The Environmental Effect Analysis of the Internalization Policy of Environmental Costs in China

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Abstract*:* This paper build a model assuming the world composed of China (A) and B which analyzed the impact on environmental effects from the unilateral environmental taxes (fee), environmental tariffs and international cooperation under three kinds of environmental cost internalization policy. It has been proved that, with a given level of emissions, the global welfare is the lowest under the environmental costs internalization policy of the unilateral environmental taxes (fee), the environmental tariff has taken the second place, while the international cooperation reaches the maximum; when it comes to the environmental effect, the environmental costs internalization policy of the international cooperation turns out to be optimal, the environment tariff policy is the suboptimal, while the unilateral environmental taxes (fee) is the worst. Such a result is mainly aroused by the cross-border environmental externality phenomenon and the "free-riding effect" existing in unilateral environmental taxes (fee), thus driving profit for those countries whose environmental standards are relatively slack. Meanwhile, strict environmental costs internalization policy will make great contributions to enhancing the international competitiveness of enterprises in countries that have slack climate policies, namely the "rent transfer effect". The Environmental tariff and the environmental costs internalization policy of international cooperation can partially or completely eliminate the impact of these effects.

Keywords Environmental costs; The internalization policy; Environmental effect

Introduction

The environmental pollution has seriously threatened the sustainable development of economy, and coincidently, its external effects have also become a severe problem stuck in the way of the harmonious development of environment and society. Economists generally believe that the environmental quality is the product of all over the world, and the environmental problem is the result of the accumulation of all countries' emissions, which is supposed to be a dynamic problem of environmental externalities. The environmental costs internalization is an effective way to control the pollutant discharge and solve the problem of environmental externalities, while the environmental taxes (fee) is wildly applied in various countries as the most effective economic means of environmental costs internalization, whose effect has already been verified in those environmental-tax-collection OECD countries. So far, considering from all over the world, places that have started collecting the environmental taxes (fee) mainly lie in the countries of European Union, Australia and the United States, as well as some cities of Canada. China has achieved the environmental costs internalization to reduce the damage to the environment by collecting the pollutant discharge fee.

Along with the implementation of the Kyoto protocol, in order to enhance the industrial competitiveness at the same time to keep the promise of reducing emissions, the developed countries has transferred lots of industries of heavy pollution to the developing countries who have no tasks for emission reduction through FDI, thereby reducing the environmental effectiveness of their emission reduction and causing the cross-border environmental externalities. In the end of 2009, France put forward that, since the January 1, 2010, products imported from countries whose environmental legislation is not as strict as EU will be required for huge environmental tariffs. On June 22, 2009, the U.S. House of Representatives passed the American Clean Energy and Security Act, announcing that since 2020 the United States will have the right to collect the environmental tariffs for products imported from countries of non-emission-reduction quota, which provided a legal basis for the environmental tariff collection. Considering from the developed countries as United States, the European Union and so on, such measure means larger trading interests with lower prices for those importing products since their international prices will be cut down due to the reduction of import caused by the huge tariffs imposed on those polluting products. At the same time, China has started relatively late in those fields, thus being vulnerable in the industrial structure and emission reduction technology compared with the developed country.

Since for now China is the country of the largest carbon emissions in the world and the one who has promised to reduce the 2020 levels of amount of carbon dioxide produced per unit of GDP by 40%—50% compared with that of 2005 levels before the Copenhagen Climate Conference, a seriously stressed future of carbon emission is waiting for China.

Therefore, research on the environmental effect of environmental costs internalization policy as well as its solutions becomes very urgent, and moreover, it's endowed with great theoretical value and realistic significance. In view of this, this thesis has built the dynamic differential game model to study and compare the impact on the emissions and the welfare of various countries brought by the environmental costs internalization policy under three different circumstances, based on the most influential and controversial environmental costs internalization policies for current such as the environmental taxes (fee), the environmental tariffs and the international cooperation policies, etc.

ANALYSIS ON THE EFFECT OF CHINESE ENVIRONMENTAL COSTS INTERNALIZATION POLICY

The internalization of environment cost policy is that the government forces companies to achieve external environmental cost internalization and calibration environment external economic problems by levying Environmental taxes to achieve a series of policies such as saving resources, protect the ecological environment .The basic idea of Environmental tax is a tax on emissions of pollutants and the use of natural resources.It is an effective policy tool on educing emissions, and realize the coordinated development of the economic and environmental.

Assuming the world consists of China(A) and another country B. These two countries' enterprises produce homogeneous products and the marginal cost is zero. Production of enterprises from China(A) is Q_A , production for domestic consumption is h, at the same time, the amount of exports to country B is n. The production of country B is Q_A , production for domestic consumption is g, meanwhile , the amount of exports to country B is m. The inverse demand function of market is set to $P_h = P_m = 1-(h+m)$
$P_x = P_f = 1-(n+g)$

So the benefits of A and B, respectively is:
$R_1 = [1-(h+m)]h + [1-(x+g)]n$
$R_2 = [1-(h+m)]m + [1-(n+g)]g$

Since every enterprise will discharge pollutants in the process of production, which damage the ecological environment. And moreover, the amount of emissions will be accumulated over time, causing the deterioration of global ecological environment. To control the negative effect brought by the pollution of the environment, various governments shall achieve the environmental costs internalization by collecting environmental taxes (fee) from the enterprises for net emissions and by building the profit-driven system among enterprises to realize the environmental costs internalization.

This text assumes that the unit products have the unit amount of emissions, and the two countries have the same technology to reduce emissions, and meanwhile the cost to reduce unit a's pollution emission is $C(a) = \frac{1}{2}a^2$. At time t, the pollution stock for the whole world is Z (t) which satisfies the dynamic equations as following:

$$E(Z) = d\dot{Z}(t)/dt = \sum_{i=A,B}[Q_i(t)-a_i(t)] - \delta Z(t)$$
$$Z(0) = Z_0 \qquad (1)$$
$$Z_0 > 0$$

Among them: $Q_i(t)$ is the production of country i, $a_i(t)$ is the reduction of the enterprises among various countries, $\delta(\geq 0)$ is the decline rate for pollution inventory.

The negative utility function brought by the global ecological environmental worsening, namely the environmental damage function, which is the same in every country, is $D_i(Z) = Z^2/2$. Considering the following three conditions:

(1) China implements the environmental costs internalization without protest, namely to levy the environmental tax on domestic enterprises, but country B do not implement. A (China) doesn't collect environmental duties from country B;

(2) China implements environmental costs internalization without protest, country B does not implemented, namely China levies environmental tax on domestic enterprises, and collects environmental dutiesт from country B;

(3) China and B carry out international cooperation, and they collect environmental taxes $t_{A,tt}$, $t_{B,tt}$ for domestic enterprises respectively.

Analysis on the Effect of the Environment Costs Internalization Policy under the Unilateral Environmental Tax

Assuming that China implement environmental cost internalization without protest, while country B is not currently implemented. Chinese government collects environmental taxes (fee) from the enterprise on net emissions to control their own emissions: $h_t + n_t - a > 0$ .Under the current policy on the internalization of environmental cost, the enterprise profit of these two countries A and B is:

$$\pi_{A,t} = R_A - C(a) - t_t(h_t + n_t - a) \qquad (2)$$
$$\pi_{B,t} = R_B$$

t_t is the environmental taxes imposed by the government in China A. Assuming t_t is exogenous, given under Cournot - Nash equilibrium, the first-order condition is met:

$$\partial \pi_{A,t} / \partial h_t = 1 - 2h_t - m_t = 0$$
$$\partial \pi_{A,t} / \partial n_t = 1 - 2n_t - g_t - t_t = 0 \quad (3)$$
$$\partial \pi_{A,t} / \partial a = t_t - a = 0$$
$$\partial \pi_{B,t} / \partial m_t = 1 - h_t - 2m_t = 0$$
$$\partial \pi_{B,t} / \partial g_t = 1 - n_t - 2g_t = 0$$

We can have the solution:

$$h_t^{CN} = n_t^{CN} = \frac{1 - 2t_t}{3}$$
$$m_t^{CN} = g_t^{CN} = \frac{1 + t_t}{3} \quad (4)$$
$$t_t^{CN} = a$$

Accordingly, if $t_t = 0$, both sides are equal, and there exist no cross-border environmental externalities problems. But if the two sides perform the different internalization of environment cost policies, namely $t_t > 0$, the emissions of country A is $h_t + n_t - a$, country B 's emissions is $m_t + g_t$, which lead to both sides unequal, and countries in the implementation of the relatively loose environment standard have higher emissions, appearing environmental externalities across borders. In addition, the implementation of different standards of the internalization of environmental costs policy will still produce "free-riding effect" proposed by Marschinski et al. (2010). Due to the execution of the relatively strict environmental standards, global pollution will be reduced, countries in the implementation of the relatively loose environment standard benefit for free, and this is known as the "free-riding effect". Secondly, emission levels are only related to the environment tax rate tax (fee), the increase of taxes will enhance the emission reduction, and the output is also relevant to the tax rate. Country A's increase of environmental taxes (fee) rate will lead to the reduction of the amount of domestic enterprises, but instead give rise to the increase of the production of country B's competitive enterprise. This is known as the "rent transfer effect" proposed by Marschinski et al (2010).

Therefore, if the China carry out a strict environmental cost internalization policy, it will improve competitiveness of the enterprises of countries whose internalization of environmental costs policy is loose, namely the "rent transfer effect", China's exertion of environmental costs internalization policy under the unilateral environmental taxes (fee) produces cross-border environmental externality phenomenon and the "free-riding effect", benefitting those countries whose environmental standards are relatively loose.

Analysis of the internalization of environment cost under the environment tariff effect policy

Due to the existence of cross-border environmental externalities, "free-riding effect" and "rent transfer effect", the game party doesn't enforce strict emission standards in the international market competition motivation. According to the WTO ruling,

voluntary nations that implement the internalization of environmental costs without protest can punish the countries that don't. It is assumed that a tariff for the environment. Assume that country A collect environmental duties from country B for export products, environment tariff is expressed as τ.

This time the profits of enterprises in China remain unchanged, it is still $\pi_{A,\tau} = R_A - K(a) - t_\tau(h_\tau^{CN} + n_\tau^{CN} - a)$, profit of enterprises in country B is $\pi_{B,\tau} = R_B - m\tau$, by equilibrium solution it can be obtained that the solution of the first-order conditions is:

$$h_\tau^{CN} = (1 - 2t_\tau + \tau)/3$$
$$n_\tau^{CN} = (1 - 2t_\tau)/3$$
$$m_\tau^{CN} = (1 + t_\tau - 2\tau)/3 \quad (5)$$
$$g_\tau^{CN} = (1 + t_\tau)/3$$
$$t_\tau = a(10)$$

It is visible that, as long as $t_\tau > 0$ country A collect environmental duties from B who hasn't implemented the internalization of environmental costs will cause the rise of domestic enterprises production.The decrease of Country B's production is beneficial to restore the normal order of international trade competition and to promote the internalization of environment cost measures in B countries. If $\tau = t_\tau$, it will eliminate environmental externalities across borders, "free-riding effect" and "rent transfer effect". According to the WTO ruling, the environment duties shall not be higher than the corresponding environmental taxes, therefore, the optimal carbon tariffs is: $\tau^* = t_\tau$.

In view of this, the internalization of environmental costs for environmental tariffs policy implemented in China will be beneficial to reduce the environmental externalities across borders, "free-riding effect" and "rent transfer effect", and it is adding pressures to the country who hasn't implemented the policy. Optimal policy for the environmental tariffs is $\tau^* = t_\tau$ .If China's environmental tariff is equal to the environment tax ($\tau = t_\tau$), it will eliminate the cross-border environmental externalities issues, "free-riding effect" issues and "rent transfer effect" issues.

From this perspective, environmental costs policy under the environmental tariffs can be called as the internalization of environmental of punishment policy.

Analysis of the Effect on the Environment Costs Internalization Policy under the International Cooperation

Because A (China) collect environmental duties, country B's production may have declined. So the country B necessarily implement environmental costs

internalization policy to eliminate the influence of environmental tariffs in China. Assuming that the two countries have the identical technology in reducing emissions, then enterprise's profit function is $\pi_{i,tt} = R_i - K_i(a) - t_i(Q_i - a)$: Q_i is the production of the party i, i = A, B $Q_A = h+n$, $Q_A = m+g$ .By the first-order condition we can get the solution:

$$h_{tt}^{CN} = n_{tt}^{CN} = \left(1 - 2t_{A,tt} + t_{B,tt}\right)/3$$

$$m_{tt}^{CN} = g_{tt}^{CN} = \left(1 + t_{A,tt} - 2t_{B,tt}\right)/3 \quad （6）$$

$$t_{A,tt} = t_{B,tt} = a$$

Which are:

$\partial(h_{tt}^{CN} + n_{tt}^{CN})/\partial t_{A,tt} < 0$, $\partial(m_{tt}^{CN} + g_{tt}^{CN})/\partial t_{B,tt} < 0$, $\partial(h_{tt}^{CN} + n_{tt}^{CN})/\partial t_{B,tt} > 0$, $\partial(m_{tt}^{CN} + g_{tt}^{CN})/\partial t_{A,tt} > 0$ .namely a country's output is not only influenced by its environmental taxes (fee),but also related to foreign environment tax. A country's output will decrease when their environmental taxes (fee) rate increase, and will also increase when the environmental taxes (fee) rate increases in other countries. If two countries' environmental taxes (fee) rates are equal, the two countries' amount of emissions will be equal. At this point there is no cross-border environmental externalities, and no "free-riding effect" and "rent transfer effect".

It is visible that if China and foreign countries have taken the environmental costs internalization policies under international cooperation, it will completely eliminate the cross-border environmental externalities, "free-riding effect" and "rent transfer effect".

COMPARISON OF THE EFFECT OF CHINESE ENVIRONMENT COSTS INTERNALIZATION

For comparison, assuming that China (A)'s environmental taxes (fee) in the three conditions are the same, namely $t_t = t_\tau = t_{A,tt}$,and the optimal solution is $t_\tau = t_{A,tt} = a$ .Under three conditions of the internalization of environment cost policy, A, B and global emissions under the three policy are listed in table 1.

From table 1 it can be seen that, Compared with the tax policy of the internalization of environment cost under the unilateral environment , Tariffs under the environment of the internalization of environment cost is not conducive to the internalization of environmental costs in China ,but it can promote the internalization of environmental costs in other countries .The effect of international cooperation and environmental duty of the internalization of environment cost policy environment is the same ,but environmental effect is bigger.It is visible that ,in order to achieve the optimal environmental effect, international cooperation of the environmental cost internalization policy is optimal

International cooperation of the environmental cost internalization policy is optimal, and environment tariff policy followed the internalization of environment cost (emission reductions for emissions reductions under the cooperation of half). The environmental costs internalization policy of unilateral environmental taxes (fee) is the worst. The environmental cost internalization policy of the environmental tariffs is a believable and effective threat strategy in prompting the policy of international cooperation of environmental cost adopted internalization.

Table 1: comparison of emissions under different environmental cost internalization policy

indicators	Unilateral environmental taxes (fee)	Environmental tariffs	International cooperation
Emissions of A	CQ_t^A $\dfrac{2}{3} - \dfrac{4}{3}t_t$	CQ_τ^A $\dfrac{2}{3}(1 - 2t_t) + \dfrac{1}{3}\tau$	CQ_{tt}^A $\dfrac{2}{3}(1 - 2t_{A,tt}) + \dfrac{2}{3}t_{B,tt}$
Emissions of B	CQ_t^B $\dfrac{2}{3} + \dfrac{2}{3}t_t$	CQ_τ^B $\dfrac{2}{3}(1 + t_t) - \dfrac{2}{3}\tau$	CQ_{tt}^B $\dfrac{2}{3}(1 + t_{A,tt}) - \dfrac{4}{3}t_{B,tt}$
World emissions	CQ_t $\dfrac{4}{3} - \dfrac{2}{3}t_t$	CQ_τ $\dfrac{2}{3}(2 - t_t) - \dfrac{1}{3}\tau$	CQ_{tt} $\dfrac{2}{3}(2 - t_{A,tt}) - \dfrac{2}{3}t_{B,tt}$
Increased emissions of A		$\Delta CQ_A^1 = \dfrac{\tau}{3}$	$\Delta CQ_A^2 = 2t_{B,tt}$
Increased emissions of B		$\Delta CQ_B^1 = -\dfrac{2\tau}{3}$	$\Delta CQ_B^2 = -4t_{B,tt}$
World emissions growth		$\Delta CQ^1 = -\dfrac{\tau}{3}$	$\Delta CQ^2 = -2t_{B,tt}$

Note: $\Delta CQ_A^1 = CQ_\tau^A - CQ_t^A$, $\Delta CQ_B^1 = CQ_\tau^B - CQ_t^B$,

$\Delta CQ^1 = CQ_\tau - CQ_t$, $\Delta CQ_A^2 = CQ_{tt}^A - CQ_t^A$ $\Delta CQ_B^2 = CQ_{tt}^B - CQ_t^B$, $\Delta CQ^2 = CQ_{tt} - CQ_t$. In order to get to a facilitate comparison, Assuming that $t_t = t_\tau = t_{A,tt}$

Substitute the obtained parameters into the plug (1), we get the stock of pollution under different environmental cost internalization policy:

$$E_t(Z) = [18 + 25(A_t Z + B_t)]/11 - \delta Z$$

$$E_\tau(Z) = [9 + 13(A_\tau Z + B_\tau)]/5 - \delta Z \quad （7）$$

$$E_{tt}(Z) = [24 + 50(A_{tt}Z + B_{tt})]/13 - \delta$$

Compare the stock of pollution under three situations:

$E_t'(Z) - E_\tau'(Z) = 25/11 A_t - 13/5 A_\tau = \rho_t - \rho_\tau > 0$ This means that the slope ratio of $E_t(Z)$ is bigger than $E_\tau(Z)$'s

$E_t(0) - E_\tau(0) = 9\{2/[11(r + \delta - \rho_t)] - 1/[5(r + \delta - \rho_\tau)]\}(r + \delta) > 0$

that is $E_\tau(0) > E_t(0)$. China's unilateral environmental taxes (fee) of the internalization of environment cost

under the policy of pollution amount greater than tariffs under the environment cost internalization pollution inventory policy

As follows,we can say that $E'_{\tau}(Z) > E'_{tt}(Z)$ China's stock of pollution of environmental costs internalization under environmental taxes (fee) is greater than the stock of pollution under the reduction cooperation.

Therefore, for a given level of pollution Z, China's unilateral environmental taxes (fee) of the internalization of environment cost under the policy of pollution amount greater than tariffs under the environment cost internalization policy of pollution,and the stock is greater than the international cooperation under the environmental cost internalization pollution inventory policy.

CONCLUSION

This thesis analyzes the impact of the internalization of environmental policy on the global welfare and global pollution under three cases by constructing differential game model which is assuming that the world is composed of China and national B. At a given level of the sewage, by comparison, the global welfare is the minimum under unilateral environmental taxes (fee) of the environmental cost internalization policy in China. Environmental tariff policy has taken the second place, while the international cooperation under the environmental cost internalization policy is the maximum;

Therefore, all countries should take an active part in international cooperation and formulate plans and schemes related to the environmental cost internalization policy, if the international cooperation of the environmental cost internalization policy is not fully implemented, countries who have been involved in the international cooperation and environmental taxes (fee) will carry out tariff policy on those who haven't, forcing it to participate in international cooperation plan and scheme or actively implement environmental taxes (fee) policy. This will eliminate the cross-border environmental externalities, "free-riding effect" and "rent transfer effect", and is helpful for the improvement of the national welfare and the global welfare. In the near term, China's emission reduction pressure is pretty tough, so they should optimize the existing environment tax (fee) policy, reflect their initiative to participate in the global environment pollution control and cooperation, and actively participate in the international cooperation and solution of the scheme. On the one hand, when negotiations with the developed country China can

have the initiative, on the other hand, they can keep the wealth stay at home rather than rush to other countries through the environmental tariff.

In the long run, countries all over the world should take the initiative to implement the environmental cost internalization policy, insist on the principle of "common but differentiated responsibilities" in the international cooperation plan, pay attention to the rationality of the environmental objectives and make practical and effective to ensure the system arrangement will become the key factor. Under the Kyoto protocol, through controlling the total global emissions amount, environmental cost internalization policies are advancing to environmental taxes (fee), international cooperation of environmental cost internalization policy from the environmental tax, suggesting the environmental cost internalization policies of international cooperation's optimality. Although in the short term, the achievement of international partnership has certain difficulty, but in the long term this can yet be regarded as a better solution.

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