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Developing the Economic Model of Green Tax for Polluting Industries

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Abstract: Environmental problems are not new phenomena. The production process of private market is usually associated with unwanted by-products such as industrial wastes which are released into the environment. Each firm may reduce its emission by using pollutants abatement technologies which bring marginal abatement cost to the firm. This paper develops a green tax model for Iranian pulp and paper industry which is one of the polluting industries in Iran. Government can impose green tax as a fiscal policy instrument, on the polluting industries. With respect to direct and indirect taxes, green tax has more advantages, because it can provide more revenue for the government. Moreover it can also reduce the negative effect of externalities. Theoretical result indicates that the tax rate is inversely related to the waste proportion and it is directly related to the difference between price and marginal cost. Based on this theoretical model and using pooled cross section and time series data the green tax rate of 7.14% is obtained as the empirical result of the paper.

Key words: Green tax · Panel data · Shepard's lemma · Abatement cost · Waste proportion

INTRODUCTION

Since environmental quality and protection are the major challenges and concerns of policy makers, environmental tax reform has become increasingly popular issues in recent years.Goulder [1, 2] argued that green tax provides a "double dividend" not only raising government revenues used to reduce existing tax distortions, but also used as an efficient instrument for environmental conservation and cleaner environment. Double dividend hypothesis was considerably reformed by Bovenberg and de Mooij [3], Parry [4], Oates [5], Bovenberg and Goulder [6]. Pearce [7] and Repetto [8] believed that the "triple dividend" impacts of a green tax are 1. improved environment quality and amenities, 2. contribution to a reduction in the overall excess burden of tax system and 3. helping to alleviate unemployment problem. Bohringer [9] pointed out that green tax system was highly political agenda among OECD countries. This is why many researches were oriented with financial support regarding the green tax policies over the last decade. In environmental economics, a pollution tax was first introduced by Pigou [10]. Pollution stock as a negative externality damages social welfare. So a polluter must pay for the damages of its polluting activities. Subsequently the theory of externality has been emphasized by Sandmo [11a,b]. Externality can be internalized by the optimal environmental tax to restore efficiency in production and consumption through market mechanism. The internalization of negative externalities by the green tax instrument can induce private market agents toward lower damages as illustrated by Koskela and schob [12] and Martin Hill [13]. Green tax reform is a new financial instrument to reduce social damage cost and to improve environmental quality and also to control the polluting firms within industry. Many OECD countries such as Sweden apply green tax as a tax reform. Thus the main aim of this paper is to introduce green tax application in pulp and paper industries in the selected provinces in Iran industrial sector. For this purpose, a theoretical green tax model is developed in order to show how it can be employed in practice. Materials and methods section deals with a theoretical model of green tax, whereas its application for pulp and paper industries in the six

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provinces is provided by using pooled cross section and time series data. The next section discusses the results of the model and the last section concludes.

MATERIALS AND METHODS

Data Set: The theoretical model developed in this section is applied to the third polluting industries, pulp and paper industries, in Iran. The needed data of pulp and paper industries is collected for the time period 1380-1385.

These industries are located in the provinces of Tehran, Fars, Khozestan, Gilan, Mazandran,and Markazi. The variables used in the model are:

Capital cost, labor wage, water and energy expenditure, maintaining and repairing costs for tools and equipment.

A Theoretical Model of Green Tax: Assume that a polluting industry which has increasing cost, produces a commodity q, with cost function C= C (q), where (1) $C_q(q)=\frac{dC}{dq}$ is the marginal cost. As output increase the marginal cost increases that lead to:

$$C_{qq}=\frac{dMC}{dq}>0 \tag{2}$$

Let P be the market competitive price and ℓ be the output proportion that can be changed to waste by-products. Then we have:

$$B = \ell q \tag{3}$$

In above formula B is the pollutant that is released to the environment as solid wastes and wastewater.

Suppose that environmental tax rate, t, imposed by the government to the polluting firms and then the total tax or the government revenue will be:

$$T = t B \tag{4}$$

In this case, the firm's profit function can be written as:

$$\Pi = pq - C(q) - tB \tag{5}$$

The point- and non point-based sources of pollutants emission are the major causes of damages victimized not only human beings but also plants, wildlife and they also change the ecosystem diversities. These damages expand their impacts as depletion and non-depletion negative externalities. By imposing green tax, the government internalizes the negative externality costs caused by the pollutants. To obtain the optimal level of output, a polluter firm maximizes its own profit as follow:

$$\frac{\partial \Pi}{\partial q}=0, \quad P=C_q(q)+t\ell \tag{6}$$

The second order condition of maximization process which is negative definite, gives us the optimum level of output we can also obtain the output proportion that can be changed to waste by-products from the first order condition, equation (6) as below:

$$\frac{\partial^2 \Pi}{\partial q^2}<0 \tag{7}$$

$$\frac{\partial^2 \Pi}{\partial q^2}=-\frac{\partial MC}{\partial q}<0 \quad Or \quad \frac{\partial MC}{\partial q}>0 \tag{8}$$

$$\ell=\frac{P-C_q(q)}{t} \tag{9}$$

It indicates that a green tax rate is inversely related to the pollutants emission parameter.

Let n be the inputs used in production process associated with pollutant by-products, then a polluter total cost function in the logarithmic form can be shown as:

$$\log C=\alpha_0+\sum_{i=1}^{n}\alpha_i \log r_i+\frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n}\gamma_{ij}\log r_i \log r_j+\sum_{i=1}^{n}\beta_i \log r_i \log q \tag{10}$$

Where:

r_i is the competitive market price of i th input paid by polluting firms. Using Shepard's lemma, each input expenditure share, w_i, is obtained by taking derivative from equation (10) with respect to r_i, so that the final outcomes can be extracted as:

$$w_i=\frac{r_i x_i}{C} \tag{11}$$

I=1, 2, 3,..., n

$$w_i=\alpha_i+\sum_{j=1}^{n}\gamma_{ij}\log r_j+\beta_i \log q \tag{12}$$

By estimating n-1 equations of the input's expenditure share, the coefficients of equation (12) or the parameter β_i for all, i, can be obtained.

From the price-cost margin of equation (9) and the cost function of equation (10), we can derive the marginal cost equation. The partial derivative of equation (10) with respect to output is summarized as:

$$\frac{\partial \log C}{\partial \log q} = \sum_{i=1}^{n} \beta_i \log r_i \quad (13)$$

Where:

$$\frac{C_q(q)}{AC} = \frac{\partial \log C}{\partial \log q} \quad (14)$$

is the elasticity of total cost function with respect to output and AC is the total average cost.

RESULTS AND DISCUSSION

In the production process, unwanted by-products such as industrial wastes, suspended solids, organic materials, color and chemical materials are released into the environment. The proportion of wastewater, cellulose substances, solid wastes and the other pollutants materials which are produced in the private market is higher than the world permitted standard.

All input costs such as capital expenditure, labor wage, water and energy expenses, maintaining and repairing costs are used in order to estimate the parameters of equation (12) or the share cost's equations. Their estimated β_i's with t-statistical values are summarized in Table1.

The pooled cross section and time series data econometric technique are applied for estimating the parameters of equation (12).

By substituting the estimated β's coefficient associated with the mean values of independent variable in the cost function elasticity denoted by equation (13), we obtain the value of 0.143 which represents the ratio of marginal cost over average cost. Using the calculated average cost, 0.59, the value of marginal cost will be 0.0844. Since the price of paper per ton is approximately 0.1024 milliard Rials, price- marginal cost margin becomes 0.018, so that the equilibrium relationship as noted by (9) is determined as follows:

$$\ell = \frac{0/018}{1} \quad (15)$$

Table 1: Estimated β_i's with t-statistical values

Input expenditure share costs	t- values	Estimated β values
Capital expenditure	2.1970	0.046
Labor wage	1.51	0.037
water expenses	1.57	0.006
Maintaining and repairing costs	1.61	0.008
Electricity costs	1.88	0.01
Fuel expenditure	1.83	0.022

Due to the equation (3), if $\ell = 1$, the instantaneous commodity units produced as a good commodity, q, transforms into the instantaneous waste units, B, as a bad good which is the by-product of the production process. However, it is obvious that ℓ always varies between one and zero, with upper and lower limits of one and zero respectively[1]. As the recycling dynamic model developed by V.L. Smith (14) in order to transform the waste disposal ℓ can be one.

Experts in the pulp and paper industry claim that about 25 percent of the final private market good is consisted of wastes which are created in the production process, therefore the rate of green tax can be calculated as 7.14 percent. According to equation (15), by increasing a green tax rate, a proportion of wastes will be decreased.

CONCLUSION

Green tax as a government fiscal policy instrument can be imposed on the firms within polluting industries, due to its advantages with respect to government direct and indirect taxes. It can provide not only government revenues but also reduce the negative effect of pollution externalities. Each firm may reduce its pollutants emission through production declines or using abatement technologies for emission reduction. Using pooled cross section and time series method, this paper estimates that the rate of green tax for the pulp and paper industry is about 7.14 percent and if the government imposes this tax rate, it may force the polluters to use clean technologies in their production process. In addition, many different irreversible outcomes of social damages and victims caused by pollutions will decrease.

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