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efficiency and political feasibility

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Abstract: Command-and-control measures, despite their inefficiencies, are still the standard in environmental policy. This might be due to the fact that command-and-control instruments prevent monetary redistribution between sectors and households and leave property rights on remaining pollution with the emittents. The present paper interprets the no-redistribution policy as a political constraint and investigates on more efficient alternatives to command-and-control, using a computable general equilibrium model for Switzerland. Simulation results render schemes that refund environmental tax revenues by a sector-by-sector-subsidy on labor or output as welfare enhancing.

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1 Introduction

At the UN climate convention in Kyoto 1997, the industrialized world agreed on reducing greenhouse gas emissions by an average of five percent down from the 1990 level over the next fifteen years. The European Union member states committed themselves to an eight percent reduction[1]. The adequacy of this goal as well as the scope for unilateral action by the EU are not the subject matter of this paper. Rather, the focus is on the set of measures that would allow the countries to achieve their goal.

It is well known from the economic literature that only a uniform effluent charge ensures that a given environmental standard is achieved at minimal cost. Since a uniform rate equalizes the marginal abatement costs across economic agents, it minimizes the total cost of an environmental constraint. This so called price-standard-approach dates back to *Baumol* and *Oates* (1971). Originally, there was no discussion on the use of revenues from effluent charges as it was implicitly assumed that revenues are redistributed to households in form of a lump sum[2]. In the last years though the debate on ecological tax reform highlighted the importance of the way in which redistribution takes place. With prior tax distortions, it is more efficient to use environmental tax revenues to finance cuts in distortionary taxes than to redistribute lump-sum since the former allows for a lower overall excess burden of taxation in the economy. The efficiency gain from such recycling schemes is undisputed nowadays – it is commonly referred to as the weak double dividend of ecological tax reform (*Goulder*, 1995a).

Although the efficiency argument in favor of economic measures in environmental policy is strong, such instruments constitute the exception rather than the rule in the real world. Moreover, the measures that have been implemented do not correspond to textbook versions. For instance, energy taxes almost always include exemptions granted for energy-intensive sectors. This policy increases the shadow value of an environmental standard, which appears to be - from a narrow perspective of economic efficiency – disappointing. From a political point of view, this policy is, however, not surprising. Although economic measures such as effluent charges do minimize the cost of an environmental standard, they also redistribute income between economic agents to a large extent. Agents that would loose will oppose an efficient scheme in environmental policy and may successfully prevent its realization provided their political influence is sufficiently strong.

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[1] Kyoto Protocol to the United Nations Framework Convention on Climate Change, Annex B.

[2] As an exception, see *Sandmo* (1975) for an early and thorough discussion of this issue within a pigouvian tax scheme.

The present paper considers both efficiency and political feasibility of environmental policy. Employing a computable general equilibrium model (CGEM) for Switzerland, it investigates on the efficiency property of different redistribution devices that compensate agents for paying environmental taxes so that no intersectoral transfers takes place. The targeted environmental standard is a ten percent reduction of CO_2 emissions fixed in the Swiss federal bill on the reduction of CO_2 emissions[3]. Within this framework, the present article does not discuss different institutional setups for environmental policy but asks for more efficient environmental instruments given the political restrictions.

The remainder of the paper is organized as follows. *Section 2* gives a brief overview on political environmental economics and the existing CO_2-tax schemes in Europe. *Section 3* discusses the efficiency of environmental tax reform subject to the political constraint that sectors subject to the environmental tax are compensated, and introduces the tax reform scenarios that are analyzed in this paper. *Section 4* presents the Swiss CGEM and the welfare results of different redistribution devices. *Section 5* concludes.

2 Political Opposition and Existing CO_2 Tax Schemes in Europe

The central public choice aspect of environmental charges has been analyzed by *Buchanan* and *Tullock* (1975)[4]. In particular, they compare the political feasibility of environmental charges with a command-and-control approach that obliges the emittents to a uniform reduction of their emissions[5]. Their main argument is based on the observation that with the introduction of an effluent charge, pollution rights are entirely relocated from the polluters to the government, since polluters have to pay taxes even after having reduced their emission levels. In contrast to a tax, a command-and-control scheme leaves the pollution rights on the remaining emissions with the polluters. Therefore, if the polluters cannot expect the tax revenue to be paid back, they will always favor the command-and-control instrument[6]. If, on the other hand, revenues were redistributed lump-sum to the polluters, they would prefer the

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[3] Although Switzerland committed itself to an eight percent reduction in greenhouse gases, it unilaterally adopted a ten percent cut in CO_2 emissions.

[4] See Hahn (1990) for an overview on political economy of environmental economics.

[5] Note that we do not discuss or model the allocation of pollution rights to various emittents within a command-and-control scheme but concentrate on the comparison between environmental charges and a uniform emission reduction across sectors.

[6] *Buchanan* and *Tullock* (1975), p. 144.

tax instrument[7]. These findings only apply to a situation where emissions are uniformly distributed across polluters. If the polluters produce different quantities of emissions, however, the effect of redistribution depends on the individual polluter's emission level. A uniform transfer of revenues to firms results in a redistribution from large to small polluters. Firms with low emission levels therefore will most likely favor the tax/transfer scheme, while large polluters still prefer to stick with the command-and-control solution. The public choice literature suggest that small interest groups that would be heavily affected will be most effective in influencing government policy (*Olson*, 1965). Thus, in an economy with relatively few large and many small polluters, the small but strongly affected group of losers, i.e. energy-intensive sectors, can prevail over many but weakly affected winners and therefore prevent the introduction of environmental taxes.

The public choice considerations explain to a large extent why the European countries that have already introduced substantial CO_2 taxes partially exempt energy-intensive sectors from the tax[8]. This is true for Denmark, Norway and Sweden. Finland and the Netherlands, on the other hand, have not established any exemptions for energy-intensive sectors. However, in these two countries the tax rates are very moderate (38.3 Fmk and 5.16 Gld per ton CO_2, respectively) and only led to price increases in the range of a few percent[9]. Also, the EU commission planned extensive tax relieves for energy-intensive sectors in its proposal for a combined CO_2/energy taxation – a proposal which has been approved by the new German government in its plan for an ecological tax reform.

In the bill on the reduction of CO_2 emissions, the Swiss government follows its own strategy, although it also aims at preventing large redistribution in order to minimize political opposition against environmental policy. In particular, big emittents have the option of getting exempted from the tax provided they commit themselves on reducing their emissions to a negotiated level[10]. With such an incentive scheme in place, it can be expected that all the big emittents will opt for an exemption in order to maintain the pollution rights on the remaining emissions. The drawback of this policy is an efficiency loss: the marginal abatement costs will not be equalized across sectors implying that the targeted ten percent reduction will not be achieved at minimal cost.

[7] In the original article by *Buchanan* and *Tullock*, there was a mistake in the derivation of this result (see the comment by *Maine* and *Baird*, 1976).

[8] For an overview on the existing environmental taxes in Europe, see *Cansier* and *Krumm* (1997).

[9] *Cansier* and *Krumm* (1997), p. 65.

[10] Art. 9, Swiss federal bill on the reduction of CO_2 emissions.

The existing and planned CO_2-tax schemes intend to reduce political opposition at the cost of efficiency. The trade-off between efficiency and political feasibility is fundamental and cannot be overcome. However, the question arises as to whether existing and planned schemes are on the efficient frontier of this trade-off or whether alternative schemes provide a better (more efficient) solution. *Buchanan* and *Tullock* (1975, p. 143) already raised this issue: ”If the economist ties his recommendation for the penalty tax to an accompanying return of tax revenues to those in the industry who suffer potential capital losses, he might be more successful than he has been in proposing unilateral or one-sided application of policy norms. [...] a two-sided tax subsidy arrangement can remove the industry source of opposition while still ensuring efficient results.” In the next section, we present a set of two-sided tax subsidy arrangements which will then be evaluated using a CGEM for Switzerland.

3 Scenarios: The Trade-off between Efficiency and Political Feasibility

All scenarios are subject to an environmental constraint as the maximum amount of CO_2 emissions is fixed. In the tax scenarios, the government owns emission permits and sells them to the emittents, household and sectors. At the same time we assume a fixed public budget, i.e. government will transfer revenues from CO_2 permits to households and firms or cut existing taxes[11]. In the first scenario, which serves as the simulations’ reference case (*REF*, see *Table 1*), the government uses lump-sum transfers to the household in order to hold the budget constant.

With existing distortionary taxes, a scope for environmental tax reform arises. If the government used CO_2-permits revenues to finance cuts in distortionary taxes, it would reap a weak double dividend, i.e. an efficiency gain relative to a lump-sum redistribution[12]. *Goulder* (1995b) calculates the size of the weak double dividend for the US. In its base case, the use of the revenue from a \$25 tax rate per ton of CO_2 to reduce existing taxes diminishes the cost of the CO_2 tax by 36 to 53 percent, depending on the specific tax that is reduced[13]. The largest efficiency gain is achieved when the payroll tax, the tax with the highest marginal excess

[11] Note that this approach which combines a standard where the government exclusively owns permission permits with a redistribution of government permit revenues such that its budget remains constant is equivalent to an environmental tax reform.

[12] The strong double dividend, on the other hand, is characterized by an efficiency gain due to the introduction of an environmental tax. *Bovenberg* in a series of articles (see, for example, *Bovenberg* and *De Mooij*, 1994) showed that in general a strong double dividend cannot be reaped.

[13] *Goulder* (1995b), p. 285.

burden, is reduced. The second scenario (*WDD*) in our simulations calculates the weak double dividend of using the government's revenue from CO_2 permits for a reduction of the labor tax.

Any tax reform gives – intended or not – rise to redistributive effects and therefore to political opposition. The opposition against effluent charges arises from sectors that are net-payers of the environmental tax. As illustrated by the political discussion in Switzerland, opposition against CO_2 taxes is much stronger than against incurring abatement cost. The industrial sector agreed on 'voluntary' emission reduction, provided government refrains from introducing a tax on carbon use[14]. Although, voluntary reductions in general will not minimize total abatement cost, it allows the industrial sector to maintain pollution rights on the remaining emissions.

With this opposition in mind, we evaluate further tax reforms involving refunding of government's revenue from a CO_2 tax. These scenarios are subject to the specific political constraint that no monetary transfers between sectors occur. Such a two-sided tax subsidy scheme as proposed by *Buchanan* and *Tullock* (1975) asks for an intrasectoral redistribution of environmental tax revenues, while holding the overall tax payments of each sector, including the household sector, constant.

Table 1: Tax Reform Scenarios

Scenario	**Tax revenue replacement**	**Political constraint**
REF	Lump-sum	Not fulfilled
WDD	Labor	Not fulfilled
COCO	no tax no revenue	Fulfilled
YSUB	Sector-by-sector output	Fulfilled
LSUB	Sector-by-sector labor	Fulfilled

The first scenario that fulfills this political constraint is the command-and-control system (*COCO*). Firms in every industry as well as households must reduce emissions by a fixed amount. They are neither compensated nor taxed. This approach constitutes a sector-specific shadow price on CO_2 use, combined with a sector-specific subsidy equal to the value of the

[14] The Swiss CO_2 emissions reduction bill assigns a CO_2 tax for the years 2004+, in case the voluntary reductions will miss the target.

emissions. This scheme is inefficient because it does not allow for trade in permits across sectors. The second scenario with the political constraint in place is the *YSUB* scenario. Here as in the third scenario, the shadow price of the CO_2 standard is uniform across sectors; there is one price for CO_2 permits, and sectors are refunded by a sector-by-sector output subsidy for the costs of permit purchases. The last scenario refunds the expenditure for permits by a sector-by-sector labor subsidy (*LSUB*). For both scenarios, we assume the sectors to be big enough that on the individual firm level, the subsidy from the government is independent from the environmental tax payment.

Table 1 gives an overview on the different scenarios with respect to the revenue replacement and the political restriction. When government chooses the adequate channel for redistributing revenues of permit sales to sectors and households, two aspects must be considered: the distortion of existing taxes discussed above and a new distortion that arises due to different subsidy rates across sectors when refunding the tax yield. With regard to existing distortions, the taxed factor with the highest marginal excess burden should be chosen for revenue replacement. However, if such a factor tax is narrowly based, i.e. the cost share of this factor is small, a sector-by-sector reduction of tax rates induces large factor price differences between the sectors and, as a consequence, heavily distorts production efficiency. In particular, *Schleiniger* and *Felder* (1998) showed in a (partial equilibrium) two-sector-two-factor model that a differentiated subsidy of labor is less distorting than a sectoral differentiation of energy taxes, provided the cost share for labor in both sectors is larger than for energy. When this condition holds, sector-specific labor subsidies lead to relatively small differences in the producer price for labor. Hence, the factor price ratios as well as the technical rates of substitution vary only little and the corresponding distortion of production efficiency is rather small.

4 The Price of the Political Constraint: Results from a CGEM for Switzerland

4.1 Model Structure

Our analysis of the efficiency of different tax recycling scenarios is based on a static large scale general equilibrium model of the Swiss economy for the year 1990. Producers and consumers are perfectly competitive, i.e. they take market prices as given. The following subsections give an overview of the model structure[15].

[15] See the appendix of *Felder* and *van Nieuwkoop* (1996) for an exhaustive description of the model.

Sectoral Disaggregation

The model features 38 sectors based on the Swiss input-output table (*Swiss Federal Office for Statistics,* 1998). With regard to carbon emission constraints, the sectoral disaggregation is chosen on the basis of carbon intensity, i.e. carbon-intensive sectors are as disaggregated as possible given the original data sources. To account for different carbon intensities and substitution possibilities across energy goods, the model identifies six primary and secondary energy goods: gas, refined oil products such as heavy and light fuel-oil, gasoline and diesel, and electricity. *Table 2* summarizes the sectoral disaggregation.

Table 2: The 38 Sectors of the Swiss input-output table

Agriculture, forestry	Leather and leather products	Public transportation
Electricity	Chemicals	Private transportation
Gas	Petroleum refining	Communication
Water	Rubber and plastic products	Finance
Food products	Non metal minerals	Insurance
Beverages	Primary and non-ferrous metals	Real estate
Tobacco products	Machinery, except electrical	Consulting
Textile mill products	Electrical machinery	Education
Textile products	Main Construction	Health
Wood products, furniture	Finishing Construction	Domestic economy
Paper and pulp products	Wholesale trade	Government
Fine paper	Retailing	Social Security
Printing and publishing	Tourism	

Production

For each industry *i* a nested constant elasticity of substitution (CES) function describes the technological substitution possibilities in production (*Y*) between capital, labor, energy and intermediate materials (KLEM). At the highest nest, the composition of intermediate materials and KLE is fixed:

$$Y_i = f\left(K_i, L_i, E_i, m_i\right) = \min\left(m_i, KLE_i\right) \quad .$$

At the next level, the capital-energy composite KE can be traded off with labor, the elasticity of substitution χ being 0.6:

$$KLE_i = \alpha_i\left(\beta_i KE_i^{\chi} + \left(1-\beta_i\right)L_i^{\chi}\right)^{1/\chi} \quad .$$

Energy can be substituted in the next lower nest with capital. Here, the elasticity of substitution ϕ is 0.45:

$$KE_i = \delta_i \left(\varepsilon_i K_i^{\phi} + \left(1 - \varepsilon_i\right) E_i^{\phi} \right)^{1/\phi} \quad .$$

Finally, energy inputs to sector *i* production involve an elasticity of substitution between gas, fossil fuels and electricity η equal to 0.6:

$$E_i = \nu_i \left(\sum_m \gamma_{im} E_{im}^{\eta} \right)^{1/\eta} \quad .$$

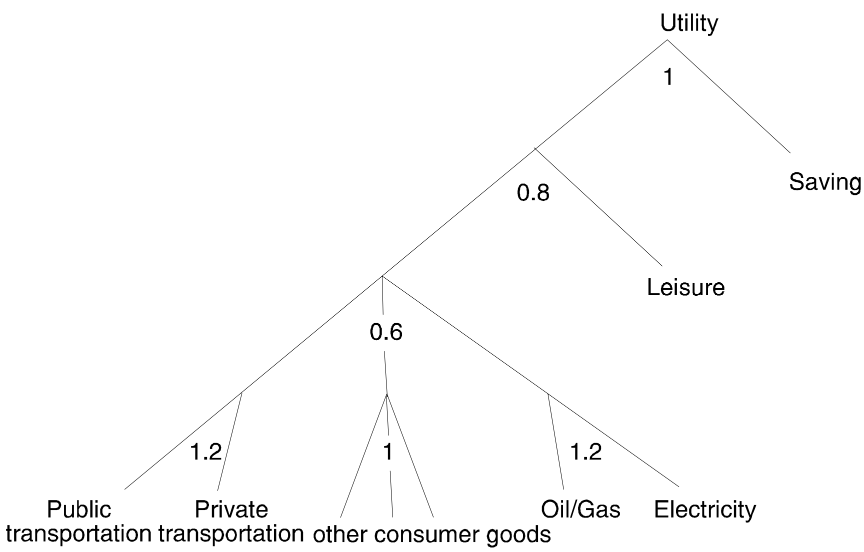
The oil sector features a specific production structure. Here a joint product including the four oil derivatives gasoline, diesel, and light and heavy fuel-oil is produced using crude oil (exclusively imported). The elasticity of transformation π is assumed to be 4.0:

$$\left(\sum_n o_n E_n^{-\pi} \right)^{-1/\pi} = \min\left[m_e , KL_e \right] \quad .$$

The efficiency parameters of the technology as well as the share parameters of input costs are calibrated using the 1990 input-output table for Switzerland which includes interindustry flows, and value added inputs in the 38 sectors.

Household Behavior

Figure 1: The nested CES utility functions



The submodel of households behavior is based on a hierarchical tier structure of decision problems, as illustrated in *figure 1*. Each household starts with a budget that equals the rental value of his capital and labor endowments (whether sold or retained as leisure), plus transfers, minus (lump-sum) taxes. At the highest decision level the household divides this income between present consumption and savings (future consumption) according to a Cobb-Douglas function.

At the second level of the optimization process, the household chooses the optimal mix of leisure and consumer goods. The (constant) elasticity of substitution equals 0.8. At the third decision level, 13 consumer goods are grouped into three composite consumer goods: transportation, energy goods and other consumer goods. The elasticity of substitution at this level is 0.6. In the first nest private and public transportation, and in the third nest oil/gas and electricity are aggregated, the elasticity of substitution being 1.2 in both nests. In the second nest, the remaining nine consumer goods are traded off according to a unitary elasticity of substitution. This nesting of the utility function follows standard rules [see *Ballard et al* (1985)] except for the fact that commodities with a high carbon content are differentiated from other consumer goods in two separate nests. The 13 consumer goods are generated by 13 fixed-coefficient technologies transforming the 38 output commodities into 13 consumption commodities.

Goods Markets

Domestic markets clear, equating aggregate domestic output (*D*) plus imports (*M*) to aggregate demand, where demand adds up from intermediate inputs (*m*), investment (*I*), private consumption (*C*) plus government consumption (*G*). Market clearance for non-energy goods is given by:

$$A_i\left(D_i, M_i\right) = \sum_j a_{ij} m_i + I_i + C_i + G_i \ .$$

Factor Markets

We assume perfectly competitive factor markets in which factor prices adjust so that supply equals demand. Primary factors include labor and capital which are both assumed to be homogenous and perfectly mobile between sectors but not between countries. Capital supply is exogenous, as we do not consider a dynamic model.

Government Sectors

The government distributes transfers and provides a public good which is produced with commodities purchased at market prices. Government expenditure are financed with tax revenues. The model incorporates the main features of both the Swiss tax and social transfer system. *Table 3* provides a summary of taxes and transfers. All of our simulations are based on revenue-neutral tax reforms. This is implemented by keeping the amount of the public good provision fixed, and recycling any residual revenue lump sum (*reference case*) or through the channels that have been described in *section 3*. There is a budget deficit in the benchmark which is kept constant in all scenarios (and financed by a lump-sum transfer from the household).

Table 3: Tax Incidence and Revenue in billion CHF

Tax Instrument	Incidence	Revenue
Corporate tax	Capital	7.46
Income tax	Labor	39.91
Income tax	Capital	14.94
Indirect production tax	Output	4.58
Sales tax	Output	9.79
Import tax and duties	Imports	4.74
Social security payments	Labor	16.11*
Total tax payments		97.53

Source: Statistical Yearbook of Switzerland (1998), own calculations.

* Social security payments indicated represent only those contributions which have the character of a tax. Contributions for which households receive well-defined services are not included in this amount.

Foreign Trade

Switzerland is a small and open economy. We therefore assume that changes in Swiss import and export volumes have no effect on terms of trade. Domestic and foreign products are distinguished by origin according to the Armington assumption. The Armington goods are aggregated with identical import shares for a given import good across all components of final and intermediate demand. On the export side, products of the Armington sectors destined for domestic and international markets are treated as imperfect substitutes, produced subject to a constant elasticity of transformation (equal to 4.0). Switzerland had a small trade surplus in 1990. This surplus is kept constant in all simulations runs.

4.2 Simulation Results

In presenting the results, we follow the scenarios as presented in *table 2*. The reference case (*REF*) is the scenario where the government transfers revenues from pollution permit lump-sum to the household. The second scenario (*WDD*) uses the revenues to finance a reduction in the labor tax. As expected, it produces a welfare gain. This so-called weak second dividend of environmental tax reform equals 0.52 percent in equivalent terms relative to the value of endowment (total income) in the reference scenario.

The remainder of the scenarios are subject to the political constraints that no intersectoral redistribution takes place. The command-and-control scenario (*COCO*) fares badly. The costs, compared to *REF*, is 0.83 percent. If we compare it with *WDD*, the loss in equivalent terms amounts to 1.35%. It is noteworthy that the model assumes uniform substitution elasticities in all sectors. If this assumption were relaxed, the marginal abatement cost would substantially differ across sectors, which in turn would result in even larger welfare losses for *COCO*.

Table 4: Equivalent Variation in percentage terms (%EV)

Scenario	%EV
REF	0
WDD	0.52
COCO	-0.83
YSUB	0.35
LSUB	0.38

According to the simulation results, there are more efficient alternatives to *COCO* that also satisfy the political constraint. Subsidizing labor demand and supply on a sector-by-sector base instead of command-and-control would increase welfare. The welfare gain compared to *REF* is 0.38 percent. About the same welfare improvement could be achieved when output were subsidized. The welfare gains with *YSUB* and *LSUB* relative to *REF* indicate that the effect of the weak double dividend is stronger that the additional distortion caused by the sectoral differentiation of labor and output prices, respectively. Comparing *YSUB* and *LSUB*, we conclude that the relative welfare gain form reducing the highly distorting labor tax is almost offset by a relative large differentiation of producer prices of labor. Both effects can be explained with the small tax base of labor relative to output.

As *table 4* illustrates, there is a price to be paid when environmental tax reform is subject to a political constraint. In all corresponding scenarios welfare is lower compared to WDD. However there are large differences. The price of the political constraint, when household and sectors are compensated for the purchases of CO_2 permits via an output or a labor subsidy, is 0.17 percent and 0.14 percent, respectively. In the case of a labor subsidy, this is almost a magnitude smaller than with a command-and-control scheme.

5 Summary

The existing as well as the planned measures to curb CO_2 emissions in most European countries do not follow standard economic rules. They are characterized by a number of exceptions designed to protect energy-intensive sectors. While these exemptions involve efficiency losses, they are apparently successful in overcoming the political opposition against effluent charges.

The present paper investigates on alternatives measures that would better solve the tradeoff between efficiency and political feasibility. We use a computable general equilibrium based on the Swiss input-output table of 1990. Switzerland's CO_2 goal is a ten percent emission reduction by 2010. The present law asks sectors to voluntarily reduce emission by the fixed amount, a policy we interpret as a sector-by-sector command-and-control approach. This policy forgives the efficiency gain that could be realized if the shadow value of the overall emission constraint were equalized across sectors. We thus compare the command-and-control scheme with a CO_2 tax accompanied by a sector-by-sector subsidy on labor or output. Like command-and-control the two scenarios also satisfy the political constraint of no intersectoral transfers. The simulation results indicate that the two-sided tax-subsidy arrangements are about 1.2 percent more efficient than command-and-control.

The two alternative scenarios, while equalizing the shadow value of the environmental constraint, introduce a new distortion in the labor market or in the goods market, as the subsidy rates differ across sectors. However, the simulations suggest that there are efficiency gains compared to a situation where accruals from the environmental tax are refunded lump-sum to the household. Hence the weak double dividend that can be reaped when using environmental tax revenues to finance cuts in distortionary taxes does not vanish with the introduction of a political constraint. The efficiency gain compared to the lump-sum reference scenario is still around 0.35 percent in both alternative scenarios.

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