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# Pollution, the cost of public funds and endogenous growth

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**Abstract**

Theories of endogenous growth are used to investigate the effect of environmental policy on the rate of economic growth and the provision of public goods in a second-best market outcome. Pollution gives rise to a negative environmental externality and is modeled as an inevitable by-product of production. The government faces the dual task of, on the one hand, internalising environmental externalities, and, on the other hand, raising public funds to finance public spending. A tougher environmental policy reduces the rate of economic growth, improves environmental quality, raises the optimal tax rate, and changes the composition of public spending away from productive government spending towards public consumption and abatement. The marginal cost of public funds falls (rises) if productive government spending is negligible (substantial) relative to public consumption and abatement

*Keywords:* Endogenous growth; Productive government spending; Public consumption; Pollution; Abatement; Optimal taxation; Marginal cost of public funds; Second best

*JEL classification:* E60; D62; H21; H41; Q38

## 1. Introduction

The deterioration of the natural environment is an important issue in policy debates nowadays. Firms and households pollute too much, since they do not pay the price for the social damages they cause. This environmental externality calls for government intervention. One of the instruments at the government's disposal is a Pigovian tax on detrimental activities. Such a tax corrects the market failure by raising the private cost to the level of the social cost. If there are no other distortions present in the economy, the government can set the optimal Pigovian tax and attain the first-best outcome in a decentralised economy. However, another

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task of government is to raise tax revenue to finance public spending. If lump-sum taxes and subsidies cannot be called upon to balance the budget, the government has to resort to distortionary taxes. The government then faces the dual task of raising revenues to finance public goods on the one hand and internalising environmental externalities on the other hand. Thus, the relevant problem is the setting of an optimal tax in a second-best world (cf. Sandmo, 1975; Auerbach, 1985). In these circumstances it is of considerable interest to study how more environmental concern affects the marginal cost of public funds. Bovenberg and van der Ploeg (1994) analyse the relation between pollution, the optimal mix of taxes and the marginal cost of public funds in a static setting. This paper investigates the relation between environmental policy, public finance and economic growth. We analyse the effect of more environmental concern on the rate of economic growth, the optimal tax rate, the composition of public spending and the marginal cost of public funds. To this end we make use of endogenous growth theory as developed by Romer (1986) among others. We extend the work of Barro (1990) on endogenous growth and public finance to allow for environmental externalities. We analyse a second-best world in which the government uses its tax policy to internalise environmental externalities as well as to raise revenue.

Section 2 presents an endogenous growth model in which there is a flow of pollution and in which society derives positive utility from private consumption and government consumption, and derives negative utility from environmental damages. The optimal tax rate is determined and we investigate its relationship to the marginal cost of public funds. In Section 3 we extend the analysis to allow for the effect of public abatement on the emission–output ratio. In Section 4 we also allow for growth-promoting public spending. The government then faces three tasks: (i) internalising a negative environmental externality; (ii) providing three public goods, namely public consumption, public abatement and productive government spending; and (iii) using a distortionary tax system to finance public spending. To get further insight in the properties of the second-best optimum, we present some numerical results. Section 5 concludes with a summary of the results.

## 2. Pollution, the cost of funds and endogenous growth

### 2.1. *Preferences, production and environmental quality*

Consider an economy with a large number of firms which produce a homogeneous final good under perfect competition. The production function of the representative firm has the simple form $Y = AK$, where $Y$ and $K$ denote output and capital, respectively, while $A$ stands for economy-wide production efficiency. Firms maximise profits. Ignoring depreciation, the first-order condition for a maximum is $r = (1 - \tau)A$, where $r$ stands for the market rate of interest and $\tau$ denotes the tax rate on output.

Utility of household $j$ (say, $U_j$) is, for simplicity, given by a quasi-linear specification:

$$U_j = \int_0^{\infty} [\log[C_j(t)] + \eta_G \log[G(t)] - \eta_E D(t)] \exp(-\partial t)\, dt \,, \tag{1}$$

where $C$, $G$ and $D$ stand for private consumption, public consumption and environmental damages, respectively. Society attaches a weight $\eta_G$ to public consumption and a weight $\eta_E$ to environmental quality. Social welfare depends on private consumption, public consumption and environmental quality. Consumers have a rate of time preference $\theta$ and the elasticity of intertemporal substitution for private and public consumption is unity.

Households take the levels of public consumption and environmental quality as given, and maximise utility (1) subject to their present value budget constraint. Hence, the growth in private consumption equals the gap between the market rate of interest and the rate of time preference:

$$\dot{C}/C = r - \theta \, . \tag{2}$$

Eq. (2) is the familiar Keynes–Ramsey rule, which determines the optimal allocation of private resources between current and future consumption.

Pollution is an inevitable by-product of production. Environmental damages are thus given by $D = BY$, where $B$ is the emission–output ratio. Individual firms are too small to care about the flow of pollution (e.g. noise, smoke, etc.) they generate. Of course, this external effect implies that the decentralised market equilibrium is inefficient. Government policy, in the form of a tax on output, is called upon to fight pollution.

### 2.2. *The government budget and market equilibrium*

The government finances its consumptive expenditures with a tax on production, so that $G = \tau Y$. A tax on output acts as an implicit tax on capital, so that similar results are obtained if the tax is replaced by a tax on capital. We assume that the government has no access to lump-sum taxes and subsidies. Thus, the government has to employ a distortionary tax for the dual task of, on the one hand, raising revenues to finance public consumption, and, on the other hand, internalising environmental externalities. Goods market equilibrium requires that the supply of goods equals the total demand for goods, i.e. $Y = C + \dot{K} + G$.

### 2.3. *Optimal government policy*

From the goods market equilibrium condition, the government budget constraint and the production function, we derive the growth rate of capital:

$$\frac{\dot{K}}{K} = (1 - \tau)A - \frac{C}{K} \, . \tag{3}$$

The growth rate of private consumption is low if the tax rate is high, households are impatient (high $\theta$) and the production efficiency of the economy is low:

$$\pi \equiv \frac{\dot{C}}{C} = (1 - \tau)A - \theta \, . \tag{4}$$

For balanced growth it is necessary that the capital stock and consumption grow at the same rate, i.e. $\dot{C}/C = \dot{K}/K = \pi$. This condition is satisfied if the consumption–capital ratio immediately jumps to the pure rate of time preference ($c = C/K = \theta$). There are no transitional dynamics. Balanced growth implies a corresponding rate of growth in environmental damages ($\dot{D}/D = \pi$).

To determine the optimal policy, the government maximizes the social welfare function,[1]

$$U = \frac{(1+\eta_G)\pi}{\theta^2} + \frac{\eta_G \log(\tau)}{\theta} - \frac{\eta_E ABK_0}{\theta - \pi} + \left[\frac{\log(\theta) + \log(K_0) + \eta_G \log(AK_0)}{\theta}\right], \qquad (1')$$

with respect to the tax rate ($\tau$), subject to the Keynes–Ramsey rule (2). This gives rise to the modified Samuelson rule:

$$\sum MRS \equiv \frac{\eta_G C}{G} = \frac{\theta \eta_G}{\tau A} = MCPF \equiv 1 + \eta_G - \eta_E\left(\frac{\theta}{\theta - \pi}\right)^2 ABK_0, \qquad (5)$$

or, alternatively, the optimal tax rate:

$$\tau = \frac{\theta \eta_G}{A \cdot MCPF} = \frac{\theta \eta_G}{\left[1 + \eta_G - \eta_E\left(\frac{\theta}{\theta - \pi}\right)^2 ABK_0\right]A}. \qquad (5')$$

The modified Samuelson rule (5) says that (the sum of) the marginal rate(s) of substitution between public consumption and private consumption, i.e. the ratio of the marginal utility of public consumption ($\eta_G/G$) and the marginal value of private income ($1/C$), should equal the marginal cost of public funds (*MCPF*). The *MCPF* is unity if $\eta_E = \eta_G = 0$. If the role of environmental externalities and public consumption is negligible, there are no externalities or distortions present in the economy and the first-best outcome results. The optimal (distortionary) tax rate is zero in this case. A positive weight to public consumption ($\eta_G > 0$) raises the *MCPF* above unity[2] indicating that public goods are more costly than private goods. This distortion induces substitution away from public spending towards private goods, thereby depressing the tax rate. However, a positive weight to environmental damages ($\eta_E > 0$) depresses the *MCPF* below unity (if $\eta_G = 0$), as taxation reduces growth in environmental damages and thus boosts the supply of environmental quality, thereby inducing substitution away from private towards public consumption.

Consider first the case without environmental externalities ($\eta_E = 0$). Given that $\theta > \tau A$, if more priority is given to public consumption (higher $\eta_G$), the national income share of public consumption and thus the optimal tax rate rises. This depresses the rate of economic growth. However, there is also a rise in the *MCPF* which depresses the demand for public consumption goods and thus attenuates the rise in the tax rate. A higher productivity of capital or more patient households (lower $\theta$) leads to a lower optimal tax rate, a lower share of public consumption and a higher rate of economic growth.

The general case in which environmental externalities are present ($\eta_E > 0$) is depicted in Fig. 1. The first equality of (5) corresponds to a negatively sloped *demand curve* (*DD*) which implies that a rise in the *MCPF* leads to a decline in the demand for public consumption

[1] For utility to be bounded, it is necessary to assume that the rate of time preference exceeds the rate of economic growth, i.e. $\theta - \pi > 0$.

[2] This is the case if $\eta_G > \eta_E(\theta/(\theta - \pi))^2 ABK_0$.

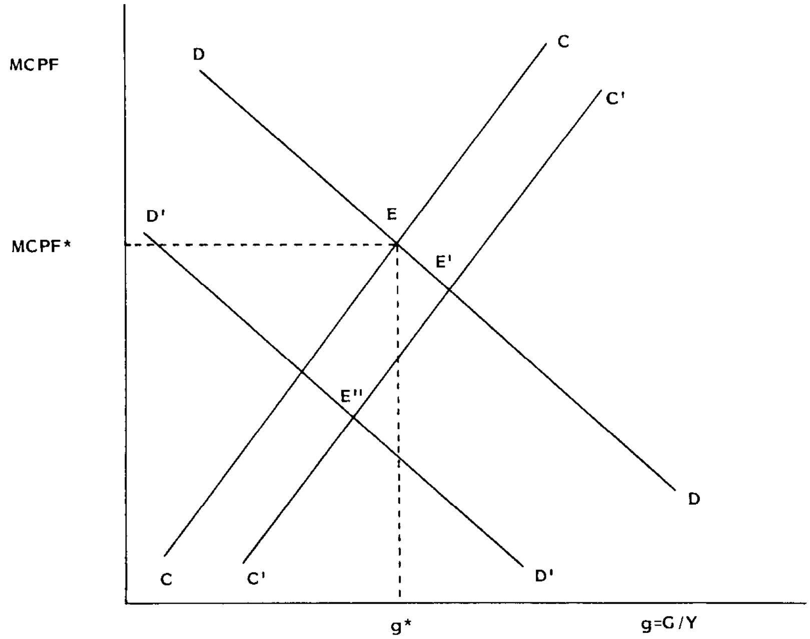


Fig. 1. Marginal cost of public funds and environmental quality. *Note:* Greater weight to environmental damages shifts $E$ to $E'$, thereby lowering the $MCPF$ and raising the tax rate. Smaller weight to public consumption shifts $E$ to $E''$, thereby lowering both the tax rate and the $MCPF$.

goods. Hence, the optimal tax rate and the national income share of public consumption fall. The last equality of (5) corresponds to a positively sloped *cost curve* ($CC$), which implies that a rise in the tax rate raises the $MCPF$. A higher tax rate on output depresses the rate of capital accumulation and economic growth. This depresses the tax base and raises the $MCPF$.

Consider a shift towards greener preferences ($\eta_E$ rises). This makes distortionary taxes on output less harmful. More concern with environmental damages thus shifts the cost curve ($CC$) downwards, thereby shifting the equilibrium from $E$ to $E'$. The $MCPF$ declines and the optimal tax rate rises, which in turn leads to a bigger share of public consumption in national income, less capital accumulation and a lower rate of economic growth. The decline in the rate of economic growth reduces the rate of growth in pollution damages.

Now, consider what happens if society attaches less priority to public consumption ($\eta_G$ declines). Both the demand curve ($DD$) and cost curve ($CC$) are shifted downward, thereby shifting the equilibrium from $E$ to $E''$. The decline in demand for public goods makes them relatively cheap, which depresses the $MCPF$. If the tax rate is not too large (i.e. $\tau < \theta / A$), the optimal tax rate falls[3] and the growth rates of the economy and pollution damages rise. In this sense, there is less provision of the two public goods, namely public consumption and environmental quality.

[3] If $\theta > \tau A$, the downward shift in the demand curve ($DD$) dominates the downward shift in the cost curve ($CC$) so that a reduction in $\eta_G$ induces a fall in $\tau$. Conversely, if $\theta < \tau A$, a fall in $\eta_G$ depresses $\tau$.

## 3. Public abatement and public consumption

### 3.1. Abatement and optimal government policy

Abatement policies can limit pollution damages. Hence, assume that government spending on abatement ($Z$) reduces the emission–output ratio.[4]

$$B = \left(\frac{Z}{Y}\right)^{-\psi}, \quad 0 < \psi < 1, \; Z > 0, \tag{6}$$

where $\psi$ is the elasticity of pollution with respect to abatement. A higher elasticity of abatement implies that an increase in the national income share of public abatement yields a greater reduction in the emission–output ratio. The government budget constraint becomes $\tau = g + z$, where $g \equiv G/Y$ and $z \equiv Z/Y$ stand for the national income shares of public consumption and public abatement, respectively. The optimum government policy must satisfy the Keynes–Ramsey rule (4), the modified Samuelson rule (5), and the optimality condition for the national income share of public abatement:

$$\left(\frac{\eta_E \psi}{z}\right)\left(\frac{\theta^2 B K_0}{\theta - \pi}\right) = MCPF. \tag{7}$$

Expression (7) says that the marginal discounted utility of one unit of public funds spent on public consumption must be the same as that spend on public abatement. Alternatively, (the sum of) the marginal rate(s) of substitution between public abatement and private consumption should equal the *MCPF*.

### 3.2. Comparative statics

We denote loglinear deviations from an initial equilibrium by a tilde (e.g. $\tilde{z} = dz/z$). Loglinearising (7) and $\tau = g + z$ shows that public abatement rises if the concern with environmental damages increases, the cost of public funds falls and the rate of economic growth rises (i.e. if the tax rate or the national income share of public consumption falls):

$$\tilde{z} = \Delta[\tilde{\eta}_E - M\tilde{C}PF - (\gamma g/z)\tilde{g}], \tag{8}$$

where $\gamma \equiv Az/(\theta - \pi) > 0$ and $\Delta \equiv (1 + \psi + \gamma)^{-1} > 0$. It follows that the tax rate rises if the priority given to environmental quality rises, the cost of public funds falls and the national income share of public consumption rises:

$$\tau\tilde{\tau} = \Delta[z(\tilde{\eta}_E - M\tilde{C}PF) + (1 + \psi)g\tilde{g}]. \tag{9}$$

Effectively, (8) and (9) indicate that the demand for public abatement and the corresponding tax rate are low if public funds are scarce.

Upon substitution of (8) and (9) into the right-hand side of (5) and loglinearising, we obtain the cost curve:

[4] $B = 1$ in the absence of expenditures on abatement.

$$\tilde{MCPF} = \Delta^*\{\eta_G \tilde{\eta}_G + (1 + \eta_G - MCPF)\Delta[(2+\psi)(g\gamma/z)\tilde{g} - (1-\gamma)\tilde{\eta}_E]\}\,, \tag{10}$$

where $\Delta^* \equiv [MCPF + (1+\eta_G - MCPF)\Delta(\psi + 2\gamma)]^{-1} > 0$ and $1 + \eta_G - MCPF > 0$. The cost curve shows that the cost of public funds rises with the national income share of public consumption and the priority given to public consumption, but falls with the priority given to environmental quality.

The demand curve for public consumption goods follows from loglinearising the modified Samuelson rule:

$$\tilde{g} = \tilde{\eta}_G - \tilde{MCPF}\,. \tag{11}$$

Society is willing to pay a higher marginal cost of public funds if more priority is given to public consumption.

A greater concern for environmental quality leaves the demand curve unaffected, but shifts the cost curve downward. Since the *MCPF* falls and $g$ rises, it follows from (8), (9) and (11) that $z$ and $\tau$ rise.

*Proposition. More environmental concern with pollution damages leads to a lower MCPF and a higher tax rate. Both the national income share of public consumption and that of public abatement increase. Environmental quality improves due to the lower rate of economic growth and the reduction in the emission–output ratio.*

Intuitively, a shift towards greener preferences raises the price of the environment which leads to an increase in the tax rate on output. The marginal cost of public funds falls, since taxation and limiting economic growth (i.e. a smaller tax base) are considered less harmful if there is a greater concern for environmental quality. The shift towards greener preferences increases the national income share of public abatement, thereby lowering the emission–output ratio and thus limiting pollution damages.

Less priority given to public consumption shifts the demand curve for public consumption inwards and the cost curve upwards. Provided the initial priority given to public consumption is not too large (i.e. $\eta_G \Delta^* < 1$), the shift in the demand curve dominates the shift in the cost curve. Hence, the lower priority given to public consumption induces a lower *MCPF* and a lower national income share of public consumption. The national income share of public abatement rises. If the effect on abatement is large, the tax rate rises so that the decline in the rate of growth together with the emission–output ratio improves environmental quality. However, if the effect on abatement is small, the tax rate falls so that the rate of economic growth rises and, typically, environmental quality deteriorates.

## 4. Growth-promoting infrastructure, abatement and the cost of public funds

### *4.1 Productive government spending*

In this section we extend the analysis to allow for productive government spending. Productive government spending boosts the productivity of private capital and thereby acts as a growth catalyst. The government can thus counteract pollution by raising spending on abatement, reducing productive government spending, and levying taxes on output. The production structure is given by a Cobb–Douglas specification (cf. Barro, 1990):

$$Y = K^{1-\beta} S^{\beta} = AK\,, \qquad A = \left(\frac{S}{Y}\right)^{\beta/(1-\beta)}\,. \tag{12}$$

There are constant returns to scale with respect to private capital ($K$) and productive government spending ($S$). Labour supply is exogenous and can, without loss of generality, be suppressed.

The government finances total public spending by a tax on production, so that the government budget constraint becomes $\tau = g + s + z$, where $s \equiv S/Y$. The goods market equilibrium is given by $Y = C + \dot{K} + G + S + Z$.

### 4.2. Optimal government policy

From the optimisation problem of the household and that of the firm, we derive the growth rate of private consumption:

$$\pi = \frac{\dot{C}}{C} = (1-\tau)(1-\beta)A - \theta = (1-\tau)(1-\beta)s^{\beta/(1-\beta)} - \theta\,. \tag{13}$$

Thus, the growth rate of private consumption is boosted by a higher national income share of productive government spending whilst a higher national income share of public spending or a higher national income share of abatement depresses the rate of economic growth. In a balanced growth equilibrium capital, output, private consumption, public consumption, public abatement, productive government spending and environmental damages all grow at the common rate $\pi$. This implies that $c = \theta + \beta(1-\tau)A$, so that the ratio of private consumption to capital exceeds the rate of time preference. The private consumption to capital ratio rises with the productivity of private capital, but falls with the tax rate. The optimisation problem for the government is to maximise social welfare,

$$U = \frac{(1+\eta_G)\pi}{\theta^2} + \frac{\log[(\theta + \beta(1-\tau)s^{\beta/(1-\beta)})K_0]}{\theta} + \frac{\eta_G \log[(\tau - s - z)s^{\beta/(1-\beta)}K_0]}{\theta} - \frac{\eta_E z^{-\psi} s^{\beta/(1-\beta)} K_0}{\theta - \pi}\,, \tag{14}$$

subject to the growth rate of private consumption (13), where use has been made of the government budget constraint $g = \tau - s - z$. The first-order condition for the tax rate ($\tau$) yields

$$\sum MRS \equiv \frac{\eta_G C}{G} = \frac{c\eta_G}{gA} = MCPF \equiv (1-\beta)\left[1 + \eta_G - \eta_E\left(\frac{\theta}{\theta-\pi}\right)^2 ABK_0\right]\frac{c}{\theta} + \beta\,. \tag{15}$$

while for the national income share of productive government spending ($s$) we get

$$s = \beta\left[1 - z - g\left(\frac{\theta}{\theta-\pi}\right)\left(\frac{\eta_E}{\eta_G}\right)ABK_0\right], \tag{16}$$

and for the national income share of public abatement ($z$) we obtain

$$\frac{\eta_E \psi}{z}\left(\frac{c\theta BK_0}{\theta-\pi}\right) = MCPF\,. \tag{17}$$

Eq. (15) is the modified Samuelson rule which says that (the sum of) the marginal rate(s) of substitution between public consumption and private consumption should equal the $MCPF$. The optimal national income share of productive government spending is less than the production share of productive government spending ($\beta$). Clearly, Barro's (1990) result, i.e. $s=\beta$, is modified, since public abatement and government consumption crowd out productive government spending. There is thus a trade-off between, on the one hand, public consumption and abatement, and, on the other hand, productive government spending. If there is no concern with pollution damages ($z=0$) and if there is no public consumption, Eq. (16) reduces to $s=\beta$. Expression (16) and government budget constraint yield the optimal tax rate:

$$\tau = \beta + (1-\beta)z + g\left[1 - \beta\left(\frac{\theta}{\theta-\pi}\right)\left(\frac{\eta_E}{\eta_G}\right) ABK_0\right]. \tag{16'}$$

### 4.3. Comparative statics

We solve numerically for the influence of more concern with pollution damages (a rise in $\eta_E$) on the optimal policies for the government and macroeconomic outcomes (see Table 1). We have included the effects on social welfare ($U = U_P + \eta_G U_G + \eta_E U_E$), which consists of a private consumption component ($U_P$), a public consumption component ($U_G$) and an environmental quality component ($U_E$).

Table 1
Abatement, growth and the marginal cost of public funds

| | Reference | $\Delta\eta_E$ [a] | $\Delta\eta_G$ [b] |
|---|---|---|---|
| $U_G$ | −16.03 | −2.14 | 1.42 |
| $U_E$ | −19.92 | 2.90 | −2.71 |
| $U_P$ | −25.09 | −2.03 | 1.00 |
| $MCPF$ | 1.74 | 0.02 | 0.35 |
| $\pi$ (%) | 0.59 | −0.29 | 0.13 |
| $s$ (%) | 20.80 | −1.66 | 1.83 |
| $z$ (%) | 11.08 | 0.95 | −1.06 |
| $g$ (%) | 46.33 | 0.86 | −0.20 |
| $\tau$ (%) | 78.21 | 0.16 | 0.57 |
| $c$ (%) | 7.06 | −0.20 | 0.09 |
| $A$ | 0.35 | −0.02 | 0.02 |
| $B$ | 1.94 | −0.05 | 0.06 |

Parameters: $\beta = 0.4$, $\theta = 0.03$, $\psi = 0.3$, $\eta_E = 4$, $\eta_G = 4$ and $K_0 = 1$.

The reference column gives the base values. The other columns give the deviations from base values. $U_P$, $U_G$ and $U_E$ refer to the discounted values of the stream of present and future values of log($C$), log($G$) and $-D$, respectively, using the discount rate $\theta$, so that $U = U_P + \eta_G U_G + \eta_E U_E$.

[a] More environmental concern: $\eta_E = 4$ rises to $\eta_E = 5$.

[b] Greater role for public consumption: $\eta_G = 4$ rises to $\eta_G = 5$.

More environmental concern boosts the national income shares of public abatement and government consumption at the expense of the share of productive government spending. The government raises the optimal tax rate which, together with the lower national income share of productive government spending, depresses the rate of economic growth. The growth in pollution damages fall, which improves environmental quality. The fall in the emission–output ratio and production efficiency combined with the lower rate of economic growth push up the *MCPF*, while the greater weight put on environmental quality depresses the *MCPF* – see the last equality in (15). The former effect dominates the latter, so that the *MCPF* rises. The reason is that the substantial fall in productive government spending necessitates a relatively large increase in the tax rate and pushes up the *MCPF*. More environmental concern raises the environmental quality component of social welfare at the expense of the private and public consumption components of social welfare.

If society attaches more importance to public consumption (higher $\eta_G$), the level of public consumption rises, but the national income share of public consumption declines due to the rise in national income. The national income share of productive government spending increases, while spending on abatement is crowded out. However, total government spending as a share of the national income increases which necessitates a higher optimal tax rate. The rate of economic growth rises, since the increased productivity of private capital more than compensates for the negative effect of the higher tax rate on the rate of economic growth. The higher rate of economic growth increases the rate of growth in pollution damages. Hence, the environmental component of social welfare declines while both the private and the public consumption component of social welfare rise. The increased demand for public consumption makes public consumption relatively more expensive which leads to a rise in the *MCPF*. The decline in public spending on abatement and the rise in the rate of economic growth attenuate the rise in the *MCPF* – see the last equality in (15).

## 5. Concluding remarks

We have investigated the interactions between endogenous growth, pollution and public finance. Society derives positive utility from public consumption and environmental quality. Without government intervention the decentralised market outcome is inefficient. There is too much production and pollution. Government policy is called upon to correct the market failure. The government employs the tax system for the two fold task of internalising environmental externalities by depressing the rate of economic growth and pollution damages, and raising revenues to finance public spending. Lump-sum taxes and subsidies are not available, so the government has to resort to distortionary taxes to meet its revenue requirement. Hence, the decentralised market outcome is *second-best*. We analysed how, in these circumstances, environmental policy influences the setting of optimal tax policy, the marginal cost of public funds, the composition of public spending, economic growth and environmental damages.

A shift towards greener preferences reduces the marginal cost of public funds, boosts the optimal tax rate, improves environmental quality and lowers the rate of economic growth. Intuitively, the rise in the price of the environment raises the tax rate on output. This generates additional tax revenue and makes public consumption relatively less expensive than private consumption. The marginal cost of public funds falls, since taxation and limiting economic growth are considered less harmful if there is more concern about environmental damages. In addition, more environmental concern raises the national income share of public abatement, thereby lowering the emission–output ratio and limiting pollution damages.

If we allow for productive government spending, more environmental concern may raise both the marginal cost of public funds and the optimal tax rate. The intuition behind this result is as follows. More environmental concern increases the price of the environment, which raises the tax rate and depresses the marginal cost of public funds. This effect is dominated by the rise in the marginal cost of public funds caused by a lower level of productive government spending and a higher level of public abatement. In fact, less productive government spending lowers the rate of growth and raises the cost of public funds. More environmental concern thus changes the composition of public spending away from productive government spending towards public consumption and public abatement. This, combined with the lower rate of economic growth, improves environmental quality.

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