the subjective indicator ϕ. Hence, we can specify country $i's$ welfare in the local pollution case as following:[6]

$$W^i = \pi^i - \phi(E^i)^2/2, \quad i = A, B \quad (4)$$

which is given by the profit of its domestic firm (π^i) net of welfare reduction

[6] The perceived marginal environmental damage derived in this paper is $\phi(E^i)$ which is equivalent to the assumption in Endres (1997) that the marginal environmental damage is strictly proportional to emissions (E^i) with multiplier ϕ. Furthermore, he argues that "increasing environmental consciousness increases the marginal willingness to pay for pollution abatement. Thus, the parameter ϕ in the marginal damage functions can be used as a proxy for environmental awareness, *ceteris paribus*." Therefore, we use ϕ to indicate the state of environmental consciousness.

$\phi(E^i)^2/2$ from environmental damage $(E^i)^2/2$ resulted from pollution emissions (E^i). Using (2) and (3), the Nash equilibrium emission standards are derived by solving $\frac{dW^A}{dE^A}=0$ and $\frac{dW^B}{dE^B}=0$ simultaneously,

$$E^A=\frac{9G^B[(15+24\phi)G-8(1+\phi)]}{(32\phi+23)(7+16\phi)}, \tag{5}$$

$$E^B=\frac{9G^B[(15+24\phi)-8(1+\phi)G]}{(32\phi+23)(7+16\phi)}, \tag{6}$$

where $G^A=(\alpha-C^A)$ and $G^B=(\alpha-C^B)$ are absolute cost competitiveness of firm A and B, respectively, and $G=\frac{G^A}{G^B}=\frac{(\alpha-C^A)}{(\alpha-C^B)}$ is firm $A's$ relative cost competitiveness (in terms of firm B). From (5) and (6), we can evaluate the effects of changing in environmental consciousness (ϕ) on the optimal emission standards:

$$\frac{\partial E^A}{\partial\phi}=\frac{72G^B[(431+1024\phi+512\phi^2)-(627+1920\phi+1536\phi^2)G]}{(32\phi+23)^2(7+16\phi)^2}, \tag{7}$$

$$\frac{\partial E^B}{\partial\phi}=\frac{72G^B[(431+1024\phi+512\phi^2)G-(627+1920\phi+1536\phi^2)]}{(32\phi+23)^2(7+16\phi)^2}. \tag{8}$$

Equations (7) and (8) lead to the following proposition:

Proposition 1. *In a local pollution case, when environmental consciousness rises, country A tends to tighten and country B tends to slacken their own environmental policies if firm $A's$ relative cost competitiveness is high enough. However, both countries will tighten their environmental policies if cost competitiveness in both firms is near.*

Proof. Six lines in Fig.1 are drawn by setting Q^A, Q^B, E^A, E^B, $\frac{\partial E^A}{\partial\phi}$ and $\frac{\partial E^B}{\partial\phi}$

to zero.[7] Under the assumptions of Q^A, Q^B, E^A and E^B being nonnegative, these lines partition the space into three regions:

region $\frac{\partial E^A}{\partial \phi}$ 0 $\frac{\partial E^B}{\partial \phi}$ 0,

region $\frac{\partial E^A}{\partial \phi}$ 0 $\frac{\partial E^B}{\partial \phi}$ 0,

region $\frac{\partial E^A}{\partial \phi}$ 0 $\frac{\partial E^B}{\partial \phi}$ 0.

Given the initial level of ϕ, if the difference of cost competitiveness between the two firms is large enough (i.e., the value of G is far enough away from one), it is likely to fall into region or where one country tightens and the other slackens their own environmental policies when environmental consciousness rises. However, it will fall into region when the cost competitiveness in both firms is near (i.e., the value of G is close to one). Therefore, both countries will tighten their environmental policies. *Q.E.D*

The economic interpretation is simple. In the model of two countries competing with each other in a third market, the optimal emission standard is specified where profits shifted away from the competitor is equal to the marginal environmental damage. The higher the firm $A's$ relative cost competitiveness (G), the higher the profits which can be shifted away to firm B, and the lower the profits which can be shifted away from firm B.[8] Since increasing environmental consciousness (ϕ) raises the marginal environmental damage (ϕE^i), if firm $A's$ relative cost competitiveness (G) is high, it is less likely to shift enough profit from firm B by increasing emission standard to compensate the increase in marginal environmental damage. Therefore, country A has incentive to tighten her environmental policy. However, with large value of G, it is more likely for country

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[7] The lines of $Q^A = 0$ and $Q^B = 0$ are drawn based on the values of Q^A and Q^B derived from substituting (5) and (6) into (2) and (3), respectively. It is noted that both lines of $Q^A = 0$ and $E^A = 0$ are identical, and both lines of $Q^B = 0$ and $E^B = 0$ are the same in Fig.1.

[8] The profit levels and the difference for both firms are $\pi^A = \frac{3(G^B)^2(37+128\phi+64\phi^2)[(15G-8)+8\phi(3G-1)]^2}{2(23+32\phi)^2(7+16\phi)^2}$, $\pi^B = \frac{3(G^B)^2(37+128\phi+64\phi^2)[(15-8G)+8\phi(3-G)]^2}{2(23+32\phi)^2(7+16\phi)^2}$ and $\pi^A - \pi^B = \frac{3(G^B)^2(37+128\phi+64\phi^2)(G^2-1)}{2(23+32\phi)(7+16\phi)}$.

B to shift enough profit from firm A by increasing emission standard. Country B, then, tends to slacken her environmental policy.

4. Environmental policy adjustment under global pollution case

If the pollution is global, the emissions generated by one firm can damage not only the country where the firm is located but also the other country as well. Therefore, we can define the country $i's$ welfare as following:

$$W^i = \pi^i - \phi(E^A + E^B)^2/2, \quad i = A, B \tag{9}$$

where $\phi(E^A + E^B)^2/2$ is perceived environmental damage resulted from global emissions $(E^A + E^B)$. As discussed in section 3, the Nash equilibrium emission standards can be derived as:

$$E^A = \frac{9G^B[(15+32\phi)G - 8(1+4\phi)]}{7(23+64\phi)}, \tag{10}$$

$$E^B = \frac{9G^B[(15+32\phi) - 8(1+4\phi)G]}{7(23+64\phi)}. \tag{11}$$

From (10) and (11), we have

$$\frac{\partial E^A}{\partial \phi} = -\frac{288G^B(G+1)}{(23+64\phi)^2}, \tag{12}$$

$$\frac{\partial E^B}{\partial \phi} = -\frac{288G^B(G+1)}{(23+64\phi)^2}, \tag{13}$$

where $\frac{\partial E^A}{\partial \phi} = \frac{\partial E^B}{\partial \phi} < 0$. This leads to the following proposition:

Proposition 2. *In a global pollution case, both countries will tighten their environmental policies as environmental consciousness rises.*

The economic intuition is similar to that in Proposition 1. Since the global pollution enlarges the marginal environmental damage ($\phi(E^A + E^B)$), which increases the cost to undertake slacken environmental policies. Hence, both countries will tighten their environmental policies.

5. Conclusion

This paper attempts to examine how an exporting country adjusts her environmental policy when worldwide environmental consciousness increases. We set up an oligopoly game where two large heterogeneous firms (countries) sell all their output in a third market. Governments move first by choosing environmental policies (emission standards) for their own firms. Firms take these standards as given and compete with each other by choosing output levels. Pollution emissions associated with output levels are either local pollution or global pollution.

This paper shows that, in a local pollution case, the country with high enough cost advantage to the rival has incentives to tighten while the other country to slacken their environmental policies as worldwide environmental consciousness increases. However, both countries will tighten their environmental policies if firms' cost competitiveness in both countries is near. In a global pollution case, regardless of relative cost competitiveness, both countries always tighten their environmental policies.

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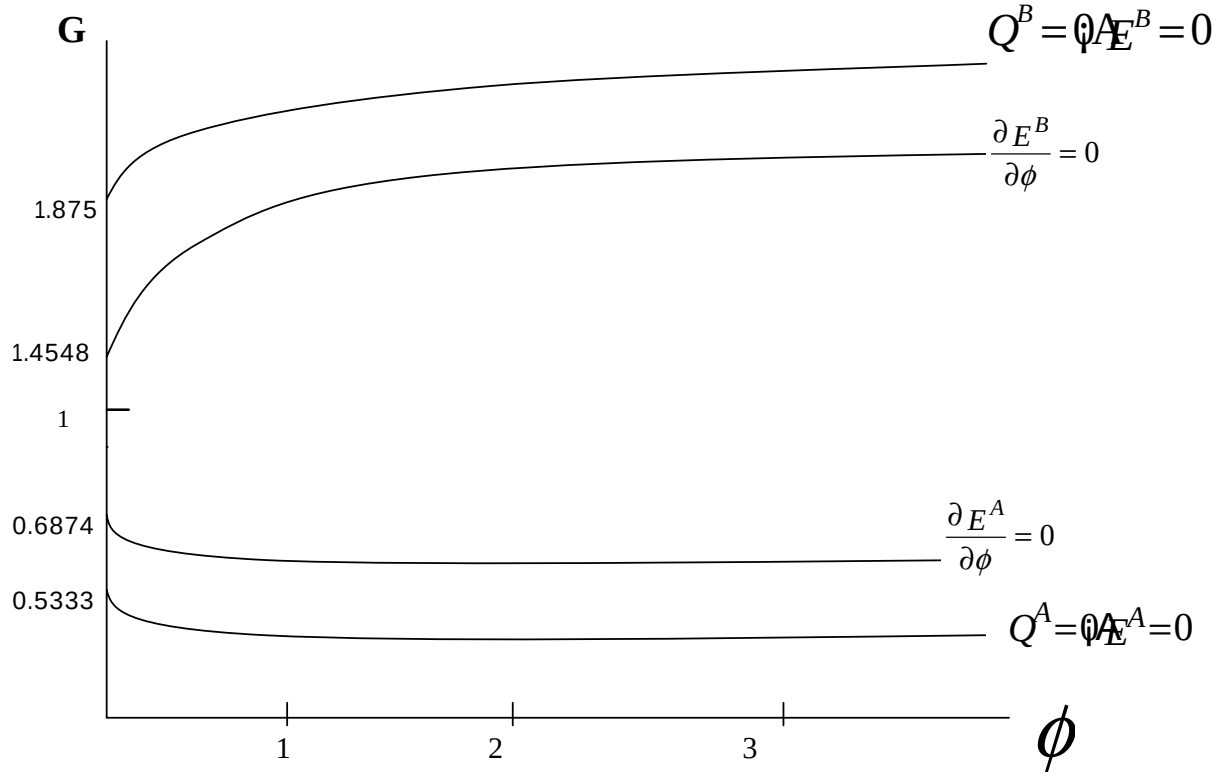

Fig.1: environmental policy adjustment