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# Growth and welfare effects of environmental tax reform and public spending policy

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ABSTRACT

This paper considers the implications of environmental tax reform and public spending policy for growth and welfare. Using a two-sector endogenous growth model where the interactions between health, education, and the environment are taken into account, we show that revenue-positive tax reforms combined with a change in the public spending structure may improve long-run growth and welfare. However, this outcome incurs relatively high welfare cost during the transition phase. This is particularly the case when the spending policy favors education spending.



## 1. Introduction

Over the recent years, the debate on environmental tax reform has moved on from theoretical discussion to become a practical policy issue in many countries (OECD, 1997, 2010). Several European countries, such as Sweden, Norway, Finland, Denmark, and the Netherlands, implemented environmental tax reforms during the 1990s. More recently, other European countries such as Germany, Italy and the United Kingdom have introduced environmental taxes to reduce their greenhouse gas emissions and raise revenues which may be used in a number way. The public debate on such tax reform is ongoing in other countries, such as France and Switzerland.

For any policy discussion it is absolutely critical to know how the environmental tax revenue is recycled. The key issue is to identify the most appropriate policy for achieving two government goals: (1) lower pollution emissions and (2) high economic growth leading to improved social welfare. In this paper we address some question related to environmental tax reforms. How can tax reform be undertaken without reducing growth and social welfare? Do the transitional and long term effects conflict with each other? What are the associated impacts of a change in public spending structures? These questions are central to public debate, not only in countries where environmental tax reform has been introduced, but also in countries where such reform is still under consideration.

Recent macroeconomic developments have made progress in analyzing the dynamic effects of taxes, particularly within the framework of endogenous growth models.[1] As a consequence, endogenous growth models have often been used to analyze the effects of environmental taxes on the rate of long-term growth. Ricci (2007) provides a comprehensive survey, which presents various impacts of restrictive environmental policy on growth that have been discussed in the literature. A tighter environmental policy can potentially operate through different mechanisms such as investment, education and R&D. Overall, to generate a positive growth effect, many studies incorporate environmental quality into the firm's production function as an externality by assuming that a clean environment would improve the productivity of inputs or the efficiency of the educational system (see for instance Ligthart and van der Ploeg, 1994; Bovenberg and Smulders, 1995; Grimaud, 1999; Hart, 2004; Nakada, 2004; Chen et al., 2009; Paturel, 2009; Aloi and Touremaine, 2011; among others). By developing an endogenous growth model, in which pollution affects human capital depreciation and worker's productivity, Gradus and Smulders (1993, 1996), van Ewijk and van Wijnbergen (1994) and Paturel (2008) show that a tax on emissions, via its effect on learning abilities, promotes long run growth. Using a similar framework, Hettich (1998) and Oueslati (2002) have also highlighted that the labor–leisure choice played a

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[1] Lucas (1990), Devereux and Love (1994), and Stokey and Rebelo (1995), Ortigueira (1998) among others, have focused on the relationship between tax rates and long-term growth rates.

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role in the transmission of the environmental tax effect in a two-sector model of endogenous growth.

The literature on environmental tax has also addressed the so-called "double dividend" issue. The basic idea is whether a switch from different taxes to taxes on polluting goods or production factors can achieve both an improvement in the environment and a reduction in distortions arising from labor or capital taxation.[2] The environmental tax reform allows the government to carry out the operation in a revenue-neutral way, i.e. leaving total tax revenues unchanged. However, environmental tax reform can also be revenue-positive or revenue-negative, depending on how much tax revenue is recycled. In this respect, the environmental tax reform issue has been extensively investigated within the endogenous growth framework (see Bovenberg and Smulders, 1995; Bovenberg and Mooij, 1997; Hettich, 1998; Fullerton and Kim, 2008; Greiner, 2005; Fernandez et al., 2011; among others). Overall, this literature has considered the relationship between environmental tax reform from different aspects and within different endogenous growth frameworks. However, it should be noted that these studies paid relatively little attention to any associated modifications to the public spending structure.[3] In practice, environmental tax reforms are combined with changes in the public spending structure. This is particularly true since governments include the impacts of environmental tax reform within a comprehensive overview of their budget and often wish to allocate additional resources to support productive sectors and/or to increase spending on reducing pollution levels.

The purpose of this paper is to study the effects of tax reform and public expenditure policies within a unified growth model. We use an endogenous growth model with human capital (Lucas, 1988) to assess the effects of environmental tax reform and changes in public spending structure. Thus, we introduce an explicit trade-off between two types of public spending: (1) education spending, which supports the accumulation of human capital, and (2) public abatement spending which aims to improve environmental quality by reducing pollution. Following Gradus and Smulders (1993), we assume that pollution influences agents' abilities to learn. As the learning process is the ultimate engine of growth, reducing pollution can establish a channel through which environmental tax can enhance growth. Moreover, we utilize a numerical approach to compute the entire dynamic transition path towards balanced growth path. The analysis of the dynamic adjustment path enables us to perform welfare calculations. In particular, we make explicit the trade-off between the transitional and long term welfare costs of six policy scenarios, combining environmental tax reforms and changes in the public spending structure.

Our main results can be summarized as follows. We show that tax reform policies may improve growth and social welfare in the long term. Coupled with a change in the structure of public spending, the growth and welfare effects can be amplified. However, these positive effects are achieved at the expense of a reduced growth rate and a relatively high welfare cost during the transition period.

The remainder of the paper is organized as follows. In Section 2 the general model is presented and a market solution is derived. Section 3 discusses the growth and welfare effects of different policies for the use of pollution tax revenues. Section 4 proposes a numerical simulation of different policy scenarios. Here we parameterize the model at the steady state so that it incorporates some macroeconomic stylized facts. We then simulate and comment on the transitional dynamics. Section 5 computes welfare costs for each reform in the transitional and long term. Section 6 summarizes the main findings.

[2] See Goulder (1995), Carraro et al. (1996), Bovenberg and van der Ploeg (1997), Bovenberg (1999) and Giménez and Rodríguez (2010) for a review of the main arguments in this discussion.

[3] To the best of our knowledge, only Kempf and Rossignol (2007) have analyzed the choice of repartition of public spending by a median voter and its impact on growth.

## 2. The model

We consider a discrete time economy populated with a continuum of identical, infinitely-lived households. Each household owns the stock of physical capital in the economy, $K_t$, and is endowed with a (normalized) unit time. A proportion of the final product ($Y_t$) produces a flow of pollution that can be reduced by a public effort towards reducing pollution. The effective pollution flow is assumed to affect individuals' utility and learning process.

### 2.1. The household

The behavior of the rational household is guided by the maximization of the discounted lifetime utility

$$\mathcal{W}_0 = \sum_{t=0}^{\infty} \beta^t (\log C_t - \phi_P \log P_t) \tag{1}$$

where $C_t$ is consumption and $0 < \beta < 1$ is the discount factor. $P_t$ is the effective pollution flow and $\phi_P$ represents the weights of pollution in utility. The consumer budget constraint can be written as follows:

$$K_t = \left[1 + \left(1 + \tau_t^K\right) r_t\right] K_{t-1} + \left(1 - \tau_t^H\right) w_t u_t H_{t-1} - C_t + T_t \tag{2}$$

where $r_t$ is the return to physical capital and $w_t$ is the gross wage rate per effective unit of human capital $u_t H_{t-1}$. $\tau_t^K$ and $\tau_t^H$ are respectively a tax on capital income, and wage tax. $T_t$ represents a lump-sum transfer from the government.

The representative household can increase their human capital stock $H_t$, by devoting time to schooling $(1 - u_t)$. We assume that this activity takes place outside the market, and new human capital can be acquired by spending time. According to the formulation of Gradus and Smulders (1993), we consider that effective pollution causes human capital to depreciate at a faster rate. This reflects the potential effect of pollution on health that negatively affects the process of human capital accumulation.[4] Let us denote the influence of pollution on the learning process as $\eta P_t$, where $\eta > 0$. Thus, the law of motion for human capital is given by

$$H_t = [1 + B_t(1 - u_t) - \eta P_t] H_{t-1}. \tag{3}$$

$B_t > 0$ represents human capital productivity, which is assumed to depend on public efforts to support education. That is, we define

$$B_t = \widetilde{B} \left(\frac{E_t}{Y_t}\right)^{\xi} \tag{4}$$

where $\widetilde{B} > 0$ is a constant scale parameter, $E_t$ is public education spending and $0 \le \xi \le 1$ captures the productivity of public education spending. The assumption that human capital productivity depends on public education expenditure is consistent with the goal of public education policy in practice, as well as with many theoretical works (see for instance Glomm and Ravikumar, 1992; Blankenau, 2005; Angelopoulos et al., 2011).

### 2.2. Firms and pollution

The economy comprises a large number of identical and competitive firms. They rent capital and hire effective labor from the households at

[4] See Zivin and Neidell (2013) for a comprehensive survey on the relationship between pollution and human capital.