A Note on Environmental Policy Reform, Distortionary Taxation and Imperfect Competition*

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Abstract

This paper concerns the welfare effects of public abatement projects, and concentrates on the influence of distortionary taxes and imperfect competition in the labor market. In addition to the direct environmental benefits and costs of resource use, abatement policies give rise to welfare effects via the tax system as well as via changes in the employment. We also show how the cost benefit rule is modified, if the other policy instrument are optimally chosen conditional on the level of abatement.

Keywords: Environmental policy, distortionary taxation, the labor market

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1 Introduction

The welfare effects of environmental policy reform are commonly analyzed by means of cost benefit analysis. In light of the Kyoto Protocol and other agreements to reduce pollution, this literature has increased rapidly since the

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mid 1990s. With a few exceptions[1], previous studies typically concentrate on various aspects of measuring the direct environmental benefits of such reforms and/or the direct costs. Although important for our understanding of environmental policy, this means that previous studies commonly neglect that the welfare effects of such policy reforms depend on the functioning of the economic system. Real world market economies are often characterized by a number of distortions, each of which may influence the welfare effects of projects aimed at improving the environment[2].

In this short paper, we consider cost benefit rules for public abatement policies under preexisting taxes on labor income, capital income and energy input as well as imperfect competition in the labor market. As such, the paper provides a natural complement to the literature cost benefit analysis of environmentally motivated projects, where preexisting distortions are often being neglected, as well as to the literature on environmental taxation in the presence of other tax distortions. The paper is, to some extent, an offspring from Aronsson et al. (2002), in which we analyze the welfare effects of increased provision of a public good, in case the other preexisting policy instruments are not optimally chosen. We shall here extend their analysis to an economy with environmental damage as well as by considering the situation where the taxes and other public expenditures are optimally chosen conditional on the public expenditures on abatement.

[1]The main exceptions refer to the literature on environmental taxes and/or environmental tax reform in the presence of other tax distortions; see e.g. Bovenberg and de Mooij (1994), Bovenberg and Goulder (1996), Parry et al. (1999) and Aronsson (1999).

[2]Methodological discussions of cost benefit analysis in environmental economics are not typically concerned with public sector aspects or labor market aspects of environmental projects. The focus is, instead, concentrated on other issues such as the valuation of nonmarket goods, equity, uncertainty and the evolution of the ecosystem. See e.g. Pindyck (2000), Tol (2001) and the practical application by Sarafides et al. (2002). See also the introductory text by Hanley (2000) and the references therein.

2 The Model

The production side of the economy consists of many identical competitive firms, which produce a homogenous good by using labor and energy as the variable production factors. Since the firms are identical, we describe the production side in terms of a single competitive firm. The objective function can be written

$$\Pi = f(L, g) - wL - tg \tag{1}$$

where Π is profits, L total employment, g energy use in production, w the wage rate and t an energy tax. Total employment, L, is measured as the hours of work per employee, l, times the number of employed persons, N. The production function, $f(\cdot)$, is increasing in each argument and strictly concave, and we assume that the firm treats w, l and t as exogenous. The first order conditions implicitly define the labor demand and energy demand functions. By using the labor demand, we can define the number of persons to be employed conditional on the hours of work per employee,

$$N = N(w, l, t) \tag{2}$$

Note also that, without loss of generality, we assume that the supply of energy is infinitely elastic. The marginal cost of producing energy is set to zero for notational convenience.

There are M consumers in the economy, among which N are employed and $M - N$ unemployed. The consumers share a common utility function, $u = u(c, z, x)$, where c is private consumption, z leisure and x environmental quality. The utility function is assumed to be increasing in each argument and strictly quasiconcave. The consumers treat x as exogenous. If employed, the budget constraint facing an individual can be written as $c^e = wl(1 - \tau) + \pi(1 - s)$, where τ is the labor income tax rate, π profit income and s the profit income tax rate. By using $z = T - l$, where T is a time endowment, the first order condition for the hours of work is given by

$$u_c^e w(1 - \tau) - u_z^e = 0 \tag{3}$$

in which $u_c^e = \partial u(c^e, z)/\partial c^e$ and $u_z^e = \partial u(c^e, z)/\partial z$. In a similar way, for an unemployed individual, the budget constraint is given by $c^u = q + \pi(1-s)$, where q is a fixed unemployment benefit. Profit income is divided equally among consumers[3], meaning that $\pi = \Pi/M$.

We will make two important assumptions about wage formation; (i) the wage formation system causes unemployment, and (ii) wage formation is decentralized[4]. We interpret the latter to mean that the wage setters treat the policy instruments facing the government and π as exogenous (recall that π reflects the profit level in the economy as a whole and not the particular firm where an individual happens to be employed). Examples of such systems include wage bargaining between local unions and firms in the context of the 'right-to-manage' framework[5] and the efficiency wage model. The wage rate will be written as a general function of τ, s, π, t, q and x, i.e.[6]

$$w = \omega(\tau, s, \pi, t, q, x), \tag{4}$$

The government collects tax revenues to finance the benefit to the unemployed and expenditures on abatement. The budget constraint facing the government is written

[3] An alternative might be to introduce a 'firm-owner', whose income consists of profits, while the consumption sets of the employed and unemployed only consist of labor income and unemployment benefits, respectively. Such a change of assumption will influence the distributional aspects of environmental policy. It is not important for the qualitative effects associated with the preexisting taxes and employment, which are of main concern below.

[4] Although bargaining systems differ across countries, Calmfors (1993) argues that there has been a tendency towards more decentralized wage formation.

[5] An overview of models used to analyze unionized labor markets is given by Oswald (1985).

[6] It is straight forward to interpret equation (4) as the outcome of union wage formation. Under right-to-manage wage setting, the objectives and constraints of employed and unemployed union members, as well as the parameters facing the firm, will affect the wage rate. In an efficiency wage model, on the other hand, the tax system may only affect the equilibrium wage rate if it has an influence on the effort function.

$$\tau wNl + tg + s\Pi - (M - N)\, q - \alpha = 0 \tag{5}$$

where α represents the resources spent on abatement. By combining the private budget constraints, the objective function of the firm and the government budget constraint, we obtain the resource constraint

$$f\,(Nl, g) - Nc^e - (M - N)\, c^u - \alpha = 0 \tag{6}$$

which will be used below.

Finally, the environmental quality, x, will be assumed to be a decreasing function of energy use in production and an increasing function of the expenditures on abatement. We have

$$x = p(g, \alpha) \tag{7}$$

where $\partial p/\partial g < 0$ and $\partial p/\partial \alpha > 0$.

3 A General Cost Benefit Rule for α

In this section, we shall only require that the private sector has chosen its decision variables, l, w, N and g, in an optimal way conditional on the policy instruments. By using the necessary conditions for these decision variables together with equation (7), which enables us to write x in terms of g and α, we can define l, w, N and g as functions of τ, s, t, q and α. Suppose also that the energy tax is used to raise the additional revenues needed to finance increases in the level of abatement. This means that the behavioral equations can be written as $l^0 = l\,(\tau, s, q, \alpha)$, $w^0 = w\,(\tau, s, q, \alpha)$, $N^0 = N\,(\tau, s, q, \alpha)$ and $g^0 = g(\tau, s, q, \alpha)$, in which we recognize that the energy tax will be a function of the other policy instruments, $t = t(\tau, s, q, \alpha)$. The superindex "0" is used to denote that the private sector has made an optimal choice conditional on the policy instruments.

We assume a Utilitarian social welfare function;

$$W^0 = N^0 u(c^{e,0}, T - l^0, x^0) + \left(M - N^0\right) u(c^{u,0}, T, x^0) \tag{8}$$

To shorten the notations below, let us define $u^e = u(c^e, z, x)$, $u^u = u(c^u, T, x)$, $\triangle u = u^e - u^u$, $B = [Nu_x^e + (M-N)u_x^u][\partial x/\partial\alpha]$ and $\partial x/\partial\alpha = [\partial p(g,\alpha)/\partial g]$ $[\partial g/\partial\alpha] + \partial p(g,\alpha)/\partial\alpha$. Differentiating equations (6) and (8) with respect to α, and using the private budget constraints in combination with the necessary condition for the hours of work, we obtain;

Proposition 1 *Within the given framework, the cost benefit rule for* α *can be written*

$$\begin{aligned}\frac{\partial W^0}{\partial\alpha} &= B^0 - u_c^{e,0} + u_c^{e,0}\left[\tau N^0(w^0\frac{\partial l^0}{\partial\alpha} + \frac{\partial w^0}{\partial\alpha}l^0) + s\frac{\partial\Pi^0}{\partial\alpha} + t\frac{\partial g}{\alpha} + \frac{\partial t}{\partial\alpha}g\right] \\ &\quad + \left[\Delta u^0 + u_c^e(\tau w^0 l^0 + q)\right]\frac{\partial N^0}{\partial\alpha} + u_c^{e,0}\beta^e - u_c^{u,0}\beta^u \end{aligned} \tag{9}$$

where

$$\begin{aligned}\beta^e &= N\left[\frac{\partial w}{\partial\alpha}l(1-\tau) + \frac{\partial\pi}{\partial\alpha}(1-s)\right] \\ \beta^u &= (M-N)\frac{\partial\pi}{\partial\alpha}(1-s)\end{aligned}$$

In addition to the difference between the direct marginal benefits and costs, $B^0 - u_c^{e,0}$, there are three remaining effects which have to do with the functioning of the economic system. The third term in the first row (containing the bracket) represents the welfare effects via the preexisting tax system, which are measured conditional on the number of employed persons, and the tax revenue effect associated with the change in the energy tax rate. Each preexisting tax influences the cost benefit rule for abatement via a tax base effect, and an increase in the abatement may either increase or decrease the preexisting tax distortions. The first part of the second row measures the welfare effects associated with changes in the number of employed persons. Additional employment implies a utility gain for those who become employed (the first term within the bracket) and an increase in the tax revenues net of transfer payment (the second term within the bracket). Finally, the last two terms in the second row, together, measure a distributional effect associated with the changes in w and t: changes in w affect both the labor income and the profit income, and changes in t affect the profit income. This distributional effect arises because unemployment gives rise to heterogeneity among consumers.

4 Cost Benefit Analysis in the Conditional Second Best

So far, we have made no assumptions about how the government has chosen the other policy instruments (other than the expenditures on abatement). This means that the cost benefit analysis carried out in the previous section applies to any initial level of the policy variables. Suppose, instead, that the government has chosen τ, s, t and q conditional on α by maximizing the social welfare function subject to the necessary conditions of the private sector and the resource constraint. Since α influences the necessary conditions of the private sector via (i) the other policy instruments and (ii) x, and since $x = p(g, \alpha)$, we can define $l^* = \bar{l}(\tau^*, s^*, t^*, q^*, \alpha)$, $w^* = \bar{w}(\tau^*, s^*, t^*, q^*, \alpha)$, $N^* = \bar{N}(\tau^*, s^*, t^*, q^*, \alpha)$ and $g^* = \bar{g}(\tau^*, s^*, t^*, q^*, \alpha)$, while τ^*, s^*, t^* and q^* are, in turn, functions of α. The superindex "$*$" is used to denote the socially optimal resource allocation, which is defined conditional on α. By substituting the conditionally optimal solution back into the Lagrangean corresponding to the government's optimization problem, we obtain

$$\begin{aligned} \pounds^* &= N^* u(c^{e,*}, T - l^*, x^*) + [M - N^*] u(c^{u,*}, T, x^*) \\ &\quad + \mu^* [f(N^* l^*, g^*) - N^* c^{e,*} - (M - N^*) c^{u,*} - \alpha] \end{aligned} \tag{10}$$

where $c^{e,*} = w^* l^* (1 - \tau^*) + \pi^*(1 - s^*)$ and $c^{u,*} = q^* + \pi^*(1 - s^*)$, and μ^* is the Lagrange multiplier evaluated at the social optimum and measures the social value of one additional unit of output. By using that the Lagrangean is equal to the social welfare function at the optimum, we can derive;

Proposition 2 *If the taxes and other public expenditures are chosen to support the second best resource allocation, which is defined conditional on α,* *the cost benefit rule changes to read*

$$\frac{\partial W^*}{\partial \alpha} = \Omega^* - \mu^* \tag{11}$$

where

$$\Omega^* = \frac{\partial \pounds^*}{\partial l}\frac{\partial l^*}{\partial \alpha} + \frac{\partial \pounds^*}{\partial w}\frac{\partial w^*}{\partial \alpha} + \frac{\partial \pounds^*}{\partial N}\frac{\partial N^*}{\partial \alpha} + \frac{\partial \pounds^*}{\partial g}\frac{\partial g^*}{\partial \alpha} + \frac{\partial \pounds^*}{\partial x}\frac{\partial x^*}{\partial \alpha}$$

The essence behind Proposition 2 is that, if the taxes and other public expenditures are optimally chosen conditional on α, all indirect effects of α via the policy variables vanish as a consequence of optimization. This means that Ω^* reflects the directs effects of α on the private decision variables and the effect on x^*. If environmental quality is additively separable in terms of the utility function, we obtain

$$\Omega^* = [N^* u_x^{e,*} + (M - N^*) u_x^{u,*}] \frac{\partial p(g^*, \alpha)}{\partial \alpha} \tag{12}$$

In this case, therefore, the cost benefit rule for abatement resembles the simple policy of comparing direct marginal benefits and costs.

5 Summary and Discussion

The basic message of this paper is that the functioning of the economic system matters for the welfare effects of public abatement projects. This is here exemplified by the influences of preexisting taxes and imperfect competition in the labor market. If the other policies are not optimal conditional on the initial level of abatement, we show that abatement policy gives rise to welfare effects via the preexisting tax system and via changes in employment. Although expected, at least in part, from the literature on environmental taxation, this means that important aspects of environmental projects may have been overlooked in previous studies. We also analyze the welfare effects of an increase in abatement in the special case, where the preexisting taxes and other public expenditures are optimally chosen conditional on the level of abatement. In this case, the cost benefit rule comes closer to the comparison between direct marginal benefits and costs.

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