Jouvet, Pierre-André; Oueslati, Walid

Working Paper
Tax reform and public spending trade-offs in an endogenous growth model with environmental externality

Nota di Lavoro, Fondazione Eni Enrico Mattei, No. 103.2002

Provided in Cooperation with:
Fondazione Eni Enrico Mattei (FEEM)

Suggested Citation: Jouvet, Pierre-André; Oueslati, Walid (2002) : Tax reform and public spending trade-offs in an endogenous growth model with environmental externality, Nota di Lavoro, Fondazione Eni Enrico Mattei, No. 103.2002

This Version is available at:
http://hdl.handle.net/10419/119711

Terms of use:
Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.
Tax Reform and Public Spending
Trade-offs in an
Endogenous Growth Model with
Environmental Externality
Pierre-André Jouvet and Walid Oueslati
NOTA DI LAVORO 103.2002

NOVEMBER 2002
ETA – Economic Theory and Applications

Pierre-André Jouvet, Institut National d'Horticulture, GRQAM
Walid Oueslati, Institut National d'Horticulture, THEMA

This paper can be downloaded without charge at:
The Fondazione Eni Enrico Mattei Note di Lavoro Series Index:
http://www.feem.it/web/activ/_wp.html
Social Science Research Network Electronic Paper Collection:
http://papers.ssrn.com/abstract_id=XXXXXX

The opinions expressed in this paper do not necessarily reflect the position of
Fondazione Eni Enrico Mattei
Tax Reform and Public Spending Trade-offs in an Endogenous Growth Model with Environmental Externality

Summary

This paper analyzes the trade-offs between fiscal policy reform and public expenses structures within a two-sector endogenous growth model with an environmental externality. Transitional dynamics, balanced growth path and welfare cost of alternative policy are computed. We show that taxes structure change leads to a lower welfare cost.

Keywords: Endogenous growth, human capital, environmental externality, tax reform, transitional dynamics, welfare

JEL: E62, I21, H22, Q28, O41, D62

Address for correspondence:

Walid Oueslati
INH
2 rue le Nôtre
49000 Angers
France
Phone: +33 (0) 2 41 22 54 91
Fax: +33 (0) 2 41 73 15 57
E-mail: walid.oueslati@inh.fr
1 Introduction

The relative average size of public spending in GNP for the OCDE economies has increased from 28.9% in 1965 to 41.7 in 1998. For the economies in the European Community, the public spending-GNP ratio has increased from 36.1% to 47.8% in the same period of time. Likewise, the evolution of the relative importance of the different types of taxes on total public revenues shows a clear tendency towards increases in income taxes. In the same time environmental policy becomes in the first line of sight for the majority of government.

Recent macroeconomic theory has made progress in analyzing the dynamics effects of taxes, particularly within the framework of endogenous growth model. Barro (1990) looks at the government spending and income taxation in a model where government activity enters directly into production as a public intermediate input. The analysis of fiscal policies in endogenous growth models with human capital accumulation is relatively recent [e.g. King and Rebelo (1990), Lucas(1990), Devereux and Love (1996), Stockey and Rebelo (1996), Ortiguera (1998)]. These studies have basically focused on the relationship between tax rates and long-run growth rates.

In a Uzawa-Lucas setup augmented with an explicit treatment of the environment, Gradus and Smulders (1993) and that the optimal growth rate is independent from environmental care. Only by assuming that pollution also negatively affects the efficiency in the human-capital sector, did they detect positive growth effects. Oueslati (2002) shows that in Uzawa-Lucas model with leisure a higher pollution tax might boost long-run economic growth even without assuming direct positive productivity effects of a cleaner environment.

Whereas most endogenous growth models dealing with environmental concerns restrict the analysis to the steady state, little has been said so far on the short-run effects of taxation. Van der Ploeg and Ligthart (1994), Bovenberg and Smulders (1996), Vellinga (2000) and Oueslati (2002) are the few exceptions in the literature. Without taking the environmental externality into account, Mulligan and Sala-i-Martin (1993), Devereux and Love (1994) and Lardon-de-Guevara and al.(1997) investigate the transitional dynamics within similar models.

This paper studies the effects of both public spending policy and tax reform on welfare within a two sector model of endogenous growth based on the joint accumulation
of physical and human capital. Both transitional dynamics and balanced growth path are computed.

The remainder of the paper is organized as follows. In section 2 the general model is laid out and market solution is derived. Section 3 proposes a numerical exercise: we calibrate the model at the steady state, compute the transitional dynamics and comment the short-run dynamics. Section 4 computes welfare costs of public policy choice. Section 5, summarizes the main findings.

2 The model

We consider an economy populated with an infinitely-lived representative household. The household owns the stock of physical capital in the economy, \( K_t \), and is endowed with a (normalized) unit time. The time endowment can be allocated between work (remunerated at the current competitive wage rate) and schooling. The pollution causes a negative environmental externality as a side product. Pollution is assumed to affect individuals' utility.

2.1 Preferences, technology and pollution

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

\[
W_0 = \sum_{t=0}^{\infty} u(C_t; P_t)
\]

where

\[
u(C_t; P_t) = \log C_t - \delta \log P_t \tag{2}\]

\( C_t \) is consumption, \( 0 < \delta < 1 \) is the discount factor and \( P_t \) is the net pollution flow. The parameter \( \delta \) represents the weight of pollution in utility. The consumer budget constraint can be written as follows:

\[
K_t = 1 + \frac{1}{1 - \delta} K_{t+1} + \frac{1}{1 - \delta} H_{t+1} \mathcal{W}_t H_{t+1} + C_t \tag{3}\]

where \( r_t \) is the return to physical capital and \( w_t \) is the gross wage rate per effective unit of human capital \( u_t H_{t+1} \). \( u_t \) is the supply of working time. \( \tau^K \) denotes the rate of depreciation for physical capital. \( \tau^K_t \) and \( \tau^H_t \) are respectively a tax on capital income and a wage tax.
The representative agent can increase his human capital stock $H_t$, by devoting time to schooling. We assume that this activity takes place outside the market, and new human capital can only be obtained by spending time. Thus, the law of motion for human capital is given by the constraint

$$H_t = [1 + B(1 - u_t)] H_{t-1} + E_t$$

(4)

where $B$ is the marginal productivity of schooling time $(1 - u_t)$, $\beta_t$ denotes the rate of human capital depreciation and $E_t$ is public education expenses.

The physical capital used in production is the source of the pollution flow $P_t$. This flow can be reduced by means of private abatement activities $D_t$ which in turn consume a part of output, in line with the flow resource constraint. The net pollution function has the form:

$$P_t = Y_t - D_t$$

(5)

### 2.2 Firms

The economy consists of a large number of identical and competitive firms. They rent capital and hire effective labor from the households at the interest rate $r$ and the wage rate $w$ respectively. They use the following constant-returns Cobb-Douglas technology

$$Y_t = AK_t^{(1 - \alpha)} u_t H_{t-1}^{\alpha}$$

(6)

where $A > 0$ and $0 < \alpha < 1$.

Firms are assumed to maximize their market value, which is equal to the appropriately discounted sum of profits flows, the later is given by

$$\frac{1}{\delta} = Y_t + r_t K_{t-1} + w_t u_t H_{t-1}$$

(7)

Profits maximization implies that in equilibrium, firms pay each production factor at its marginal productivity.

$$r_t = (1 - \alpha) \frac{Y_t}{K_{t-1}}$$

(8)

$$w_t = (1 + \alpha) \frac{Y_t}{u_t H_{t-1}}$$

(9)
2.3 Government

We suppose that government revenue $Z_t$ is used both as public abatement activity ($D_t$) and education spending ($E_t$). The government budget constraint implies that in every period, we have:

$$Z_t = \xi_t^r K_t + \xi_t^F W_t = D_t + E_t \quad (10)$$

Let

$$D_t = \mu Z_t \text{ and } E_t = (1 - \mu) Z_t \quad 0 \cdot \mu \cdot 1 \quad (11)$$

The market clearing condition for the goods market is

$$Y_t = C_t + K_{t+1} (1_1 - \phi) K_{t+1} + Z_t \quad (12)$$

2.4 The market solution

Definition 1 A competitive equilibrium for this economy consists of the consequences $C_t; Y_t; K_t; H_t; u_t; Z_t; r_t; w_t; \xi^r_t; \xi^F_t; P_t$ for $t = 1; 2; 3: \ldots$ and for $0 \cdot \mu \cdot 1$, that satisfy the following conditions.

(a) Household utility maximization:

Maximize (1)

subject (3), (4) and (5)

$$\lim_{t \to 1}^{\infty} t K_t = \lim_{t \to 1}^{\infty} q H_t = 0$$

$H_0$ and $K_0$ given.

(b) Profit maximization

(c) Government budget constraint (15)

(d) Market clearing: $C_t + Z_t + K_{t+1} (1_1 - \phi) K_{t+1} = Y_t$

The variables $\xi_t$ and $q_t$ represent respectively the shadow prices of physical and human capital.

So as to characterize the competitive equilibrium, let us focus on the different trade-offs faced by the household. After eliminating the shadow prices for physical and human capital, the first order conditions for the household problem write:

$$\frac{C_{t+1}}{C_t} = - \xi_t^r + \xi_t^F \xi_{t+1}^F \xi_{t+1} + \xi_t^\phi \quad (13)$$
Equation (13) and (14) are the Euler conditions determining the optimal accumulation of physical and human capital. It is obvious that environmental tax affects only the intertemporal incentive to invest in physical capital, as described by equation (13).

These conditions, along with equations (2), (3), (4), (8), (9), (10) and (11) constitute a dynamical system in $C$, $D$, $u$, $K$ and $H$ which, together with the transversality conditions\(^1\) and initial $K(0)$ and $H(0)$, fully describe the dynamic behavior of the economy along an interior equilibrium.

3 The balanced growth path

In this section we will focus on the dynamic properties of the balanced growth path.

Definition 2 A balanced growth path (or steady state) is an allocation $fC_t$, $Z_t$, $u_t$, $K_t$, $H_t$, $P_t$, $T_t$ of a price system $r_t$, $w_t$ of a taxes $t^K$ and $t^H$ satisfying Definition 1, and such that for some initial conditions $K(0) = K_0$ and $H(0) = H_0$, the paths $fC_t$, $Z_t$, $K_t$, $H_t$ grow at the constant rate $g$, and $u_t$ and $P_t$ remain constant.

For analytical convenience we use the following transformed variables: $h_t = H_t = K_t$, $c_t = C_t = K_t - 1$, $y_t = Y_t = K_t - 1$, $z_t = Z_t = K_t - 1$ and $g_t = K_t = K_t - 1$.

Using this change of variables, we obtain the following dynamic system

\[
\frac{C_{t+1}}{C_t} = - \frac{1}{1 + B} \left[ 1 + B \right] 
\]

Equation (13) and (14) are the Euler conditions determining the optimal accumulation of physical and human capital. It is obvious that environmental tax affects only the intertemporal incentive to invest in physical capital, as described by equation (13).

These conditions, along with equations (2), (3), (4), (8), (9), (10) and (11) constitute a dynamical system in $C$, $D$, $u$, $K$ and $H$ which, together with the transversality conditions\(^1\) and initial $K(0)$ and $H(0)$, fully describe the dynamic behavior of the economy along an interior equilibrium.

3 The balanced growth path

In this section we will focus on the dynamic properties of the balanced growth path.

Definition 2 A balanced growth path (or steady state) is an allocation $fC_t$, $Z_t$, $u_t$, $K_t$, $H_t$, $P_t$, $T_t$ of a price system $r_t$, $w_t$ of a taxes $t^K$ and $t^H$ satisfying Definition 1, and such that for some initial conditions $K(0) = K_0$ and $H(0) = H_0$, the paths $fC_t$, $Z_t$, $K_t$, $H_t$ grow at the constant rate $g$, and $u_t$ and $P_t$ remain constant.

For analytical convenience we use the following transformed variables: $h_t = H_t = K_t$, $c_t = C_t = K_t - 1$, $y_t = Y_t = K_t - 1$, $z_t = Z_t = K_t - 1$ and $g_t = K_t = K_t - 1$.

Using this change of variables, we obtain the following dynamic system

\[
\frac{C_{t+1}}{C_t} = - \frac{1}{1 + B} \left[ 1 + B \right] 
\]

Equation (13) and (14) are the Euler conditions determining the optimal accumulation of physical and human capital. It is obvious that environmental tax affects only the intertemporal incentive to invest in physical capital, as described by equation (13).

These conditions, along with equations (2), (3), (4), (8), (9), (10) and (11) constitute a dynamical system in $C$, $D$, $u$, $K$ and $H$ which, together with the transversality conditions\(^1\) and initial $K(0)$ and $H(0)$, fully describe the dynamic behavior of the economy along an interior equilibrium.

3 The balanced growth path

In this section we will focus on the dynamic properties of the balanced growth path.

Definition 2 A balanced growth path (or steady state) is an allocation $fC_t$, $Z_t$, $u_t$, $K_t$, $H_t$, $P_t$, $T_t$ of a price system $r_t$, $w_t$ of a taxes $t^K$ and $t^H$ satisfying Definition 1, and such that for some initial conditions $K(0) = K_0$ and $H(0) = H_0$, the paths $fC_t$, $Z_t$, $K_t$, $H_t$ grow at the constant rate $g$, and $u_t$ and $P_t$ remain constant.

For analytical convenience we use the following transformed variables: $h_t = H_t = K_t$, $c_t = C_t = K_t - 1$, $y_t = Y_t = K_t - 1$, $z_t = Z_t = K_t - 1$ and $g_t = K_t = K_t - 1$.

Using this change of variables, we obtain the following dynamic system

\[
\frac{C_{t+1}}{C_t} = - \frac{1}{1 + B} \left[ 1 + B \right] 
\]

Equation (13) and (14) are the Euler conditions determining the optimal accumulation of physical and human capital. It is obvious that environmental tax affects only the intertemporal incentive to invest in physical capital, as described by equation (13).

These conditions, along with equations (2), (3), (4), (8), (9), (10) and (11) constitute a dynamical system in $C$, $D$, $u$, $K$ and $H$ which, together with the transversality conditions\(^1\) and initial $K(0)$ and $H(0)$, fully describe the dynamic behavior of the economy along an interior equilibrium.

3 The balanced growth path

In this section we will focus on the dynamic properties of the balanced growth path.

Definition 2 A balanced growth path (or steady state) is an allocation $fC_t$, $Z_t$, $u_t$, $K_t$, $H_t$, $P_t$, $T_t$ of a price system $r_t$, $w_t$ of a taxes $t^K$ and $t^H$ satisfying Definition 1, and such that for some initial conditions $K(0) = K_0$ and $H(0) = H_0$, the paths $fC_t$, $Z_t$, $K_t$, $H_t$ grow at the constant rate $g$, and $u_t$ and $P_t$ remain constant.

For analytical convenience we use the following transformed variables: $h_t = H_t = K_t$, $c_t = C_t = K_t - 1$, $y_t = Y_t = K_t - 1$, $z_t = Z_t = K_t - 1$ and $g_t = K_t = K_t - 1$.

Using this change of variables, we obtain the following dynamic system

\[
\frac{C_{t+1}}{C_t} = - \frac{1}{1 + B} \left[ 1 + B \right] 
\]

Equation (13) and (14) are the Euler conditions determining the optimal accumulation of physical and human capital. It is obvious that environmental tax affects only the intertemporal incentive to invest in physical capital, as described by equation (13).

These conditions, along with equations (2), (3), (4), (8), (9), (10) and (11) constitute a dynamical system in $C$, $D$, $u$, $K$ and $H$ which, together with the transversality conditions\(^1\) and initial $K(0)$ and $H(0)$, fully describe the dynamic behavior of the economy along an interior equilibrium.

3 The balanced growth path

In this section we will focus on the dynamic properties of the balanced growth path.

Definition 2 A balanced growth path (or steady state) is an allocation $fC_t$, $Z_t$, $u_t$, $K_t$, $H_t$, $P_t$, $T_t$ of a price system $r_t$, $w_t$ of a taxes $t^K$ and $t^H$ satisfying Definition 1, and such that for some initial conditions $K(0) = K_0$ and $H(0) = H_0$, the paths $fC_t$, $Z_t$, $K_t$, $H_t$ grow at the constant rate $g$, and $u_t$ and $P_t$ remain constant.

For analytical convenience we use the following transformed variables: $h_t = H_t = K_t$, $c_t = C_t = K_t - 1$, $y_t = Y_t = K_t - 1$, $z_t = Z_t = K_t - 1$ and $g_t = K_t = K_t - 1$.

Using this change of variables, we obtain the following dynamic system

\[
\frac{C_{t+1}}{C_t} = - \frac{1}{1 + B} \left[ 1 + B \right] 
\]

Equation (13) and (14) are the Euler conditions determining the optimal accumulation of physical and human capital. It is obvious that environmental tax affects only the intertemporal incentive to invest in physical capital, as described by equation (13).

These conditions, along with equations (2), (3), (4), (8), (9), (10) and (11) constitute a dynamical system in $C$, $D$, $u$, $K$ and $H$ which, together with the transversality conditions\(^1\) and initial $K(0)$ and $H(0)$, fully describe the dynamic behavior of the economy along an interior equilibrium.

3 The balanced growth path

In this section we will focus on the dynamic properties of the balanced growth path.

Definition 2 A balanced growth path (or steady state) is an allocation $fC_t$, $Z_t$, $u_t$, $K_t$, $H_t$, $P_t$, $T_t$ of a price system $r_t$, $w_t$ of a taxes $t^K$ and $t^H$ satisfying Definition 1, and such that for some initial conditions $K(0) = K_0$ and $H(0) = H_0$, the paths $fC_t$, $Z_t$, $K_t$, $H_t$ grow at the constant rate $g$, and $u_t$ and $P_t$ remain constant.

For analytical convenience we use the following transformed variables: $h_t = H_t = K_t$, $c_t = C_t = K_t - 1$, $y_t = Y_t = K_t - 1$, $z_t = Z_t = K_t - 1$ and $g_t = K_t = K_t - 1$.

Using this change of variables, we obtain the following dynamic system

\[
\frac{C_{t+1}}{C_t} = - \frac{1}{1 + B} \left[ 1 + B \right] 
\]
\[ g \frac{Q_{t+1}}{C_t} = \frac{1}{2} \frac{1}{1} \frac{\tilde{z}_{t+1}^H}{h_t} W_{t+1} (1 + B (1 - l_{t+1}) i) \]  
(20)

\[ z_t = \gamma_t \xi_t^K + (1 - \gamma_t) \xi_t^H \]  
(21)

Steady-state values \( c, z, u, P \) and \( g \) are obtained by eliminating the index \( t \). From the linearization of the above system one can show that, independently of the size of taxes, the model displays a saddle path dynamic structure. Thus, unlike other models presented in the literature [Benhabib and Perli (1994), Bond and al. (1996), Xie (1994)] our model is unable to generate the indeterminacy phenomenon typical of distorted economies.  

4 Numerical results

In this section we derive a full numerical solution for the model. For this calibration exercise we cannot really hope to be as precise as those who employ the same model without environmental externality, since we lack strong empirical evidence concerning the nature of the environmental preferences and pollution function. Nevertheless, to the greatest possible extent, we follow the recent literature. Prescott (1986) cites micro evidence for many of the key parameter values are not as robust as those of the standard model, we vary some parameters around our initial benchmark setting as a check on the sensitivity of the results.

4.1 Calibration

The parameter values require are discount factor \( \bar{\gamma} \), technology parameters \( \psi, A, B, \beta_p \), and \( \bar{\psi} \), tax rates \( (\xi^K_t \text{ and } \xi^H_t) \) and abatement share in public expenses \( \mu \). We proceed by choosing parameters according to the arguments below to pin down a benchmark economy.

Following Prescott (1986) and other, we let the share of labour in final goods output \( \gamma \) be 0.64. Let depreciation rates be the same across sectors and set equal \( \psi = \beta_p = 0.01 \). Since the difference between \( A \) and \( B \) affects only the units in which the human to physical ratio is measured, we set \( A = B \). Taking this as a proxy for the industrialized economies, the growth rate is 2%.

\[ \text{In Bond and al. (1996) indeterminacy emerges from the presence of taxes in a model with physical capital as an input in the educational sector. As we assume that physical capital is only productive in the output sector, the condition for general instability or indeterminacy is never satisfied. In Benhabib and Perli (1994) and Xie (1994) indeterminacy arises from knowledge spill-overs.} \]

\[ \text{See Barro and Sala-i-Martin (1995, p. 37)} \]
For parameters tax, we consider a parameter $\lambda$ which correspond to a combination between $\zeta^H$ and $\zeta^K$ with a constant public spending-GNP ratio $^3 = Z=Y$. We let $^3BC = 0:3$ which plausible for most developed countries. In the benchmark case, we suppose that $\zeta^H = \zeta^K$. Thus, we get $^3BC = 0:136$.

Table 1: Benchmark Parameter values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\bar{\gamma}$</td>
<td>0:99</td>
</tr>
<tr>
<td>$g$</td>
<td>1:02</td>
</tr>
<tr>
<td>$\delta_K = \delta_H$</td>
<td>0:01</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0:36</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0:01</td>
</tr>
<tr>
<td>$u$</td>
<td>0:28</td>
</tr>
<tr>
<td>$^3 = Z=Y$</td>
<td>0:3</td>
</tr>
</tbody>
</table>

Thus, we have chosen the following variables and parameters values $^3, g, \delta_K, \delta_H, \delta, \lambda, u,$ and $^3$. Values of the remaining parameters and variables are solution to the system (21)-(??). Benchmark case (BC) values are summarized in the table 2.

Table 2: Calibration Results in the BC

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^3 = Z=Y$</td>
<td>0:3</td>
</tr>
<tr>
<td>$y$</td>
<td>0:1599</td>
</tr>
<tr>
<td>$h$</td>
<td>3:07753</td>
</tr>
<tr>
<td>$A = B$</td>
<td>0:0403</td>
</tr>
<tr>
<td>$c=y$</td>
<td>0:5124</td>
</tr>
<tr>
<td>$e=y$</td>
<td>0:3703</td>
</tr>
<tr>
<td>$P$</td>
<td>9:0021</td>
</tr>
</tbody>
</table>

With $^3BC = 0;3703$, we get education spending share in product $e=y = 1;^3BC = 0;1889$ and abatement share in product $d=y = \mu = 0;1111$.

4.2 Balanced growth paths

The numerical solution for the balanced growth path is easily derived using a nonlinear equations solution procedure for the stationary representation for the system (15)-(21). We study now successively the effect on the steady state of both change in the structure of public spending, described by $^3$ variation and variation in the government revenue, described by $^3BC$ change.
4.2.1 Public spending structure

The first governmental policy consists in doing a change in its expenses structure. This policy is shown by the variation of $\mu$. Thus, when $\mu$ is higher, abatement share is higher. This policy induce a decrease in the ratio $h$ (production become less intensive in physical capital) and a decrease in the pollution flow. The consumption share in the product remain constant (see table 1).

Table 1: A abatement share variation

<table>
<thead>
<tr>
<th>$\mu$</th>
<th>$h$</th>
<th>$c=y$</th>
<th>$d=y$</th>
<th>$e=y$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu = 0; 5 \mu^{BC}$</td>
<td>30; 7753</td>
<td>0; 5124</td>
<td>0; 1111</td>
<td>0; 1889</td>
<td>9; 0021</td>
</tr>
<tr>
<td>$\mu = 0; 75 \mu^{BC}$</td>
<td>29; 9131</td>
<td>0; 5124</td>
<td>0; 0555</td>
<td>0; 2445</td>
<td>18; 0041</td>
</tr>
<tr>
<td>$\mu = 1; 5 \mu^{BC}$</td>
<td>30; 3442</td>
<td>0; 5124</td>
<td>0; 0833</td>
<td>0; 2167</td>
<td>12; 0028</td>
</tr>
</tbody>
</table>

We note that all this effects are insensitive to $\phi$ and $\lambda$ (see table 2 and 3).

Table 2: Sensibility to $\phi$

<table>
<thead>
<tr>
<th>$\mu$</th>
<th>$h$</th>
<th>$c=y$</th>
<th>$d=y$</th>
<th>$e=y$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu = 0; 5 \mu^{BC}$</td>
<td>37; 4777</td>
<td>0; 5571</td>
<td>0; 0618</td>
<td>0; 2382</td>
<td>16; 192</td>
</tr>
<tr>
<td>$\mu = 0; 75 \mu^{BC}$</td>
<td>37; 1068</td>
<td>0; 5571</td>
<td>0; 0926</td>
<td>0; 2074</td>
<td>10; 790</td>
</tr>
<tr>
<td>$\mu = \mu^{BC}$</td>
<td>37; 7360</td>
<td>0; 5571</td>
<td>0; 1235</td>
<td>0; 1765</td>
<td>8; 0962</td>
</tr>
<tr>
<td>$\mu = 1; 5 \mu^{BC}$</td>
<td>38; 9944</td>
<td>0; 5571</td>
<td>0; 1853</td>
<td>0; 1147</td>
<td>5; 3975</td>
</tr>
<tr>
<td>for $\phi = 0; 3$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Sensibility to $\lambda$

<table>
<thead>
<tr>
<th>$\mu$</th>
<th>$h$</th>
<th>$c=y$</th>
<th>$d=y$</th>
<th>$e=y$</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu = 0; 5 \mu^{BC}$</td>
<td>39; 1592</td>
<td>0; 4392</td>
<td>0; 0970</td>
<td>0; 3030</td>
<td>10; 3109</td>
</tr>
<tr>
<td>$\mu = 0; 75 \mu^{BC}$</td>
<td>38; 2809</td>
<td>0; 4392</td>
<td>0; 1455</td>
<td>0; 2545</td>
<td>6; 8739</td>
</tr>
<tr>
<td>$\mu = \mu^{BC}$</td>
<td>39; 1592</td>
<td>0; 4392</td>
<td>0; 1940</td>
<td>0; 2060</td>
<td>5; 1555</td>
</tr>
<tr>
<td>$\mu = 1; 5 \mu^{BC}$</td>
<td>40; 9158</td>
<td>0; 4392</td>
<td>0; 2910</td>
<td>0; 1090</td>
<td>3; 4370</td>
</tr>
<tr>
<td>for $\lambda = 0; 4$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.2.2 Government revenue structure

We study now the effects of taxes reform on the steady state. We have calculated a parameter ($\Lambda$), which measures the variation in $\xi^C$ and $\xi^H$ for a constant government revenue.

A public policy which favor the physical capital taxation, induce an intensive production in human capital and a fall in consumption share. We note too that pollution flow rises.
Table 4: Tax reform

<table>
<thead>
<tr>
<th>Taxes (%)</th>
<th>h</th>
<th>c=y</th>
<th>d=y</th>
<th>e=y</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>A = 0.5A^LC</td>
<td>(\xi^K = 17; 18)</td>
<td>(\xi^H = 37; 18)</td>
<td>23; 463</td>
<td>0; 4782</td>
<td>0; 111</td>
</tr>
<tr>
<td>A = 0.75A^LC</td>
<td>(\xi^K = 24; 06)</td>
<td>(\xi^H = 33; 34)</td>
<td>26; 975</td>
<td>0; 496</td>
<td>0; 111</td>
</tr>
<tr>
<td>BC</td>
<td>(\xi^K = 30; 00)</td>
<td>(\xi^H = 30; 00)</td>
<td>30; 770</td>
<td>0; 512</td>
<td>0; 111</td>
</tr>
<tr>
<td>A = 1.25A^LC</td>
<td>(\xi^K = 39; 84)</td>
<td>(\xi^H = 24; 46)</td>
<td>39; 296</td>
<td>0; 5388</td>
<td>0; 111</td>
</tr>
</tbody>
</table>

All these effects are insensitive to \(\xi\) and \(\eta\) (see table 5 and 6).

Table 5: Sensitivity to \(\xi\)

<table>
<thead>
<tr>
<th>Taxes (%)</th>
<th>h</th>
<th>c=y</th>
<th>d=y</th>
<th>e=y</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>A = 0.5A^LC</td>
<td>(\xi^K = 20; 68)</td>
<td>(\xi^H = 33; 99)</td>
<td>27; 51</td>
<td>0; 522</td>
<td>0; 131</td>
</tr>
<tr>
<td>A = A^LC</td>
<td>(\xi^K = 36; 01)</td>
<td>(\xi^H = 27; 43)</td>
<td>37; 73</td>
<td>0; 557</td>
<td>0; 123</td>
</tr>
<tr>
<td>A = 1.5A^LC</td>
<td>(\xi^K = 47; 81)</td>
<td>(\xi^H = 22; 37)</td>
<td>50; 90</td>
<td>0; 583</td>
<td>0; 123</td>
</tr>
<tr>
<td>for (\xi = 0.30)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6: Sensitivity to \(\eta\)

<table>
<thead>
<tr>
<th>Taxes (%)</th>
<th>h</th>
<th>c=y</th>
<th>d=y</th>
<th>e=y</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>A = 0.5A^LC</td>
<td>(\xi^K = 22; 98)</td>
<td>(\xi^H = 49; 57)</td>
<td>26; 12</td>
<td>0; 393</td>
<td>0; 194</td>
</tr>
<tr>
<td>A = A^LC</td>
<td>(\xi^K = 40; 00)</td>
<td>(\xi^H = 40; 00)</td>
<td>39; 15</td>
<td>0; 439</td>
<td>0; 194</td>
</tr>
<tr>
<td>A = 1.5A^LC</td>
<td>(\xi^K = 53; 12)</td>
<td>(\xi^H = 32; 62)</td>
<td>58; 289</td>
<td>0; 474</td>
<td>0; 194</td>
</tr>
<tr>
<td>for (\eta = 0.40)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.3 Transitional dynamics

To compute the transitional dynamics we log-linearize the dynamic system (??)-(??) to make the equations approximately linear in the log-deviations from the steady state. After doing this, we solve the recursive equilibrium law of motion via the method of undetermined coefficients. We compute the transitional dynamics associated with each kind of public policy.

4.3.1 Spending shares change

The simulation of the transitional dynamics starts in period 0, where the government suddenly changes the spending shares (\(\mu\)). This public policy shock induces an instantaneous reaction of all economic variables. We then observe different impacts on the variables, which leave their initial level at BC and reach at different rates their new level.
The pace at which the economy reaches the new steady state is the result of the interaction between some effects. In the short-run, the stock of physical capital decreases, but inherits an increased trend after a while, and finally its growth rate reaches its initial BC level. Thus, this policy induces a factorial reallocation effect, which reduces the intensity of physical capital in production.

A higher \( \mu \) level increases the human capital-physical capital ratio (h) because the factor \( H \) is substituted for the factor \( K \). In the beginning of the transitional dynamics, the crowding out effect of abatement reduces both the growth rate (see figure 1.a) and the ratio of physical capital to production (see figure 1.b). Increased abatement spending leads to a more human capital intensive final output. The immediate response to this policy is a sectorial reallocation of resources, which reduces the physical capital-human capital ratio.

4.3.2 Taxes structure change

The simulation of the transitional dynamics starts in period 0, where the government suddenly changes the Taxes structure change (\( \Delta \)). This fiscal policy shock induces an
Figure 2: Transitional dynamics (Â change)

instantaneous reaction of all economic variables. We then observe different impacts on the variables, which leave their initial level at BC and reach at different rates their new level.

In the short-run, the stock of physical capital decreases, but inherits an increased trend after a while, and finally its growth rate reaches its initial BC level.

A higher Â increases ÆK and decreases ÆH. In the beginning of the transitional dynamics, the crowding out effect of abatement reduces both the growth rate (Âigure 2.a) and the ratio of physical capital to production (Âigure 2.b). Abatement and education spending shares in the production are insensitive to the public policy shocks. Pollution flow falls.

5 Welfare analysis
5.1 Welfare decomposition

We decompose welfare into transitional welfare (also referred to as the short-run welfare) \( W_{1,2} \) corresponding to the economy’s transition from (BC) to a new steady state (NSS), and welfare related to the NSS \( W_2 \). So as to get a numerical result, we suppose that the transition from a steady state to another is achieved in a finite amount of periods, and we
simply denote \( T \) the date at which we consider that the economy has numerically reached its new rest point. The total welfare associated to the environmental policy change \( W^{T_{\infty}} \) is equal to the sum of utility flows, from \( t = 0 \) to \( 1 \), which can be written as the sum of \( W_{1} \) and \( W_{2} \):

\[
W^{T_{\infty}} = W_{1} + W_{2} \tag{22}
\]

Note that the economy converges only asymptotically to the steady state, and we therefore truncate the transitional dynamics in the effective computation at the horizon \( T \). This horizon is chosen so that for all \( t > T \), the difference between the value of physical capital stock at \( T (k_{T}) \) and its value at NSS \( (k_{2}) \) is numerically very small\(^4\).

Formally, the transitional welfare can be written\(^5\):

\[
W_{1} = \sum_{t=0}^{T} \log(c_{t}) + \sum_{i=0}^{m} \log(g_{i}) - \log(P_{t}) \tag{23}
\]

the welfare related to the new steady state (NSS) is given by:

\[
W_{2} = \frac{c_{2}}{1 - \bar{\gamma}} - \sum_{i=0}^{m} \log(g_{i}) + \log(P_{2}) \tag{24}
\]

and the welfare related to the BC steady state is given by\(^6\)

\[
W_{1} = \frac{\log(c_{1})}{1 - \bar{\gamma}} + \frac{\log(g_{1})}{(1 - \bar{\gamma})} \tag{25}
\]

5.2 Welfare cost:

To obtain a meaningful evaluation of the welfare cost associated to our policy change, we express all welfare measures as percentage point of the permanent consumption that generates an equivalent welfare in the benchmark case. Thus, our welfare cost measures the compensation in consumption terms that leaves the consumer indifferent between the BC consumption path and the NSS consumption path corresponding to a change in fiscal policy.

Let us denote \( c_{e} \) as the constant flow of consumption that gives a welfare \( W^{T_{\infty}} \) when pollution disutility and growth rate are constant.

\(^4\)We tolerate a difference between \( k_{T} \) and \( k_{2} \) smaller than \( 10^{-10} \).

\(^5\)The formal computation of welfare decomposition is available on request.

\(^6\)We assume that \( K_{1} = 1 \)
The total welfare cost is given by

\[ \varepsilon = \exp \left( 1 \log \frac{g^i}{P^i} \right) \frac{W_{Total}^i - \bar{W}_1 - \bar{W}_2}{1} \log g + \hat{A} \log P_1 \]  

(26)

The total welfare cost is given by

\[ \varepsilon = \frac{\varepsilon_1}{\varepsilon_2} \left( 1 - i \right) \]  

(27)

where

\[ \varepsilon_1 = \exp \left( 1 \log \frac{g^i}{P^i} \right) \frac{W_{Total}^i - \bar{W}_1 - \bar{W}_2}{1} \log g + \hat{A} \log P_1 \]  

(28)

5.2.1 Welfare cost of spending shares change

Table 7 gives a number of welfare and welfare cost figures.

<table>
<thead>
<tr>
<th>$\mu$</th>
<th>$W_{Total}^1$</th>
<th>$W_{1 \rightarrow 2}$</th>
<th>$W_2$</th>
<th>$W_1$</th>
<th>$\delta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu = 0.5L^c$</td>
<td>-120.0</td>
<td>-108.3005</td>
<td>-12.4956</td>
<td>-56.3027</td>
<td>0.9059</td>
</tr>
<tr>
<td>$\mu = L^c$</td>
<td>-121.9579</td>
<td>-109.6143</td>
<td>-12.3437</td>
<td>-56.3027</td>
<td>0.9281</td>
</tr>
<tr>
<td>$\mu = 1.5L^c$</td>
<td>-123.3629</td>
<td>-111.1082</td>
<td>-12.2548</td>
<td>-56.3027</td>
<td>0.9554</td>
</tr>
</tbody>
</table>

We look at the welfare cost of revenue-equivalent increases in the abatement share. Higher is the abatement share, higher is the welfare cost.

5.2.2 Welfare cost of taxes structure change

Table 8 gives a number welfare of welfare costs induced by a tax reform.

<table>
<thead>
<tr>
<th>$A$</th>
<th>$W_{Total}^1$</th>
<th>$W_{1 \rightarrow 2}$</th>
<th>$W_2$</th>
<th>$W_1$</th>
<th>$\delta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A = 0.5A^c$</td>
<td>-128.356</td>
<td>-110.7873</td>
<td>-17.5689</td>
<td>-56.3027</td>
<td>1.0555</td>
</tr>
<tr>
<td>$A = A^c$</td>
<td>-121.9579</td>
<td>-109.6143</td>
<td>-12.3437</td>
<td>-56.3027</td>
<td>0.9281</td>
</tr>
<tr>
<td>$A = 1.5A^c$</td>
<td>-117.9011</td>
<td>-110.0112</td>
<td>-7.8899</td>
<td>-56.3027</td>
<td>0.8515</td>
</tr>
</tbody>
</table>

We show that when we increase physical capital tax we have a lower welfare cost.

6 Conclusion

We have studied in this paper the short-run and long-run behavior of an economy responding to two kind of public policy. The model used is a version of a two sector
endogenous growth model within an environmental externality. Our ambition was to explored the effects of both tax change and expenditures structure on the welfare. We showed that a public policy which centre on spending structure leads a higher welfare cost. However, government might reduce welfare cost with a revenue-equivalent physical capital increases.

In a later version, we will explore the same public policy trade-offs when the growth rate is affected.

References


NOTE DI LAVORO DELLA FONDAZIONE ENI ENRICO MATTEI
Fondazione Eni Enrico Mattei Working Papers Series
Our working papers are available on the Internet at the following addresses:
Server WWW: WWW.FEEM.IT
Anonymous FTP: FTP.FEEM.IT
http://papers.ssrn.com/abstract_id=XXXXXX

SUST 1.2001 Inge MAYERES and Stef PROOST: Should Diesel Cars in Europe be Discouraged?
SUST 2.2001 Paola DORIA and Davide PETTENELLA: The Decision Making Process in Defining and Protecting Critical Natural Capital
CLIM 3.2001 Alberto PENCH: Green Tax Reforms in a Computable General Equilibrium Model for Italy
CLIM 4.2001 Maurizio BUSSOLO and Dino PINELLI: Green Taxes: Environment, Employment and Growth
CLIM 5.2001 Marco STAMPINI: Tax Reforms and Environmental Policies for Italy
ETA 6.2001 Walid OUESLATI: Environmental Fiscal Policy in an Endogenous Growth Model with Human Capital
CLIM 7.2001 Umberto CIORBA, Alessandro LANZA and Francesco PAULI: Kyoto Commitment and Emission Trading: a European Union Perspective
MGMT 8.2001 Brian SLACK (xliv): Globalisation in Maritime Transportation: Competition, uncertainty and implications for port development strategy
VOL 9.2001 Giulia PESARO: Environmental Voluntary Agreements: A New Model of Co-operation Between Public and Economic Actors
VOL 10.2001 Cathrine HAGEM: Climate Policy, Asymmetric Information and Firm Survival
ETA 11.2001 Sergio CURRARINI and Marco MARINI: A Sequential Approach to the Characteristic Function and the Core in Games with Externalities
ETA 12.2001 Gaetano BLOISE, Sergio CURRARINI and Nicholas KIKIDIS: Inflation and Welfare in an OLG Economy with a Privately Provided Public Good
ETA 14.2001 Valentina BOSETTI and Vincenzina MESSINA: Quasi Option Value and Irreversible Choices
CLIM 15.2001 Guy ENGELEN (xlii): Desertification and Land Degradation in Mediterranean Areas: from Science to Integrated Policy Making
SUST 16.2001 Julie Catherine SORS: Measuring Progress Towards Sustainable Development in Venice: A Comparative Assessment of Methods and Approaches
SUST 17.2001 Julie Catherine SORS: Public Participation in Local Agenda 21: A Review of Traditional and Innovative Tools
CLIM 18.2001 Johan ALBRECHT and Niko GOBRICH: Schumpeter and the Rise of Modern Environmentalism
VOL 19.2001 Rinaldo BRAU, Carlo CARRARO and Giulio GOLFETTO (xliii): Participation Incentives and the Design of Voluntary Agreements
ETA 20.2001 Paola ROTA: Dynamic Labour Demand with Lumpy and Kinked Adjustment Costs
ETA 21.2001 Paola ROTA: Empirical Representation of Firms’ Employment Decisions by an (S,s) Rule
ETA 22.2001 Paola ROTA: What Do We Gain by Being Discrete? An Introduction to the Econometrics of Discrete Decision Processes
PRIV 23.2001 Stefano BOSI, Guillaume GIRMANS and Michel GUILLARD: Optimal Privatisation Design and Financial Markets
KNOW 24.2001 Giorgio BRUNETTO, Claudio LUPI, Patrizia ORDINE, and Maria Luisa PARISI: Beyond National Institutions: Labour Taxes and Regional Unemployment in Italy
ETA 25.2001 Klaus CONRAD: Locational Competition under Environmental Regulation when Input Prices and Productivity Differ
CLIM 27.2001 Frédéric BROCHIER and Emiliano RAMIERI: Climate Change Impacts on the Mediterranean Coastal Zones
ETA 28.2001 Nunzio CAPPUCCIO and Michele MORETTO: Comments on the Investment-Uncertainty Relationship in a Real Option Model
KNOW 29.2001 Giorgio BRUNETTO: Absolute Risk Aversion and the Returns to Education
CLIM 30.2001 ZhongXiang ZHANG: Meeting the Kyoto Targets: The Importance of Developing Country Participation
ETA 31.2001 Jonathan D. KAPLAN, Richard E. HOWITT and Y. Hossein FARZIN: An Information-Theoretical Analysis of Budget-Constrained Nonpoint Source Pollution Control
ETA 33.2001 Shlomo WEBER and Hans WIESMETH: From Autarky to Free Trade: The Impact on Environment
ETA 34.2001 Margarita GENIUS and Elisabetta STRAZZERA: Model Selection and Tests for Non Nested Contingent Valuation Models: An Assessment of Methods
Carlo GIUPPONI: The Substitution of Hazardous Molecules in Production Processes: The Atrazine Case Study in Italian Agriculture

Raffaele PACI and Francesco PIGLIARI: Technological Diffusion, Spatial Spillovers and Regional Convergence in Europe

Bernardo BORTOLOTTI: Privatisation, Large Shareholders, and Sequential Auctions of Shares


Giacomo CALZOLARI and Carlo SCARPA: Regulation at Home, Competition Abroad: A Theoretical Framework

Giorgio BRUNELLO: On the Complementarity between Education and Training in Europe

Alain DESDOIGTS and Fabien MOIZEAU: Multiple Politico-Economic Regimes, Inequality and Growth

Parkash CHANDER and Henry TULKENS (xlvii): Limits to Climate Change

Michael FINUS and Bianca RUNDSHAGEN (xlvii): Endogenous Coalition Formation in Global Pollution Control

Evie LISE, Richard S.J. TOL and Bob van der ZWAAN (xlvii): Negotiating Climate Change as a Social Situation

Mohamad R. KHAWLIE (xlvii): The Impacts of Climate Change on Water Resources of Lebanon- Eastern Mediterranean

Mutasem EL-FADEL and E. BOU-ZEID (xlvii): Climate Change and Water Resources in the Middle East: Vulnerability, Socio-Economic Impacts and Adaptation

Evie IGLESIAS, Alberto GARRIDO and Almudena GOMEZ (xlvii): An Economic Drought Management Index to Evaluate Water Institutions’ Performance Under Uncertainty and Climate Change

Wietze LISE and Richard S.J. TOL (xlvii): Impact of Climate on Tourist Demand

Francesco BOSELLO, Barbara BUCHNER, Carlo CARRARO and Davide RAGGI: Can Equity Enhance Efficiency? Lessons from the Kyoto Protocol

Roberto ROSON (xlviii): Carbon Leakage in a Small Open Economy with Capital Mobility

Edwin WOERDMAN (xlviii): Developing a European Carbon Trading Market: Will Permit Allocation Distort Competition and Lead to State Aid?

Richard N. COOPER (xlviii): The Kyoto Protocol: A Flawed Concept

Kari KANGAS (xlviii): Trade Liberalisation, Changing Forest Management and Roundwood Trade in Europe

Xueqin ZHU and Ekko VAN IERLAND (xlviii): Effects of the Enlargement of EU on Trade and the Environment

M. Ozgur KAYALICA and Sajal LAHIRI (xlviii): Strategic Environmental Policies in the Presence of Foreign Direct Investment

Savas ALPAY (xlviii): Can Environmental Regulations be Compatible with Higher International Competitiveness? Some New Theoretical Insights

Roldan MURADIAN, Martin O’CONNOR, Joan MARTINEZ-ALER (xlviii): Embodied Pollution in Trade: Estimating the “Environmental Load Displacement” of Industrialised Countries

Matthew R. AUER and Rafael REUVENY (xlviii): Foreign Aid and Direct Investment: Key Players in the Environmental Restoration of Central and Eastern Europe

Onno J. KUIK and Frans H. OOSTERHUIS (xlviii): Lessons from the Southern Enlargement of the EU for the Environmental Dimensions of Eastern Enlargement, in particular for Poland

Carlo CARRARO, Alessandra POME and Domenico SINISCALCO (xlix): Science vs. Profit in Research: Lessons from the Human Genome Project

Efrem CASTELNUOVO, Michele MORETTO and Sergio VERCALLI: Global Warming, Uncertainty and Endogenous Technical Change: Implications for Kyoto

Gian Luigi ALBANO, Fabrizio GERMANO and Stefano LOVO: On Some Collusive and Signaling Equilibria in Ascending Auctions for Multiple Objects

Elbert DIJKGRAAF and Herman R.J. VOLLEBERGH: A Note on Testing for Environmental Kuznets Curves with Panel Data

Paolo BUONANNO, Carlo CARRARO and Marzio GALEOTTI: Endogenous Induced Technical Change and the Costs of Kyoto

Guido CAZZÁVILLAN and Ignazio MUSU (l): Transitional Dynamics and Uniqueness of the Balanced-Growth Path in a Simple Model of Endogenous Growth with an Environmental Asset

Giovanni BAIOCCHI and Salvatore DI FALCO (l): Investigating the Shape of the EKC: A Nonparametric Approach

Marzio GALEOTTI, Alessandro LANZA and Francesco PAULI (l): Desperately Seeking (Environmental) Kuznets: A New Look at the Evidence

Alexey VIKHLYAEV (xlvi): The Use of Trade Measures for Environmental Purposes – Globally and in the EU Context

Gary D. LIBECAP and Zeynep K. HANSEN (li): U.S. Land Policy, Property Rights, and the Dust Bowl of the 1930s
<table>
<thead>
<tr>
<th>Code</th>
<th>Year</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUST</td>
<td>108.2001</td>
<td>Valuing Farm Animal Genetic Resources by Means of Contingent Valuation and a Bio-Economic Model: The Case of the Pentro Horse</td>
<td>Gianni CICIA, Elisabetta D’ERCOLE and Davide MARINO</td>
</tr>
<tr>
<td>SUST</td>
<td>110.2001</td>
<td>Does Breed Matter to Cattle Farmers and Buyers? Evidence from West Africa</td>
<td>M.A. JABBAR and M.L. DIEDHOU</td>
</tr>
<tr>
<td>ETA</td>
<td>1.2002</td>
<td>Using Conjoint Analysis to Estimate Farmers’ Preferences for Cattle Traits in West Africa</td>
<td>K. TANO, M.D. FAMINOW, M. KAMUANGA and B. SWALLOW</td>
</tr>
<tr>
<td>WAT</td>
<td>3.2002</td>
<td>The Economics of a “Mixed Blessing” Effect: A Case Study of the Black Sea</td>
<td>Duncan KNOWLER and Edward BARBIER</td>
</tr>
<tr>
<td>CLIM</td>
<td>4.2002</td>
<td>Technological Change in Economic Models of Environmental Policy: A Survey</td>
<td>Andreas LÖSCHEL</td>
</tr>
<tr>
<td>VOL</td>
<td>5.2002</td>
<td>Stable Coalitions</td>
<td>Carlo CARRARO and Carmen MARCHIORI</td>
</tr>
<tr>
<td>KNOW</td>
<td>8.2002</td>
<td>Neoclassical Convergence Versus Technological Catch-up: A Contribution for Reaching a Consensus</td>
<td>Alain DESDOIGTS</td>
</tr>
<tr>
<td>NRM</td>
<td>9.2002</td>
<td>Renewable Resources and Waste Recycling</td>
<td>Giuseppe DI VITA</td>
</tr>
<tr>
<td>KNOW</td>
<td>10.2002</td>
<td>Is Training More Frequent when Wage Compression is Higher? Evidence from 11 European Countries</td>
<td>Giorgio BRUNELLO</td>
</tr>
<tr>
<td>ETA</td>
<td>11.2002</td>
<td>Endogenous Fluctuations and the Role of Monetary Policy</td>
<td>Moredecai KURZ, Hehui JIN and Maurizio MOTOLESE</td>
</tr>
<tr>
<td>NRM</td>
<td>13.2002</td>
<td>The Use of Common Property Resources: A Dynamic Model</td>
<td>Michele MORETTO and Paolo ROSATO</td>
</tr>
<tr>
<td>CLIM</td>
<td>14.2002</td>
<td>Macroeconomic Effects of an Energy Saving Policy in the Public Sector</td>
<td>Philippe QUIRION</td>
</tr>
<tr>
<td>CLIM</td>
<td>16.2002</td>
<td>Environmental Policy Growth when Inputs are Differentiated in Pollution Intensity</td>
<td>Francesco RICCI(1)</td>
</tr>
<tr>
<td>ETA</td>
<td>17.2002</td>
<td>Devaluation (Levels versus Rates) and Balance of Payments in a Cash-in-Advance Economy</td>
<td>Alberto PETRUCCI</td>
</tr>
<tr>
<td>NRM</td>
<td>18.2002</td>
<td>Endogenous Fluctuations and the Role of Monetary Policy</td>
<td>Mordecai KURZ, Hehui JIN and Maurizio MOTOLESE</td>
</tr>
<tr>
<td>KNOW</td>
<td>19.2002</td>
<td>Single-Peakedness and Disconnected Coalitions</td>
<td>Steven J. BRAMS, Michael A. JONES and D. Marc KILGOUR</td>
</tr>
<tr>
<td>CLIM</td>
<td>21.2002</td>
<td>Economic and Environmental Sustainability: A Dynamic Approach in Insular Systems</td>
<td>Fausto CAVALLARO and Luigi CIRAROO</td>
</tr>
<tr>
<td>CLIM</td>
<td>22.2002</td>
<td>Back to Kyoto? US Participation and the Linkage between R&amp;D and Climate Cooperation</td>
<td>Barbara BUCHNER, Carlo CARRARO, Igor CERSOSIMO and Carmen MARCHIORI</td>
</tr>
<tr>
<td>CLIM</td>
<td>23.2002</td>
<td>The Economic and Environmental Implications of the US Repudiation of the Kyoto Protocol and the Subsequent Deals in Bonn and Marrakech</td>
<td>Andreas LÖSCHEL and ZhongXIAN ZHANG</td>
</tr>
<tr>
<td>ETA</td>
<td>24.2002</td>
<td>Inventories, Employment and Hours</td>
<td>Marzio GALEOTTI, Louis J. MCCAINI and Fabio SCHIANTARELLI</td>
</tr>
<tr>
<td>ETA</td>
<td>26.2002</td>
<td>Environmental Policy and Technological Change</td>
<td>Adam B. JAFFE, Richard G. NEWELL and Robert N. STAVINS</td>
</tr>
<tr>
<td>SUST</td>
<td>27.2002</td>
<td>Farmer Premiums for the Voluntary Adoption of Conservation Plans</td>
<td>Joseph C. COOPER and Giovanni SIGNORELLO</td>
</tr>
<tr>
<td>SUST</td>
<td>28.2002</td>
<td>Towards An Analytical Strategic Environmental Assessment</td>
<td>The ANSEA Network</td>
</tr>
<tr>
<td>KNOW</td>
<td>29.2002</td>
<td>Geographic Concentration and Increasing Returns: a Survey of Evidence</td>
<td>Paolo SURICO</td>
</tr>
<tr>
<td>ETA</td>
<td>30.2002</td>
<td>Lessons from the American Experiment with Market-Based Environmental Policies</td>
<td>Robert N. STAVINS</td>
</tr>
<tr>
<td>NRM</td>
<td>31.2002</td>
<td>Multi-Criteria Analysis and Decision-Support for Water Management at the Catchment Scale: An Application to Diffuse Pollution Control in the Venice Lagoon</td>
<td>Carlo GIUPPONI and Paolo ROSATO</td>
</tr>
<tr>
<td>NRM</td>
<td>32.2002</td>
<td>National Environmental Policy During the Clinton Years</td>
<td>Robert N. STAVINS</td>
</tr>
<tr>
<td>KNOW</td>
<td>33.2002</td>
<td>Do Investments in Specialized Knowledge Lead to Composite Good Industries?</td>
<td>A. SOUBEYRAN and H. STAHN</td>
</tr>
<tr>
<td>KNOW</td>
<td>34.2002</td>
<td>Labor Taxes, Wage Setting and the Relative Wage Effect</td>
<td>G. BRUNELLO, M.L. PARISI and Daniela SOMETTI</td>
</tr>
</tbody>
</table>
CLIM 36.2002 T.TIETENBERG (lv): The Tradable Permits Approach to Protecting the Commons: What Have We Learned?
NRM 40.2002 S. M. CAVANAGH, W. M. HANEMANN and R. N. STAVINS: Muffled Price Signals: Household Water Demand under Increasing-Block Prices
CLIM 42.2002 C. OHL (lvi): Inducing Environmental Co-operation by the Design of Emission Permits
CLIM 43.2002 J. EYCKMANS, D. VAN REEGEMORTER and V. VAN STEENBERGHE (lvi): Is Kyoto Fatally Flawed? An Analysis with MacGEM
CLIM 44.2002 A. ANTOCI and S. BORGHESI (lvi): Working Too Much in a Polluted World: A North-South Evolutionary Model
ETA 45.2002 P. G. FREDRIKSSON, Johan A. LIST and Daniel MILLIMET (lvi): Chasing the Smokestack: Strategic Policymaking with Multiple Instruments
ETA 46.2002 Z. YU (lvi): A Theory of Strategic Vertical DFI and the Missing Pollution-Haven Effect
SUST 47.2002 Y. H. FARZIN: Can an Exhaustible Resource Economy Be Sustainable?
SUST 48.2002 Y. H. FARZIN: Sustainability and Hamiltonian Value
KNOW 49.2002 C. PIGA and M. VIVARELLI: Cooperation in R&D and Sample Selection
Coalition Theory Network 50.2002 M. SERTEL and A. SLINKO (lvi): Ranking Committees, Words or Multisets
ETA 51.2002 Sergio CURRARINI (lvi): Stable Organizations with Externalities
C L I M 52.2002 Robert N. STAVINS: Experience with Market-Based Policy Instruments
CLIM 54.2002 Scott BARRETT (livi): Towards a Better Climate Treaty
ETA 55.2002 Richard G. NEWELL and Robert N. STAVINS: Cost Heterogeneity and the Potential Savings from Market-Based Policies
SUST 56.2002 Paolo ROSATO and Edi DEFRANCESCO: Individual Travel Cost Method and Flow Fixed Costs
SUST 57.2002 Vladimir KOTOV and Elena NIKITINA (livii): Reorganisation of Environmental Policy in Russia: The Decade of Success and Failures in Implementation of Perspective Quests
VOL 60.2002 Giovanni DI BARTOLOMEO, Jacob ENGWERDA, Joseph PLASMANS and Bas VAN AARLE: Staying Together or Breaking Apart: Policy-Makers’ Endogenous Coalitions Formation in the European Economic and Monetary Union
PRIV 62.2002 Carlo CAPUANO: Demand Growth, Entry and Collusion Sustainability
PRIV 63.2002 Federico MUNARI and Raffaele ORIANI: Privatization and R&D Performance: An Empirical Analysis Based on Tobin’s Q
PRIV 64.2002 Federico MUNARI and Maurizio SOBRERO: The Effects of Privatization on R&D Investments and Patent Productivity
SUST 65.2002 Orley ASHENFELTER and Michael GREENSTONE: Using Mandated Speed Limits to Measure the Value of a Statistical Life
CLIM 68.2002 Barbara K. BUCHNER and Roberto ROSON: Conflicting Perspectives in Trade and Environmental Negotiations
CLIM 69.2002 Philippe QUIRIN: Complying with the Kyoto Protocol under Uncertainty: Taxes or Tradable Permits?
SUST 70.2002 Anna ALBERINI, Patrizia RIGANTI and Alberto LONGO: Can People Value the Aesthetic and Use Services of Urban Sites? Evidence from a Survey of Belfast Residents
SUST 71.2002 Marco PERCOCO: Discounting Environmental Effects in Project Appraisal
NRM 72.2002 Philippe BONTEMPS and Pascal FAVARD: Input Use and Capacity Constraint under Uncertainty: The Case of Irrigation
PRIV 73.2002 Mohammed OMEN: The Performance of State-Owned Enterprises and Newly Privatized Firms: Empirical Evidence from Egypt
PRIV 74.2002 Mike BURKART, Fausto PANUNZI and Andrei SHLEIFER: Family Firms
PRIV 75.2002 Emmanuelle AUROIOL, Pierre M. PICARD: Privatizations in Developing Countries and the Government Budget Constraint
PRIV 76.2002 Nichole M. CASTATER: Privatization as a Means to Societal Transformation: An Empirical Study of Privatization in Central and Eastern Europe and the Former Soviet Union
the Fondazione Eni Enrico Mattei, Milan, February 9-10, 2001

Climate Change in the Mediterranean: Impact, Adaptation and Mitigation Co-benefits, organised by Neuve, Belgium, January 26-27, 2001

(xlvii) This paper was presented at the RICAMARE Workshop "Socioeconomic Assessments of

Neuve, Belgium, January 26-27, 2001

(xlvi) This paper was presented at the Sixth Meeting of the Coalition Theory Network organised by

Venice, May 5-6, 2000.

(xlv) This paper was presented at the International Workshop on "New Ports and Urban and Regional


(xliii)This paper was presented at the International Workshop on "Voluntary Approaches, Competition and Competitiveness" organised by the Fondazione Eni Enrico Mattei within the research activities of the CAVA Network, Milan, May 25-26,2000.

(xliv) This paper was presented at the International Workshop on "Green National Accounting in

Europe: Comparison of Methods and Experiences" organised by the Fondazione Eni Enrico Mattei within the Concerted Action of Environmental Valuation in Europe (EVE), Milan, March 4-7, 2000

(xiv) This paper was presented at the International Workshop on "New Ports and Urban and Regional

Development. The Dynamics of Sustainability" organised by the Fondazione Eni Enrico Mattei, Venice, May 5-6, 2000.

(xvi) This paper was presented at the Sixth Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Louvain-la-Neuve, Belgium, January 26-27, 2001

(xlvii) This paper was presented at the RICAMARE Workshop "Socioeconomic Assessments of Climate Change in the Mediterranean: Impact, Adaptation and Mitigation Co-benefits", organised by the Fondazione Eni Enrico Mattei, Milan, February 9-10, 2001
(xlvi) This paper was presented at the International Workshop “Trade and the Environment in the Perspective of the EU Enlargement”, organised by the Fondazione Eni Enrico Mattei, Milan, May 17-18, 2001

(xlvii) This paper was presented at the International Conference “Knowledge as an Economic Good”, organised by Fondazione Eni Enrico Mattei and The Beijer International Institute of Environmental Economics, Palermo, April 20-21, 2001

(i) This paper was presented at the Workshop “Growth, Environmental Policies and Sustainability” organised by the Fondazione Eni Enrico Mattei, Venice, June 1, 2001

(ii) This paper was presented at the Fourth Toulouse Conference on Environment and Resource Economics on “Property Rights, Institutions and Management of Environmental and Natural Resources”, organised by Fondazione Eni Enrico Mattei, IDEI and INRA and sponsored by MATE, Toulouse, May 3-4, 2001

(iii) This paper was presented at the International Conference on “Economic Valuation of Environmental Goods”, organised by Fondazione Eni Enrico Mattei in cooperation with CORILA, Venice, May 11, 2001

(iv) This paper was circulated at the International Conference on “Climate Policy – Do We Need a New Approach?”, jointly organised by Fondazione Eni Enrico Mattei, Stanford University and Venice International University, Isola di San Servolo, Venice, September 6-8, 2001

(v) This paper was presented at the Seventh Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Venice, Italy, January 11-12, 2002

(vi) This paper was presented at the First Workshop of the Concerted Action on Tradable Emission Permits (CATEP) organised by the Fondazione Eni Enrico Mattei, Venice, Italy, December 3-4, 2001

(vii) This paper was presented at the ESF EURESCO Conference on Environmental Policy in a Global Economy “The International Dimension of Environmental Policy”, organised with the collaboration of the Fondazione Eni Enrico Mattei, Acquafredda di Maratea, October 6-11, 2001

(viii) This paper was presented at the First Workshop of “CFEWE – Carbon Flows between Eastern and Western Europe”, organised by the Fondazione Eni Enrico Mattei and Zentrum fur Europäische Integrationsforschung (ZEI), Milan, July 5-6, 2001

(ix) This paper was presented at the Workshop on “Game Practice and the Environment”, jointly organised by Università del Piemonte Orientale and Fondazione Eni Enrico Mattei, Alessandria, April 12-13, 2002

2002 SERIES

CLIM Climate Change Modelling and Policy (Editor: Marzio Galeotti)

VOL Voluntary and International Agreements (Editor: Carlo Carraro)

SUST Sustainability Indicators and Environmental Evaluation (Editor: Carlo Carraro)

NRM Natural Resources Management (Editor: Carlo Giupponi)

KNOW Knowledge, Technology, Human Capital (Editor: Dino Pinelli)

MGMT Corporate Sustainable Management (Editor: Andrea Marsanich)

PRIV Privatisation, Regulation, Antitrust (Editor: Bernardo Bortolotti)

ETA Economic Theory and Applications (Editor: Carlo Carraro)