

Quirion, Philippe

Working Paper

Macroeconomic effects of an energy saving policy in the public sector

Nota di Lavoro, No. 14.2002

Provided in Cooperation with:

Fondazione Eni Enrico Mattei (FEEM)

Suggested Citation: Quirion, Philippe (2002) : Macroeconomic effects of an energy saving policy in the public sector, Nota di Lavoro, No. 14.2002, Fondazione Eni Enrico Mattei (FEEM), Milano

This Version is available at:

<https://hdl.handle.net/10419/119623>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

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.

Fondazione Eni Enrico Mattei

**Macroeconomic Effects of an
Energy Saving Policy in the
Public Sector**

Philippe Quirion

NOTA DI LAVORO 14.2002

JANUARY 2002

CLIM – Climate Change Modelling and Policy

Philippe Quirion *CIREN (Centre international de recherches sur l'environnement et le développement, CNRS/EHESS)*

This paper can be downloaded without charge at:

The Fondazione Eni Enrico Mattei Note di Lavoro Series Index:
http://www.feem.it/web/attiv/_attiv.html

Social Science Research Network Electronic Paper Collection:
<http://papers.ssrn.com/abstract=XXXXXX>

The opinions expressed in this paper do not necessarily reflect the position of
Fondazione Eni Enrico Mattei

Macroeconomic Effects of an Energy Saving Policy in the Public Sector

Summary

Nearly all the macroeconomic literature on environmental policies deals with taxes and tradable permits. A policy instrument that still needs to be looked at is a switch in government expenditure away from environmentally-damaging goods, in particular fossil fuels, and toward resource- and energy-saving expenditure.

We analyse such policy with a two-sector theoretical general equilibrium model. A composite good is produced with constant returns to scale, and a natural resource is extracted with diminishing returns and yields a differential rent to its owners. The government purchases natural resources and composite goods from private firms.

We show that a switch in public spending from the natural resource to the composite good increases employment. It also raises private consumption and welfare if the initial share of resource in public spending is smaller than that of private consumption, or if the difference is small enough. Simulations show that last condition holds in France for energy.

Keywords: Resource conservation, energy conservation, public spending, employment, general equilibrium, multi-sectors models

JEL: E62, H57, Q38

Address for correspondence:

Philippe Quirion

CIREDE (Centre international de recherches sur l'environnement et le développement, CNRS/EHESS)

45 bis, avenue de la belle Gabrielle, F-94736 Nogent-sur-Marne, France

Phone: 33 1 43 94 73 95

Fax: 33 1 43 94 73 70

E-mail: quirion@centre-cired.fr

This paper was presented at the European Council for an Energy-Efficient Economy 2001 Summer study and at the EUREQua (University of Paris I) seminar in environmental economics. The author thank participants, referees from ECEE and FEEM, Randall Bowie, Pierre Courtois, Minh Ha Duong, Khalil Helioui, Antonio Mele and Tarik Tazdait for helpful comments, and the Institut français de l'énergie for financial support.

1. Introduction

The largest part of the literature on macroeconomic effects of environmental policies deals with ecological tax reforms – the so-called "double dividend" debate (Bosello et al., 2001). Taxes, however, are far from being the most common policy instrument for protecting the environment. Therefore a couple of recent papers, e.g. Goulder *et al.* (1999) also analyse emissions quotas, performance standards and mandated technologies. Another instrument worth looking at is the composition of public spending between environmental-friendly and unfriendly goods and services. Indeed, approximately one-fifth of GDP is purchased directly by the government in most OECD countries. Admittedly, Bovenberg and van der Ploeg (1994) analyse the optimal composition of public spending between a clean and a dirty good, but both are produced with the same production technology.

In particular, a partial but environmentally-efficient measure to fight global warming would be to switch government spending from fossil fuel consumption to energy-efficiency expenditure: thermal insulation, energy-efficient boilers, lighting and appliances, etc. Furthermore, emissions associated with the production of goods and services purchased by the government could be reduced by introducing environmental criteria in the bidding process.

In this paper, we explore the macroeconomic consequences of such policies and show that they not only reduce the use of the natural resource (the first dividend), but that they also lead to benefits as measured in terms of higher employment. Furthermore, for the most likely values of the parameters, an energy-saving policy in the public sector leads to higher household consumption and welfare, provided that the level of public spending does not rise too much.

To demonstrate these results, we use a theoretical general equilibrium model which is presented in the third section. Its main peculiarity is a mixed industrial structure, with a composite good, produced with constant returns to scale, and a domestic natural resource (energy for instance), extracted with diminishing returns, which yields a differential (Ricardian) rent to its owners. The government purchases natural resources and composite goods from private firms. The present model builds heavily on Dixon and Hansen (1999) and Dixon and Pompermaier (1999), who study the effectiveness of monetary policy in presence

of menu costs. It is described in some depth since it differs significantly from those used to assess ecological tax reforms.

Section 4 derives the equilibrium and analyses the consequences of the allocation of government spending on employment, private consumption and households' utility. Section 5 explores magnitudes for different parameter values, and section 6 concludes. Beforehand, section 2 provides some information on resource-saving policies in the government sector.

2. Resource- and Energy-saving programs in the Government sector in practice

One of the most direct ways a government can save energy and other natural resources is by cutting its own consumption. However, until recently, very few countries had concerted energy management programs for the government sector (Borg *et al.*, 1998). Since then, the situation has improved somewhat. In the U.S., an Executive Order¹ states that each federal agency shall reduce its greenhouse gas emissions attributed to facility energy use by 30 percent by 2010 compared to such emissions levels in 1990. The Federal Energy Management Program has been created to help Federal agencies increase energy efficiency, use renewable energy, and conserve water. In European countries, most national climate change programmes include provisions to reduce CO₂ emissions from the public sector, either with a quantitative target (e.g. Germany) or without (e.g. France). At last, the European Climate Change Program includes an initiative and a proposed directive on Energy-efficient public procurement, with the aim of saving 25 to 40 millions tonnes of CO₂ per year by 2005 compared to business as usual (European Commission, 2001).

Such a development is not surprising: to quote Borg *et al.* (1998), "Government-related facilities are often the largest energy users in a country and the single most important customers for energy-using products and services." Furthermore, technologies are available to cut significantly energy consumption in the public sector: thermal insulation techniques, efficient heating, ventilation and air conditioning systems, efficient appliances, boilers, motors and lighting systems, buildings energy management systems, etc.

¹ Executive Order 13123 (Greening the Government Through Efficient Energy Management), June 1999.

Nearly all public sector emissions relate to the buildings sector which, according to most engineering estimations, exhibits the highest potential CO₂ emission reduction for a given abatement cost (see Moomaw and Roberto-Moreira, ed., 2001, and references therein). Furthermore, most of these studies conclude that some reductions are available at a negative net cost – that is, the reduction in the energy bill is higher than the energy-saving expenditure. This raises the question of why this "energy-efficiency gap" exists (Jaffe and Stavins, 1994). Our paper, which exhibits some positive macroeconomic feedback from such policies, just makes the existence of such a "no-regret potential" more unexpected.

A detailed examination of this issue is well beyond the scope of the present paper. However, in the particular context of the public sector, it should be stressed that organisational barriers often play a prominent role: people in a position to save energy seldom have an incentive in making such decisions. For instance, departments are often not accountable for energy costs, nor are the actors responsible for purchasing equipment (Sorrell, ed., 2000).

Because the energy-efficiency gap is a matter of argument for energy engineers as well as economic theorists, we prefer not to make particular assumptions on this question. Thus, we do not model a public good production function. Rather, we look in turn at the effect of the *share* of resource in public spending, and at that of the *level* of public spending. This allows us to point out the relevance of the financial profitability of the government resource-saving policy for each of our results.

3. The model

3.1. Households

There is a continuum of households $i \in [0;1]$. They derive utility from leisure and from the consumption of a natural resource, C^R , and a composite good, C^C . The quality of the environment does not enter the utility function, nor does public spending. The former assumption is common in the double dividend debate and the latter in the literature on the effects of fiscal policy; cf. for instance Dixon and Lawler (1996). Formally

$$U(C_i^R, C_i^C, l_i) = \frac{(C_i^R)^\beta (C_i^C)^{1-\beta}}{\beta^\beta (1-\beta)^{1-\beta}} - \frac{\gamma}{\gamma+1} l_i^{\left(\frac{\gamma+1}{\gamma}\right)} \quad \forall i \in [0;1], \quad (1)$$

The second term of the utility function is the disutility of labour (l). γ represents the real wage elasticity of labour supply.

The consumer price index is given by

$$P(P^R, P^C) = (P^R)^\beta (P^C)^{1-\beta} \quad (2)$$

The budget constraint of household i is

$$P^R C_i^R + P^C C_i^C \leq Wl_i + \pi_i - \phi_i \equiv I_i \quad \forall i \quad (3)$$

Where W is the nominal wage, which is assumed to be the same in the two sectors, meaning that there is perfect labour mobility between the two sectors. π_i is the nominal rent received by household i and ϕ_i is a lump-sum tax. Total nominal net-of-tax income of households is denoted

$$I = \int_{i=0}^1 I_i di \quad (4)$$

Maximising utility subject to the budget constraint and assuming that all households are identical yields aggregate private consumption and labour supply:

$$C^R = \beta \frac{I}{P^R} \quad (5)$$

$$C^C = (1 - \beta) \frac{I}{P^C} \quad (6)$$

$$l_i = \left(\frac{W}{P} \right)^\gamma \quad (7)$$

The first two equations state that constant shares of income are spent on the natural resource and on the composite good. The third equation states that the labour supply is a function of the real wage and of the elasticity of labour supply.

3.2. Firms

All firms take the nominal wage W and prices P^C and P^R as exogenous. The production function of all firms in the composite sector is characterised by constant returns to scale, which is consistent with empirical estimates. For instance, Crépon et al. (1999) or Klette

(1994) obtain a scale elasticity around one for, respectively, French and Norwegian manufacturing industries.

The output is normalised to be equal to employment. Therefore we have

$$X^C = L^C \tag{8}$$

$$P^C = W \tag{9}$$

In the sector producing the natural resource there are constant or diminishing returns with

$$X^R = \frac{(L^R)^\alpha}{\alpha} \tag{10}$$

Where $\alpha \in (0,1]$ is the magnitude of decreasing returns in resource production. A corollary is that all deposits but the least productive yield a differential rent to their owners. The assumption of diminishing returns, which is crucial for our results, deserves some attention.

Such an assumption has a long pedigree, dating back to Ricardo (1821, chapter 3)². Since then, it has been used and tested by various authors who have constructed so-called cumulative cost functions, by which cumulative extraction of a non-renewable resource determines its shadow cost of extraction. One of the most comprehensive treatments is the model by Nordhaus (1973, 1979) for several primary energy resources (oil, natural gas, coal, shale, uranium) and several regions of the world. He uses step-shaped extraction cost functions: marginal cost rises step-by-step with the stock extracted. Livernois and Uhler (1987) empirically demonstrate that, in the case of oil, the dependence of costs on cumulative extraction is twofold. First, low-cost reservoirs tend to be found first. As exploration progresses, increasingly inaccessible reserves are discovered, with correspondingly higher extraction costs. Second, by lowering the pressure of oil occurring in a natural petroleum reservoir, cumulative extraction raises the cost of further exploitation. For more references, see Epple and Londregan (1993) who survey this literature. In addition, note that some recent dynamic general equilibrium models feature a cumulative cost function in fossil fuel

² "Mines, as well as land, generally pay a rent to their owner [...]. If there were abundance of equally fertile mines, which any one might appropriate, they could yield no rent; the value of their produce would depend on the quantity of labour necessary to extract the metal from the mine and bring it to market. But there are mines of various qualities, affording very different results, with equal quantities of labour. [...] The return for capital from the poorest mine paying no rent, would regulate the rent of all the other more productive mines. This mine is supposed to yield the usual profits of stock. All that the other mines

production (e.g., Bovenberg and Goulder, 2000).

From (10), when $\alpha < 1$, profit maximisation leads to the demand for labour in the resource sector:³

$$L^R = \left(\frac{W}{P^R} \right)^{\frac{-1}{1-\alpha}} \quad (11)$$

When $\alpha = 1$, output is demand determined, since the labour demand curve is infinitely elastic.

3.3. The State

The government consumes natural resources and composite goods supplied by private firms⁴ and financed by lump-sum taxes. The government's budget is always balanced. The share of natural resource in public spending is λ . Government's demand functions in real terms are

$$G^R = \lambda \frac{\phi I}{P^R} \quad (12)$$

$$G^C = (1 - \lambda) \frac{\phi I}{P^C} \quad (13)$$

Where $\phi = \int_{i=0}^1 \phi_i di / I$ is the ratio of public spending to households' revenue. The two equations

above state that government real spending in each good is an exogenous part of its revenue deflated by the price of the goods.

4. Equilibrium and comparative static

Solving for equilibrium, we find that the relative price of the composite good and the natural resource is given by

$$\frac{P^C}{P^R} = \left[\frac{1 - \beta + \phi(1 - \lambda)}{\alpha(\beta + \phi\lambda)} + 1 \right]^{\frac{1-\alpha}{\beta(1-\alpha)+1}} \quad (14)$$

Total employment is

produce more than this, will necessarily be paid to the owners for rent."

³ All demonstrations of the results below are presented in an appendix available from the author.

⁴ Direct employment in the public sector would be equivalent to public consumption of composite goods.

$$l = \left[\frac{1 - \beta + \phi(1 - \lambda)}{\alpha(\beta + \phi\lambda)} + 1 \right]^{\frac{\gamma\beta(1-\alpha)}{\gamma\beta(1-\alpha)+1}} \quad (15)$$

with employment in the resource sector

$$L^R = \left[\frac{1 - \beta + \phi(1 - \lambda)}{\alpha(\beta + \phi\lambda)} + 1 \right]^{\frac{-1}{\gamma\beta(1-\alpha)+1}} \quad (16)$$

A "balanced" variation of the nominal level of public spending, i.e. when $\lambda = \beta$, is neutral on employment⁵:

$$\frac{\partial l}{\partial \phi} = 0 \quad \text{when } \lambda = \beta.$$

More interesting is the employment effect of the share of the natural resource in public spending

$$\frac{\partial l}{\partial \lambda} = - \frac{(1 - \alpha) \beta \gamma \phi (1 + \phi) \left(1 + \frac{1 - \beta + \phi(1 - \lambda)}{\alpha(\beta + \lambda\phi)} \right)^{\frac{-1}{\gamma\beta(1-\alpha)+1}}}{\alpha (\beta \gamma (1 - \alpha) + 1) (\beta + \lambda\phi)^2} \quad (17)$$

The effect is null in case of constant returns in natural resource production ($\alpha = 1$) or when labour supply is fixed ($\gamma = 0$) and strictly negative in every other case. There is thus what we may label a "public spending employment dividend" from saving natural resources in the public sector.

The explanation is straightforward: a decrease in public consumption of the natural resource stops the production from the least efficient deposits. Hence, the price of the resource, which is set by the least efficient deposit, decreases, raising real wage thus employment.

Since the level of public spending is neutral, this result holds irrespective of the financial profitability of such a programme, i.e., would the lessening in natural resource bills exceed the

⁵ This would not hold if public spending or leisure entered households' utility function in a non-additive way, if public spending entered production functions (as in Turnovsky and Fisher, 1995, for instance), or with distortionary taxation (as in Heijdra *et al.*, 1998). We have ruled out these well-known mechanisms in order to disentangle the effects of the *level* of public spending from those of its *composition*.

expenditures needed to decrease this bill? This result is interesting since the potential for financially profitable energy-efficient investments is highly debated (see section 2 above).

Total private consumption is

$$C = \frac{\left(1 + \frac{1-\beta+\phi(1-\lambda)}{\alpha(\beta+\lambda\phi)}\right)^{\frac{1-\beta(1-\alpha)}{1+\beta\gamma(1-\alpha)}}}{\alpha(\beta+\lambda\phi)} \quad (18)$$

The effect of the level of nominal public expenditure is given by

$$\frac{\partial C}{\partial \phi} = - \frac{(\beta(1-(1-\alpha)\beta)(1+(1-\alpha)\gamma\lambda) + (1+(1-\alpha)\beta\gamma)\lambda(1-(1-\alpha)\lambda)\phi) \left(1 + \frac{1-\beta+\phi(1-\lambda)}{\alpha(\beta+\lambda\phi)}\right)^{\frac{1-(1-\alpha)\beta}{1+(1-\alpha)\beta\gamma}}}{(\alpha(1+(1-\alpha)\beta\gamma)(\beta+\lambda\phi)^2(1-\beta(1-\alpha)+\phi(1-\lambda(1-\alpha))))} \quad (19)$$

which is negative: an increase in public spending crowds out private consumption, as usual in a model without increasing returns or nominal rigidities. The effect on private consumption of the share of natural resource in public expenditure is given by

$$\frac{\partial C}{\partial \lambda} = - \frac{(1-\alpha)\phi \left(1 + \frac{1-\beta+\phi(1-\lambda)}{\alpha(\beta+\lambda\phi)}\right)^{\frac{1-\beta+\alpha\beta}{1+\beta\gamma(1-\alpha)}} \left((\beta-\lambda)\phi + \gamma\beta((1-\beta(1-\alpha))+\phi(1-\lambda(1-\alpha)))\right)}{\alpha(1-\beta\gamma(1-\alpha))(\beta+\lambda\phi)^2(1-\beta(1-\alpha)+\phi(1-\lambda(1-\alpha)))} \quad (20)$$

which equals zero in case of constant returns in natural resource production ($\alpha = 1$). When $\alpha < 1$, because the denominator and the first term of the numerator are positive, the above expression is strictly negative if and only if

$$\lambda < \beta + \frac{\beta(1-(1-\alpha)\beta)\gamma(1+\phi)}{(1-(1-\alpha)\beta\gamma)\phi} \quad (21)$$

Since the second part of the RHS is positive, this inequality means that if the initial share of natural resource in public expenditure is not greater than that of private consumption ($\lambda \leq \beta$), then (i) a decrease in λ unambiguously increases private consumption; (ii) an increase in λ reduces private consumption, up to a certain point which depends on parameters. This last non-monotonic response proceeds from the combination of two antagonistic effects. First, real wage and employment decrease with λ , lessening purchasing power of households. Second, abstracting from the first effect, the consumer price index decreases as soon as the allocation

of public spending λ departs from that of households β , improving purchasing power of households. Simulations of section 3 using French data indicate that condition 21 is likely to hold for a public-sector energy-saving program in this country.

However, remember that from (19), public spending crowds out private consumption. Hence, if the energy-saving program is not financially profitable and if the government wants to maintain the supply of public goods, the level of public spending will rise and private consumption may fall.

Let's turn to environmental effectiveness. Formally

$$X^R = \frac{\left(1 + \frac{1-\beta+(1-\lambda)\phi}{\alpha(\beta+\lambda\phi)}\right)^{-\frac{\alpha}{1+(1-\alpha)\beta\gamma}}}{\alpha} \quad (22)$$

$$\frac{\partial X^R}{\partial \lambda} = \frac{\phi(1+\phi)\left(1 + \frac{1-\beta+\phi(1-\lambda)}{\alpha(\beta+\lambda\phi)}\right)^{-\frac{\alpha}{1+\beta\gamma(1-\alpha)}}}{(\beta+\lambda\phi)(1-\beta\gamma(1-\alpha))(1-\beta(1-\alpha)+\phi(1-\lambda(1-\alpha)))} \quad (23)$$

which is positive. Intuitively, a decrease in public demand for natural resources reduces the relative price of the resource and raises private demand for the resource. However, this 'rebound' effect is never sufficient to cancel out the 'first dividend', i.e. resource extraction decreases nevertheless. This is easily understandable with a *reductio ad absurdum*: if the aggregate demand for the resource were to rise, so would its supply hence its price in terms of labour; real wage and employment would then decrease, which we know is false (equation 17).

Results on welfare are less clear-cut. Formally:

$$U = \frac{\left(1 + \frac{1-\beta+\phi(1-\lambda)}{\alpha(\beta+\lambda\phi)}\right)^{\frac{1-\beta(1-\alpha)}{1+\beta\gamma(1-\alpha)}}}{\alpha(\beta+\lambda\phi)} - \frac{\gamma}{\gamma+1} \left(1 + \frac{1-\beta+\phi(1-\lambda)}{\alpha(\beta+\lambda\phi)}\right)^{\frac{\gamma\beta(1-\alpha)}{1+\beta\gamma(1-\alpha)}} \quad (24)$$

Since government spending does not enter households' utility function, a "balanced" rise in ϕ , i.e. when $\lambda = \beta$, reduces households' utility:

$$\frac{\partial U}{\partial \phi} = -\frac{\left(1 + \frac{1-(1-\alpha)\beta}{\alpha\beta}\right)^{\frac{1-(1-\alpha)\beta}{1+(1-\alpha)\beta\gamma}}}{\alpha\beta(1+\phi)^2} \text{ when } \lambda = \beta \quad (25)$$

which is negative. The impact of a decrease in λ is ambiguous since consumption rises – as long as condition (21) holds – but leisure declines:

$$\frac{\partial U}{\partial \lambda} = \frac{\partial C}{\partial \lambda} + \frac{(1-\alpha)\beta\gamma^2\phi(1+\phi)\left(1 + \frac{1-\beta+\phi(1-\lambda)}{\alpha(\beta+\lambda\phi)}\right)^{-\frac{1}{1+\beta\gamma(1-\alpha)}}}{\alpha(1+\gamma)(1+\beta\gamma(1-\alpha))(\beta+\lambda\phi)^2} \quad (26)$$

Simulations laid out in section 3 show that the consumption effect is likely to outweigh the leisure effect, i.e., utility closely mimics consumption and is likely to raise when condition (21) holds.

5. Results of the simulations

Four scenarios are generated by varying two key parameters: the elasticity of labour supply γ and the magnitude of decreasing returns in resource production α (table 1):

Table 1 here

Graph 1 below displays the values of C (private consumption), U (welfare), l (employment) and Xr (natural resource production) for $\theta=0.2$, $\beta=0.05$ and λ ranging from 0.01 to 0.1. The particular value of β reflects the share of fossil fuels (coal, oil and gas) in households' budget in France (INSEE, 1998). To improve the clarity of the presentation, every curve is normalised at 100 for $\lambda=0.05$, so that variations of the endogenous variables are displayed as a percentage of their initial value.

Graph 1 here

Let's first focus on the two variables that respond to a variation in λ in a non-monotonic way: C and U (graphs 1.a and 1.b). For the high elasticity of labour supply scenarios, a decrease in λ raises both variables even if the initial share of resource in the public sector is twice that of the private sector. In the low elasticity of labour supply scenarios, however, a decrease in λ slightly harms consumption and welfare if the initial value of λ is at least 50% higher than β , and is beneficial in terms of consumption and welfare otherwise. The "real" values of λ and β of course depend on the country and on the resource, but taking as an illustration the final consumption of fossil fuels in France (INSEE, 1998), we have $\beta \approx 0.05$ and $\lambda \approx 0.047$. This means that according to our model, an energy-saving program in the French public sector would raise consumption and welfare, on top of employment.

Are our results quantitatively significant? U.S. and European public sector energy saving programs generally aim at a 20 to 30% reduction – meaning approximately a change in λ from 0.05 to 0.035 or 0.04. At best, it would bring a 0.1% rise in employment and a 0.05% rise in consumption and welfare. This may seem at first sight modest, but one cannot expect a huge side effect from what is only a partial climate change mitigation measure. Macroeconomic evaluations of the more ambitious carbon/energy tax proposals typically predict an employment impact of +0.1% to +0.7% and an unclear effect on welfare (Majocchi, 1996). Furthermore, the environmental effectiveness of the policy, admittedly reduced by the macroeconomic feedbacks, remains significant. For example, a 30% cut in λ , with the government initially consuming 20% of the resource, would ex ante lead to a 6% resource saving ($30\% * 0.2$). Ex post, it still yields to a saving of 3.4% (for $\alpha=0.5$) or 5% (for $\alpha=0.75$).

6. Concluding remarks

We have shown that a switch in public spending away from a natural resource (energy for instance) and towards a composite good increases employment, real wage and workers' utility. It also raises private consumption and welfare under two conditions. First, the initial share of energy in public spending must be smaller than that of private consumption, or the difference must be small enough. Simulations show that it is likely to be the case at least for energy. Second, it must not entail too high a rise in the aggregate public spending. This last question is a matter of argument for energy engineers as well as economic theorists and is outside the scope of this paper.

Furthermore, even if the private demand for the resource rises following the switch in public spending, this 'rebound' effect is never sufficient to cancel out the 'first dividend', i.e. resource extraction decreases nevertheless.

Hence, there is always an "employment dividend" from saving energy in the public sector, and also a "welfare dividend" if such policy is not too costly. Admittedly modest in quantitative terms, these macroeconomic effects are not trivial when compared to those predicted for ecological tax reforms.

Such policy is not Pareto-improving: households earning only rents are worse off (since real rents decline) while those earning only wage income are better off (because real wage rises). It

can be seen as a (small) step towards what Keynes (1936, chapter 24) calls "euthanasia of rentiers" – the latter being, in the present model, the owners of the natural resource.

The crucial assumption here is that marginal returns are decreasing in the natural resource sector and constant in the composite sector. The rationale for the former assumption is that low-cost reservoirs tend to be found first. As exploration progresses, increasingly inaccessible reserves are discovered, with correspondingly higher extraction costs. This assumption is in line with empirical modelling of exhaustible resource supply and with the dynamic general equilibrium models that distinctively model fossil fuel supply. In the composite sector, the constant returns assumption is in agreement with empirical estimates.

The other important modelling choices are those that purposively entail the neutrality of the level of public spending on employment: neither public spending nor leisure enter households' utility function in a non-additive way, public spending does not enter production functions, and lump-sum taxation is available. We have ruled out these mechanisms in order to disentangle the effects of the *level* of public spending, which is highly debated and covered by a large literature, from those of its *composition*.

The mechanisms we have formalised in this paper are best thought of as long term effects. In the short run, various rigidities may hold. On the one hand, labour (and also capital) mobility is obviously not perfect. Hence, a decrease in public demand for the natural resource might harm employment and private consumption in the short term⁶. On the other hand, price rigidities may occur. If prices were sticky, a decrease in the share of energy in public expenditure would also raise real wage and employment, through a different mechanism than in our model. Simply, since all the turnover of the composite sector is used for hiring labour while a part of that of the resource sector is distributed as rents, employment intensity of the former is larger than that of the latter.

Up to now, the bulk of the literature on macroeconomic effects of environmental policies has focused on tax reforms. Furthermore, it has typically neglected the technical heterogeneity between the sectors behind the environmental externalities and the rest of the economy. Our results constitute an invitation to devote more attention to other environmental measures than

⁶ However this adverse consequence cannot be taken for granted. Indeed Ramey and Shapiro (1998) analyse the effects of sector-specific changes in government spending in a model with two symmetric sectors. Following an increase in government

ecological tax reforms and to the modelling of the specific features of environmental-friendly and unfriendly sectors.

spending in one sector, real wage and employment are higher when the reallocation of capital across sectors is costly.

References

- Borg, N., E. Mills, N. Martin, and J. Harris, 1998, "Energy Management in the Government Sector: An International Review", *Proceedings of the 1997 ECEEE Summer Study*, Prague, Czech Republic. Panel 4, ID 150, 1-24. (European Council for an Energy-Efficient Economy, Copenhagen, Denmark)
- Bosello, F., C. Carraro and M. Galeotti, 2001, "The double dividend issue: Modelling Strategies and Empirical Findings", *Environment and Development Economics*, 6(1), 9-45
- Bovenberg, A.L. and F. van der Ploeg, 1994, "Environmental Policy, Public Finance and the Labour Market in a Second-Best World", *Journal of Public Economics*, 55(3), 349-90
- Bovenberg L. and L. Goulder, 2000, *Neutralising the adverse industry impacts of CO₂ abatement policies: What does it cost?*, Fondazione Eni Enrico Mattei Working Paper 68.2000
- Crépon, B., R. Desplatz and J. Mairesse, 1999, *Estimating price cost margins, scale economies and workers' bargaining power at the firm level*, INSEE/DESE working paper G 9917, Malakoff, France
- Dixon, H.D. and C.T. Hansen, 1999, "A mixed industrial structure magnifies the importance of menu costs", *European Economic Review*, 43, 1475-1499
- Dixon, H.D. and P. Lawler, 1996, "Imperfect Competition and the Fiscal Multiplier", *Scandinavian Journal of Economics*, 98(2), 219-31
- Dixon, H.D. and A. Pompermaier, 1999, "A comparison of menu costs in open and closed economies with a mixed industrial structure", *Open Economies Review*, 10, 365-384
- Epple, D. and J. Londregan, 1993, "Strategies for modelling exhaustible resource supply", Chapter 22 in A. Knees and J. Sweeney, *Handbook of natural resource and energy economics*, Volume III, North-Holland
- European Commission, 2001, *European Climate Change Programme Report*, June, Brussels
- Goulder, L.H., I.A.W. Parry, R.C. Williams and D. Burtraw, 1999, "The cost-effectiveness of alternative instruments for environmental protection in a second-best setting", *Journal of Public Economics*, 72, 329-360

Heijdra, B.J., J.E. Ligthart and F. van der Ploeg, 1998, "Fiscal policy, distortionary taxation, and direct crowding out under monopolistic competition", *Oxford Economic Papers*, 50, 79-88

INSEE, 1998, *Comptes et indicateurs économiques – Rapport sur les comptes de la Nation 1997*, Paris, France

Jaffe, A.B. and R.N. Stavins, 1994, "The energy-efficiency gap - What does it mean?", *Energy Policy*, 22(10)

Keynes, J.M., 1936, *General theory of employment, interest and money*, Collected Writings of John Maynard Keynes, Macmillan, London

Killingsworth, M., 1983, *Labour supply* (Cambridge University Press, Cambridge)

Klette, J., 1994, *Estimating price-cost margins and scale economies from a panel of micro data*, Discussion Paper 130, Statistics Norway

Livernois, J.R. and R.S. Uhler, 1987, "Extraction costs and the economics of non-renewable resources", *Journal of Political Economy*, 95(1), 195-203

Majocchi, A., 1996, "Green Fiscal Reform and Employment: A Survey", *Environmental and Resource Economics*, 8(4), 375-397, December

Montague, P., 2000, "Steps Toward A Corporate State", *Rachel's Environment & Health Weekly*, 694

Moomaw, W. and J. Roberto-Moreira, ed., 2001, "Technological and Economic Potential of Greenhouse Gas Emissions Reduction", Chapter 3 in Intergovernmental Panel on Climate Change, Working Group III, *Climate Change 2001 – Mitigation*, Cambridge University Press

Nordhaus, W.D., 1973, "The allocation of energy resources", *Brookings paper on Economic Activity*, pp. 529-70

Nordhaus, W.D., 1979, *The efficient use of energy resources*, Cowles Foundation Monograph 26, Yale University Press, New Haven, CT

Ramey, V. and M. Shapiro, 1998, "Costly capital reallocation and the effects of government spending", *Carnegie-Rochester Conference Series on Public Policy*, 48, 145-94

Ricardo, D., 1821, *On The Principles of Political Economy and Taxation*, Third edition, John

Murray, Albemarle-Street, London

Sorrell, S. (ed.), 2000, *Barriers to Energy Efficiency in Public and Private Organisations*, Report to the European Commission, September, Brighton, U.K.

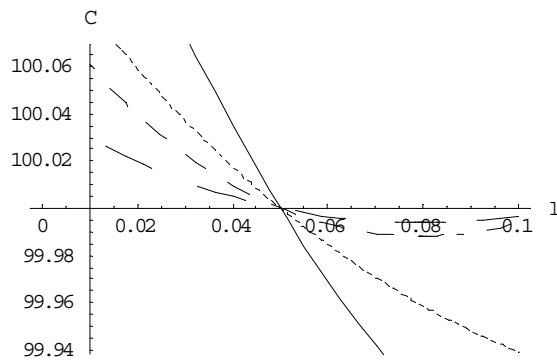
Turnovsky, S.J. and W.H. Fisher, 1995, "The composition of government expenditure and its consequences for macroeconomic performance", *Journal of Economic Dynamics and Control*, 19(4), 747-86

Table 1. Definition of the scenarios

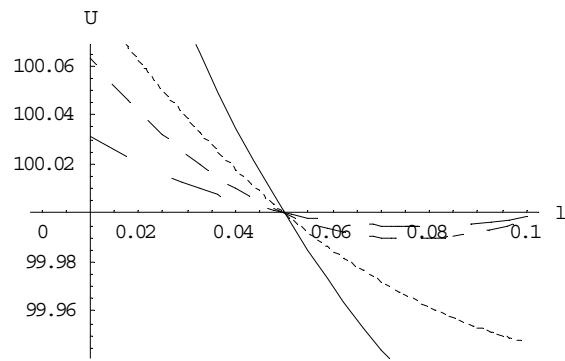
Common features: $\theta=0.2, \beta=0.05$		magnitude of decreasing returns in resource production	
		High ($\alpha=0.5$)	Low ($\alpha=0.75$)
elasticity of labour supply	High ($\gamma=0.4$)	Solid line	Short dashing
	Low ($\gamma=0.1$)	Intermediate dashing	Long dashing

Graph 1. Impact of λ on the main macroeconomic variables

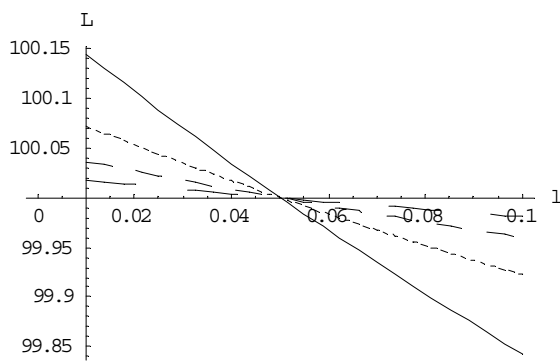
a. Private consumption



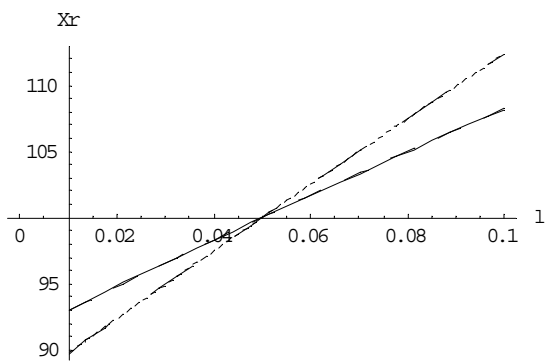
b. Welfare



c. Employment



d. Resource production



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

To order any of these papers, please fill out the form at the end of the list.

SUST	1.2001	<i>Inge MAYERES and Stef PROOST: <u>Should Diesel Cars in Europe be Discouraged?</u></i>
SUST	2.2001	<i>Paola DORIA and Davide PETTENELLA: <u>The Decision Making Process in Defining and Protecting Critical Natural Capital</u></i>
CLIM	3.2001	<i>Alberto PENCH: <u>Green Tax Reforms in a Computable General Equilibrium Model for Italy</u></i>
CLIM	4.2001	<i>Maurizio BUSSOLO and Dino PINELLI: <u>Green Taxes: Environment, Employment and Growth</u></i>
CLIM	5.2001	<i>Marco STAMPINI: <u>Tax Reforms and Environmental Policies for Italy</u></i>
ETA	6.2001	<i>Walid OUESLATI: <u>Environmental Fiscal Policy in an Endogenous Growth Model with Human Capital</u></i>
CLIM	7.2001	<i>Umberto CIORBA, Alessandro LANZA and Francesco PAULI: <u>Kyoto Commitment and Emission Trading: a European Union Perspective</u></i>
MGMT	8.2001	<i>Brian SLACK (xlv): <u>Globalisation in Maritime Transportation: Competition, uncertainty and implications for port development strategy</u></i>
VOL	9.2001	<i>Giulia PESARO: <u>Environmental Voluntary Agreements: A New Model of Co-operation Between Public and Economic Actors</u></i>
VOL	10.2001	<i>Cathrine HAGEM: <u>Climate Policy, Asymmetric Information and Firm Survival</u></i>
ETA	11.2001	<i>Sergio CURRARINI and Marco MARINI: <u>A Sequential Approach to the Characteristic Function and the Core in Games with Externalities</u></i>
ETA	12.2001	<i>Gaetano BLOISE, Sergio CURRARINI and Nicholas KIKIDIS: <u>Inflation and Welfare in an OLG Economy with a Privately Provided Public Good</u></i>
KNOW	13.2001	<i>Paolo SURICO: <u>Globalisation and Trade: A "New Economic Geography" Perspective</u></i>
ETA	14.2001	<i>Valentina BOSETTI and Vincenzina MESSINA: <u>Quasi Option Value and Irreversible Choices</u></i>
CLIM	15.2001	<i>Guy ENGELN (xlii): <u>Desertification and Land Degradation in Mediterranean Areas: from Science to Integrated Policy Making</u></i>
SUST	16.2001	<i>Julie Catherine SORS: <u>Measuring Progress Towards Sustainable Development in Venice: A Comparative Assessment of Methods and Approaches</u></i>
SUST	17.2001	<i>Julie Catherine SORS: <u>Public Participation in Local Agenda 21: A Review of Traditional and Innovative Tools</u></i>
CLIM	18.2001	<i>Johan ALBRECHT and Niko GOBBIN: <u>Schumpeter and the Rise of Modern Environmentalism</u></i>
VOL	19.2001	<i>Rinaldo BRAU, Carlo CARRARO and Giulio GOLFETTO (xliii): <u>Participation Incentives and the Design of Voluntary Agreements</u></i>
ETA	20.2001	<i>Paola ROTA: <u>Dynamic Labour Demand with Lumpy and Kinked Adjustment Costs</u></i>
ETA	21.2001	<i>Paola ROTA: <u>Empirical Representation of Firms' Employment Decisions by an (S,s) Rule</u></i>
ETA	22.2001	<i>Paola ROTA: <u>What Do We Gain by Being Discrete? An Introduction to the Econometrics of Discrete Decision Processes</u></i>
PRIV	23.2001	<i>Stefano BOSI, Guillaume GIRMANS and Michel GUILLARD: <u>Optimal Privatisation Design and Financial Markets</u></i>
KNOW	24.2001	<i>Giorgio BRUNELLO, Claudio LUPI, Patrizia ORDINE, and Maria Luisa PARISI: <u>Beyond National Institutions: Labour Taxes and Regional Unemployment in Italy</u></i>
ETA	25.2001	<i>Klaus CONRAD: <u>Locational Competition under Environmental Regulation when Input Prices and Productivity Differ</u></i>
PRIV	26.2001	<i>Bernardo BORTOLOTTI, Juliet D'SOUZA, Marcella FANTINI and William L. MEGGINSON: <u>Sources of Performance Improvement in Privatised Firms: A Clinical Study of the Global Telecommunications Industry</u></i>
CLIM	27.2001	<i>Frédéric BROCHIER and Emiliano RAMIERI: <u>Climate Change Impacts on the Mediterranean Coastal Zones</u></i>
ETA	28.2001	<i>Nunzio CAPPUCCIO and Michele MORETTO: <u>Comments on the Investment-Uncertainty Relationship in a Real Option Model</u></i>
KNOW	29.2001	<i>Giorgio BRUNELLO: <u>Absolute Risk Aversion and the Returns to Education</u></i>
CLIM	30.2001	<i>ZhongXiang ZHANG: <u>Meeting the Kyoto Targets: The Importance of Developing Country Participation</u></i>
ETA	31.2001	<i>Jonathan D. KAPLAN, Richard E. HOWITT and Y. Hossein FARZIN: <u>An Information-Theoretical Analysis of Budget-Constrained Nonpoint Source Pollution Control</u></i>
MGMT	32.2001	<i>Roberta SALOMONE and Giulia GALLUCCIO: <u>Environmental Issues and Financial Reporting Trends</u></i>

Coalition Theory Network	33.2001	<i>Shlomo WEBER and Hans WIESMETH</i> : <u>From Autarky to Free Trade: The Impact on Environment</u>
ETA	34.2001	<i>Margarita GENIUS and Elisabetta STRAZZERA</i> : <u>Model Selection and Tests for Non Nested Contingent Valuation Models: An Assessment of Methods</u>
NRM	35.2001	<i>Carlo GIUPPONI</i> : <u>The Substitution of Hazardous Molecules in Production Processes: The Atrazine Case Study in Italian Agriculture</u>
KNOW	36.2001	<i>Raffaele PACI and Francesco PIGLIARU</i> : <u>Technological Diffusion, Spatial Spillovers and Regional Convergence in Europe</u>
PRIV	37.2001	<i>Bernardo BORTOLOTTI</i> : <u>Privatisation, Large Shareholders, and Sequential Auctions of Shares</u>
CLIM	38.2001	<i>Barbara BUCHNER</i> : <u>What Really Happened in The Hague? Report on the COP6, Part I, 13-25 November 2000, The Hague, The Netherlands</u>
PRIV	39.2001	<i>Giacomo CALZOLARI and Carlo SCARPA</i> : <u>Regulation at Home, Competition Abroad: A Theoretical Framework</u>
KNOW	40.2001	<i>Giorgio BRUNELLO</i> : <u>On the Complementarity between Education and Training in Europe</u>
Coalition Theory Network	41.2001	<i>Alain DESDOIGTS and Fabien MOIZEAU</i> (xlv): <u>Multiple Politico-Economic Regimes, Inequality and Growth</u>
Coalition Theory Network	42.2001	<i>Parkash CHANDER and Henry TULKENS</i> (xlv): <u>Limits to Climate Change</u>
Coalition Theory Network	43.2001	<i>Michael FINUS and Bianca RUNDSHAGEN</i> (xlv): <u>Endogenous Coalition Formation in Global Pollution Control</u>
Coalition Theory Network	44.2001	<i>Wietze LISE, Richard S.J. TOL and Bob van der ZWAAN</i> (xlv): <u>Negotiating Climate Change as a Social Situation</u>
NRM	45.2001	<i>Mohamad R. KHAWLIE</i> (xlvii): <u>The Impacts of Climate Change on Water Resources of Lebanon-Eastern Mediterranean</u>
NRM	46.2001	<i>Mutasem EL-FADEL and E. BOU-ZEID</i> (xlvii): <u>Climate Change and Water Resources in the Middle East: Vulnerability, Socio-Economic Impacts and Adaptation</u>
NRM	47.2001	<i>Eva IGLESIAS, Alberto GARRIDO and Almudena GOMEZ</i> (xlvii): <u>An Economic Drought Management Index to Evaluate Water Institutions' Performance Under Uncertainty and Climate Change</u>
CLIM	48.2001	<i>Wietze LISE and Richard S.J. TOL</i> (xlvii): <u>Impact of Climate on Tourist Demand</u>
CLIM	49.2001	<i>Francesco BOSELLO, Barbara BUCHNER, Carlo CARRARO and Davide RAGGI</i> : <u>Can Equity Enhance Efficiency? Lessons from the Kyoto Protocol</u>
SUST	50.2001	<i>Roberto ROSON</i> (xlviii): <u>Carbon Leakage in a Small Open Economy with Capital Mobility</u>
SUST	51.2001	<i>Edwin WOERDMAN</i> (xlviii): <u>Developing a European Carbon Trading Market: Will Permit Allocation Distort Competition and Lead to State Aid?</u>
SUST	52.2001	<i>Richard N. COOPER</i> (xlviii): <u>The Kyoto Protocol: A Flawed Concept</u>
SUST	53.2001	<i>Kari KANGAS</i> (xlviii): <u>Trade Liberalisation, Changing Forest Management and Roundwood Trade in Europe</u>
SUST	54.2001	<i>Xueqin ZHU and Ekko VAN IERLAND</i> (xlviii): <u>Effects of the Enlargement of EU on Trade and the Environment</u>
SUST	55.2001	<i>M. Ozgur KAYALICA and Sajal LAHIRI</i> (xlviii): <u>Strategic Environmental Policies in the Presence of Foreign Direct Investment</u>
SUST	56.2001	<i>Savas ALPAY</i> (xlviii): <u>Can Environmental Regulations be Compatible with Higher International Competitiveness? Some New Theoretical Insights</u>
SUST	57.2001	<i>Roldan MURADIAN, Martin O'CONNOR, Joan MARTINEZ-ALER</i> (xlviii): <u>Embodied Pollution in Trade: Estimating the "Environmental Load Displacement" of Industrialised Countries</u>
SUST	58.2001	<i>Matthew R. AUER and Rafael REUVENY</i> (xlviii): <u>Foreign Aid and Direct Investment: Key Players in the Environmental Restoration of Central and Eastern Europe</u>
SUST	59.2001	<i>Onno J. KUIK and Frans H. OOSTERHUIS</i> (xlviii): <u>Lessons from the Southern Enlargement of the EU for the Environmental Dimensions of Eastern Enlargement, in particular for Poland</u>
ETA	60.2001	<i>Carlo CARRARO, Alessandra POME and Domenico SINISCALCO</i> (xlix): <u>Science vs. Profit in Research: Lessons from the Human Genome Project</u>
CLIM	61.2001	<i>Efrem CASTELNUOVO, Michele MORETTO and Sergio VERGALLI</i> : <u>Global Warming, Uncertainty and Endogenous Technical Change: Implications for Kyoto</u>
PRIV	62.2001	<i>Gian Luigi ALBANO, Fabrizio GERMANO and Stefano LOVO</i> : <u>On Some Collusive and Signaling Equilibria in Ascending Auctions for Multiple Objects</u>
CLIM	63.2001	<i>Elbert DIJKGRAAF and Herman R.J. VOLLEBERGH</i> : <u>A Note on Testing for Environmental Kuznets Curves with Panel Data</u>

CLIM	64.2001	<i>Paolo BUONANNO, Carlo CARRARO and Marzio GALEOTTI</i> : <u>Endogenous Induced Technical Change and the Costs of Kyoto</u>
CLIM	65.2001	<i>Guido CAZZAVILLAN and Ignazio MUSU (I)</i> : <u>Transitional Dynamics and Uniqueness of the Balanced-Growth Path in a Simple Model of Endogenous Growth with an Environmental Asset</u>
CLIM	66.2001	<i>Giovanni BAIOCCHI and Salvatore DI FALCO (I)</i> : <u>Investigating the Shape of the EKC: A Nonparametric Approach</u>
CLIM	67.2001	<i>Marzio GALEOTTI, Alessandro LANZA and Francesco PAULI (I)</i> : <u>Desperately Seeking (Environmental) Kuznets: A New Look at the Evidence</u>
CLIM	68.2001	<i>Alexey VIKHLYAEV (xlviii)</i> : <u>The Use of Trade Measures for Environmental Purposes – Globally and in the EU Context</u>
NRM	69.2001	<i>Gary D. LIBECAP and Zeynep K. HANSEN (I)</i> : <u>U.S. Land Policy, Property Rights, and the Dust Bowl of the 1930s</u>
NRM	70.2001	<i>Lee J. ALSTON, Gary D. LIBECAP and Bernardo MUELLER (I)</i> : <u>Land Reform Policies, The Sources of Violent Conflict and Implications for Deforestation in the Brazilian Amazon</u>
CLIM	71.2001	<i>Claudia KEMFERT</i> : <u>Economy-Energy-Climate Interaction – The Model WIAGEM -</u>
SUST	72.2001	<i>Paulo A.L.D. NUNES and Yohanes E. RIYANTO</i> : <u>Policy Instruments for Creating Markets for Biodiversity: Certification and Ecolabeling</u>
SUST	73.2001	<i>Paulo A.L.D. NUNES and Erik SCHOKKAERT (II)</i> : <u>Warm Glow and Embedding in Contingent Valuation</u>
SUST	74.2001	<i>Paulo A.L.D. NUNES, Jeroen C.J.M. van den BERGH and Peter NIJKAMP (II)</i> : <u>Ecological-Economic Analysis and Valuation of Biodiversity</u>
VOL	75.2001	<i>Johan EYCKMANS and Henry TULKENS (I)</i> : <u>Simulating Coalitionally Stable Burden Sharing Agreements for the Climate Change Problem</u>
PRIV	76.2001	<i>Axel GAUTIER and Florian HEIDER</i> : <u>What Do Internal Capital Markets Do? Redistribution vs. Incentives</u>
PRIV	77.2001	<i>Bernardo BORTOLOTTI, Marcella FANTINI and Domenico SINISCALCO</i> : <u>Privatisation around the World: New Evidence from Panel Data</u>
ETA	78.2001	<i>Toke S. AIDT and Jayasri DUTTA (I)</i> : <u>Transitional Politics. Emerging Incentive-based Instruments in Environmental Regulation</u>
ETA	79.2001	<i>Alberto PETRUCCI</i> : <u>Consumption Taxation and Endogenous Growth in a Model with New Generations</u>
ETA	80.2001	<i>Pierre LASSERRE and Antoine SOUBEYRAN (I)</i> : <u>A Ricardian Model of the Tragedy of the Commons</u>
ETA	81.2001	<i>Pierre COURTOIS, Jean Christophe PÉREAU and Tarik TAZDAÏT</i> : <u>An Evolutionary Approach to the Climate Change Negotiation Game</u>
NRM	82.2001	<i>Christophe BONTEMPS, Stéphane COUTURE and Pascal FAVARD</i> : <u>Is the Irrigation Water Demand Really Convex?</u>
NRM	83.2001	<i>Unai PASCUAL and Edward BARBIER</i> : <u>A Model of Optimal Labour and Soil Use with Shifting Cultivation</u>
CLIM	84.2001	<i>Jesper JENSEN and Martin Hoidt THELLE</i> : <u>What are the Gains from a Multi-Gas Strategy?</u>
CLIM	85.2001	<i>Maurizio MICHELINI (III)</i> : <u>IPCC “Summary for Policymakers” in TAR. Do its results give a scientific support always adequate to the urgencies of Kyoto negotiations?</u>
CLIM	86.2001	<i>Claudia KEMFERT (III)</i> : <u>Economic Impact Assessment of Alternative Climate Policy Strategies</u>
CLIM	87.2001	<i>Cesare DOSI and Michele MORETTO</i> : <u>Global Warming and Financial Umbrellas</u>
ETA	88.2001	<i>Elena BONTEMPI, Alessandra DEL BOCA, Alessandra FRANZOSI, Marzio GALEOTTI and Paola ROTTA</i> : <u>Capital Heterogeneity: Does it Matter? Fundamental Q and Investment on a Panel of Italian Firms</u>
ETA	89.2001	<i>Efrem CASTELNUOVO and Paolo SURICO</i> : <u>Model Uncertainty, Optimal Monetary Policy and the Preferences of the Fed</u>
CLIM	90.2001	<i>Umberto CIORBA, Alessandro LANZA and Francesco PAULI</i> : <u>Kyoto Protocol and Emission Trading: Does the US Make a Difference?</u>
CLIM	91.2001	<i>ZhongXiang ZHANG and Lucas ASSUNCAO</i> : <u>Domestic Climate Policies and the WTO</u>
SUST	92.2001	<i>Anna ALBERINI, Alan KRUPNICK, Maureen CROPPER, Nathalie SIMON and Joseph COOK (II)</i> : <u>The Willingness to Pay for Mortality Risk Reductions: A Comparison of the United States and Canada</u>
SUST	93.2001	<i>Riccardo SCARPA, Guy D. GARROD and Kenneth G. WILLIS (II)</i> : <u>Valuing Local Public Goods with Advanced Stated Preference Models: Traffic Calming Schemes in Northern England</u>
CLIM	94.2001	<i>Ming CHEN and Larry KARP</i> : <u>Environmental Indices for the Chinese Grain Sector</u>
CLIM	95.2001	<i>Larry KARP and Jiangfeng ZHANG</i> : <u>Controlling a Stock Pollutant with Endogenous Investment and Asymmetric Information</u>
ETA	96.2001	<i>Michele MORETTO and Gianpaolo ROSSINI</i> : <u>On the Opportunity Cost of Nontradable Stock Options</u>
SUST	97.2001	<i>Elisabetta STRAZZERA, Margarita GENIUS, Riccardo SCARPA and George HUTCHINSON</i> : <u>The Effect of Protest Votes on the Estimates of Willingness to Pay for Use Values of Recreational Sites</u>
NRM	98.2001	<i>Frédéric BROCHIER, Carlo GIUPPONI and Alberto LONGO</i> : <u>Integrated Coastal Zone Management in the Venice Area – Perspectives of Development for the Rural Island of Sant’Erasmo</u>

NRM	99.2001	<i>Frédéric BROCHIER, Carlo GIUPPONI and Julie SORS: <u>Integrated Coastal Management in the Venice Area – Potentials of the Integrated Participatory Management Approach</u></i>
NRM	100.2001	<i>Frédéric BROCHIER and Carlo GIUPPONI: <u>Integrated Coastal Zone Management in the Venice Area – A Methodological Framework</u></i>
PRIV	101.2001	<i>Enrico C. PEROTTI and Luc LAEVEN: <u>Confidence Building in Emerging Stock Markets</u></i>
CLIM	102.2001	<i>Barbara BUCHNER, Carlo CARRARO and Igor CERSOSIMO: <u>On the Consequences of the U.S. Withdrawal from the Kyoto/Bonn Protocol</u></i>
SUST	103.2001	<i>Riccardo SCARPA, Adam DRUCKER, Simon ANDERSON, Nancy FERRAES-EHUAN, Veronica GOMEZ, Carlos R. RISOPATRON and Olga RUBIO-LEONEL: <u>Valuing Animal Genetic Resources in Peasant Economies: The Case of the Box Keken Creole Pig in Yucatan</u></i>
SUST	104.2001	<i>R. SCARPA, P. KRISTJANSON, A. DRUCKER, M. RADENY, E.S.K. RUTO, and J.E.O. REGE: <u>Valuing Indigenous Cattle Breeds in Kenya: An Empirical Comparison of Stated and Revealed Preference Value Estimates</u></i>
SUST	105.2001	<i>Clemens B.A. WOLLNY: <u>The Need to Conserve Farm Animal Genetic Resources Through Community-Based Management in Africa: Should Policy Makers be Concerned?</u></i>
SUST	106.2001	<i>J.T. KARUGIA, O.A. MWAI, R. KAITHO, Adam G. DRUCKER, C.B.A. WOLLNY and J.E.O. REGE: <u>Economic Analysis of Crossbreeding Programmes in Sub-Saharan Africa: A Conceptual Framework and Kenyan Case Study</u></i>
SUST	107.2001	<i>W. AYALEW, J.M. KING, E. BRUNS and B. RISCHKOWSKY: <u>Economic Evaluation of Smallholder Subsistence Livestock Production: Lessons from an Ethiopian Goat Development Program</u></i>
SUST	108.2001	<i>Gianni CICIA, Elisabetta D'ERCOLE and Davide MARINO: <u>Valuing Farm Animal Genetic Resources by Means of Contingent Valuation and a Bio-Economic Model: The Case of the Pentro Horse</u></i>
SUST	109.2001	<i>Clem TISDELL: <u>Socioeconomic Causes of Loss of Animal Genetic Diversity: Analysis and Assessment</u></i>
SUST	110.2001	<i>M.A. JABBAR and M.L. DIEDHOU: <u>Does Breed Matter to Cattle Farmers and Buyers? Evidence from West Africa</u></i>
SUST	1.2002	<i>K. TANO, M.D. FAMINOW, M. KAMUANGA and B. SWALLOW: <u>Using Conjoint Analysis to Estimate Farmers' Preferences for Cattle Traits in West Africa</u></i>
ETA	2.2002	<i>Efrem CASTELNUOVO and Paolo SURICO: <u>What Does Monetary Policy Reveal about Central Bank's Preferences?</u></i>
WAT	3.2002	<i>Duncan KNOWLER and Edward BARBIER: <u>The Economics of a "Mixed Blessing" Effect: A Case Study of the Black Sea</u></i>
CLIM	4.2002	<i>Andreas LÖSCHEL: <u>Technological Change in Economic Models of Environmental Policy: A Survey</u></i>
VOL	5.2002	<i>Carlo CARRARO and Carmen MARCHIORI: <u>Stable Coalitions</u></i>
CLIM	6.2002	<i>Marzio GALEOTTI, Alessandro LANZA and Matteo MANERA: <u>Rockets and Feathers Revisited: An International Comparison on European Gasoline Markets</u></i>
ETA	7.2002	<i>Effrosyni DIAMANTOUDI and Eftichios S. SARTZETAKIS: <u>Stable International Environmental Agreements: An Analytical Approach</u></i>
KNOW	8.2002	<i>Alain DESDOIGTS: <u>Neoclassical Convergence Versus Technological Catch-up: A Contribution for Reaching a Consensus</u></i>
NRM	9.2002	<i>Giuseppe DI VITA: <u>Renewable Resources and Waste Recycling</u></i>
KNOW	10.2002	<i>Giorgio BRUNELLO: <u>Is Training More Frequent when Wage Compression is Higher? Evidence from 11 European Countries</u></i>
ETA	11.2002	<i>Mordecai KURZ, Hehui JIN and Maurizio MOTOLESE: <u>Endogenous Fluctuations and the Role of Monetary Policy</u></i>
KNOW	12.2002	<i>Reyer GERLAGH and Marjan W. HOFKES: <u>Escaping Lock-in: The Scope for a Transition towards Sustainable Growth?</u></i>
NRM	13.2002	<i>Michele MORETTO and Paolo ROSATO: <u>The Use of Common Property Resources: A Dynamic Model</u></i>
CLIM	14.2002	<i>Philippe QUIRION: <u>Macroeconomic Effects of an Energy Saving Policy in the Public Sector</u></i>

- (xlii) This paper was presented at the International Workshop on "Climate Change and Mediterranean Coastal Systems: Regional Scenarios and Vulnerability Assessment" organised by the Fondazione Eni Enrico Mattei in co-operation with the Istituto Veneto di Scienze, Lettere ed Arti, Venice, December 9-10, 1999.
- (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
- (xlv) 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.
- (xlvi) 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
- (xlviii) 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
- (xlix) 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
- (l) This paper was presented at the Workshop "Growth, Environmental Policies and + Sustainability" organised by the Fondazione Eni Enrico Mattei, Venice, June 1, 2001
- (li) 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
- (lii) 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
- (liii) 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

2001 SERIES

MGMT	<i>Corporate Sustainable Management</i> (Editor: Andrea Marsanich)
CLIM	<i>Climate Change Modelling and Policy</i> (Editor: Marzio Galeotti)
PRIV	<i>Privatisation, Antitrust, Regulation</i> (Editor: Bernardo Bortolotti)
KNOW	<i>Knowledge, Technology, Human Capital</i> (Editor: Dino Pinelli)
NRM	<i>Natural Resources Management</i> (Editor: Carlo Giupponi)
SUST	<i>Sustainability Indicators and Environmental Evaluation</i> (Editor: Marialuisa Tamborra)
VOL	<i>Voluntary and International Agreements</i> (Editor: Carlo Carraro)
ETA	<i>Economic Theory and Applications</i> (Editor: Carlo Carraro)

2002 SERIES

MGMT	<i>Corporate Sustainable Management</i> (Editor: Andrea Marsanich)
CLIM	<i>Climate Change Modelling and Policy</i> (Editor: Marzio Galeotti)
PRIV	<i>Privatisation, Antitrust, Regulation</i> (Editor: Bernardo Bortolotti)
KNOW	<i>Knowledge, Technology, Human Capital</i> (Editor: Dino Pinelli)
NRM	<i>Natural Resources Management</i> (Editor: Carlo Giupponi)
SUST	<i>Sustainability Indicators and Environmental Evaluation</i> (Editor: Marialuisa Tamborra)
VOL	<i>Voluntary and International Agreements</i> (Editor: Carlo Carraro)
ETA	<i>Economic Theory and Applications</i> (Editor: Carlo Carraro)

