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THE DUAL POLITICAL ECONOMY OF TAXES AND TRADABLE PERMITS: APPLICATIONS IN CENTRAL AND EASTERN EUROPE

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A

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SUMMARY

The default distributional impacts of typical tax and tradable permit approaches differ significantly. Default tax policy taxes all units of pollution and leads to a large monetary transfer to the government while default permit policy grants the asset value of the permit to the polluting firm. These distributional differences caused by the default policy assumptions create a large political barrier to the implementation of behaviorally relevant pollution tax rates. Yet in Central and Eastern Europe, in contrast to the U.S., the pollution tax system is one of the stronger components of the system. Changing the default assumption for taxes can address two issues of major concern in Central and Eastern Europe--raising pollution tax rates to behaviorally relevant levels without extracting so much in taxation that insurmountable industry opposition results.

Recent general equilibrium literature on pollution taxes and revenue recycling however, raises a significant concern that grants of rent to polluting firms, either through grandfathered permits or by tax credits, can result in decreases in welfare when labor taxes exist. The paper investigates whether the potential change in welfare from the adoption of economic instruments is more likely to be positive than assumed in the literature depending on: 1) the stage of privatization, 2) pre-existing environmental regulations, 3) parameter uncertainty, and 4) whether Government expenditures must be held constant.

1.0 INTRODUCTION

Attempts to introduce the basic economic instruments of taxes or tradable permits into U.S. environmental regulations have had a variety of successes and failures (e.g. Hahn, 1989) The results occurred in part from the peculiar grafting of economic instruments onto existing U.S. regulatory programs. The regulatory and economic background in Central and Eastern Europe naturally differs from the U.S. experience. Section 2 of this paper investigates how the pre-existing basis of environmental taxes in Central and Eastern Europe can be modified to address incentive and distributional issues. Section 3 of the paper addresses a fundamental design issue as to when economic instruments can be expected to increase welfare in an economy with pre-existing taxes. Recent work by Bovenberg and deMooij (1994), Bovenberg and Goulder (1996), Goulder (1995), Parry (1995, 1996), Goulder, Parry and Burtraw (1996), Fullerton (1996), and Fullerton and Metcalf (1996) among others questions when the use of taxes or tradable permits will increase welfare in the economy. The applicability of some results in the literature to pre-existing conditions in Central and Eastern Europe is illustrated by a limited investigation of Fullerton and Metcalf.

Stylized Institutional Facts of Central and Eastern Europe

Among the many countries of the former Soviet Union there exist a relatively common approach to environmental controls (Vincent and Farrow, 1996). These common elements typically include:

- a pollution tax (charge) system for air and water pollutants,
- a permitting system for each facility involving either or both of concentration or weight,
- a state fund to receive tax income and to direct environmental investments,
- ambient standards that are to be met at the facility property line,
- weak monitoring and enforcement.

The stylized facts regarding the larger economy in the countries in transition tend to be:

- Large uncertainty about the viability of firms,
- Large financial demands to compete in world markets combined with weak access to financial capital,
- a political concern for social issues regarding the prices of key items such as rent, power, and fuel and the level of employment.

This paper focuses on economic questions and policy design issues that are driven by the prior existence of a pollution tax system, permitting, and political concerns about the viability of firms. The paper proceeds by first addressing the dual political economy of taxes and tradable permits.

2.0 INCENTIVE AND DISTRIBUTIONAL ISSUES IN THE AUGMENTATION OF EXISTING TAX SYSTEMS

The pollution tax systems in Central and Eastern Europe tend to be inconsistent with the quantity goals of environmental policy. This occurs because the tax level is less than that consistent with the quantity targets. A result is that the existing taxes are thought to have only a minor behavioral effect but serve primarily to raise money for centrally directed state environmental funds. Political efforts to raise the level of taxes are blocked on the grounds that pollution taxes high enough to have a behavioral effect might adversely effect the precarious financial situation of many enterprises. This section summarizes and extends work on pollution tax credits which can alter the distributional impacts of higher tax levels. Links to the distributional impacts of tradable permits, some existing policies on temporary tax credits, and state environmental funds are also investigated.

The default distributional impacts of typical tax and tradable permit approaches differ significantly (Howe, 1994). This can have a significant impact on the political support for alternative policies (Hahn, 1990). Default tax policy taxes all units of pollution and leads to a large monetary transfer to the government. A default tradable permit policy such as implemented in the U.S. allocates permits to existing firms which avoids the large transfer to the government. These distributional differences caused by the default policy assumptions creates a large barrier to the implementation of behaviorally relevant pollution tax rates. Yet in Central and Eastern Europe, in contrast to the U.S., the pollution tax system is one of the stronger components of the system.

Changing the default assumption for taxes can however, address two issues of major concern in Central and Eastern Europe--raising pollution tax rates to behaviorally relevant levels without extracting so much in taxation that socially expensive closures result. As discussed in Farrow (1995) as an application of the lump sum distribution of taxes in a first best world, a tax credit can be introduced at the same time that pollution taxes are increased. The higher tax changes the incentives without necessarily changing the amount of money paid by the enterprise. More specifically, it is possible to provide an annual lump sum tax credit to a polluting firm at the same time that a higher marginal tax is imposed. Define q_t and q_0 as current and base year emissions, **t** as the tax rate and **a** ($0 \leq \mathbf{a} \leq 1$) as a revenue parameter. Then the Net Tax is computed as :

Net Tax	$= \mathbf{t}q_t - \mathbf{a}\mathbf{t}q_0$
i)	$= \mathbf{t}q_t$ - constant
ii)	$= \mathbf{t}\,(q_t - \mathbf{a}q_0) <$ or > 0 as $(q_t - \mathbf{a}q_0) <$ or > 0

Several implications emerge. Equation i indicates how the lump sum credit does not alter the marginal incentive to reduce emissions as is well known. This is the property that can lead to a least cost solution in a single tax system. However, equation ii indicates how the revenue portion of the tax can be set by the decision-maker by choosing **a**, the revenue parameter. The current tax policy default is that **a** equals zero. In this case the implicit property right is entirely assigned to the Government providing revenues equal to $\mathbf{t}^*q_t$. If **a** is set to 1 then no revenue is raised at the current level of emissions and the implicit property right and potential rent is assigned to the firm yielding zero revenue to the Government at

current levels of emissions. With **a** at a non-zero level, the Government is acting as a broker who will tax emissions over a threshold ($\mathbf{a}q_o$) at rate **t** but who will give a tax credit on emissions under the threshold (note this requires positive income to generate positive taxes so that entry and exit conditions may not be dramatically altered.). The choice of **a** clearly determines the distributional impact and is of great importance to politicians. In a first best world with no other distortions, what is important for economic efficiency is that *however* **a** is set, it merely defines the distributional effect. The tax rate **t** provides the correct marginal incentive for the firm regardless of the value of **a**, assuming **t** is set at an efficient rate.

Several additional issues are of varying concern to economists and to policy makers. Among them are: 1) the potential for equivalent distributional impacts between grandfathered permits and tax credits, 2) the existence of cost neutral tax increases, 3) permanent versus temporary or partial tax credits and 4) the implications for the number of firms in the industry. Each of these are considered in turn.

Dual distributional effect between grandfathered permits and tax credit

Implicit above is that lump sum tax credits can have equivalent distributional implications as tradable permits in which the permits are distributed to the current polluters, perhaps recognizing historical use of the implicit property right. Under appropriate conditions, the lump sum distribution can equal the economic value of grandfathered tradable permits. Consider a tax system and a tradable permit system that are dual to each other in the sense that the tax, t, and the equilibrium price of a permit, p, are equivalent and therefore, so are the relevant quantities. When permits are given to existing polluters, say in value equal to $\mathbf{p}q_i$, it would be possible to define a tax credit which exactly matches the initial value of the permits, namely $\mathbf{t}q_i$. The distributional effects of both taxes and permits can be designed to be equivalent.

Cost neutral tax increase

In the economic conditions of Central and Eastern Europe, there is concern about additional transfer of income away from firms. While politicians may choose the lump sum credit to be of any amount, some stakeholder may wish to design the tax credit to have no impact on the cash flow of the firm at the base amount of pollution. Consider the new, higher tax rate as t', the old rate to be t and other terms as above. The tax credit required to achieve a cost neutral increase in pollution taxes, before any optimal response to the higher rates, can be simply computed as:

$$\begin{aligned} \text{Initial new taxes - old taxes} &= 0 \\ \text{requires} \quad (\mathbf{t'}q_o - c) - \mathbf{t}q_o &= 0 \\ (\mathbf{t'} - \mathbf{t})\, q_o &= c \end{aligned}$$

Clearly, neutrality can be defined with respect to other quantities than q_o such as the legally permissible level of pollution.

Interaction with State Funds

In general, pollution taxes in Central and Eastern Europe flow into a State Environmental Fund which is disbursed in an often vague process to cities and firms who are thought to represent the best environmental investments. Such funds have a dubious basis in theory for allocating funds to the environmental projects with the highest rates of return. They can of course, be perceived as having an important distributional impact, perhaps by reallocating funds from firms to cities.

A tax credit provides a possible link between the State Funds and the efficiency of their investments. Even if a tax credit is provided, some firms are likely to pay pollution taxes. Other firms may control more than the value of their tax credit and so be reducing their overall tax payment to the Government. This can be viewed as a loss of general tax revenues to support environmental controls. It would be possible for the environmental fund to reimburse the general fund for any loss in revenue that results from firms controlling beyond the value provided as a tax credit. This reimbursement would automatically use the State Fund moneys for those firms who can reduce pollution at a cost less than or equal to the tax rate. Such a use of money from the State Funds may be significantly more efficient than operating the current bureaucracy and evaluating projects for funding.

Permanent versus temporary or partial tax credits

The above structure defined a constant, annual lump sum tax credit. This is only one possible form. Continuing the parallel between a tax credit and grandfathered tradable permits, it is possible to design tax systems that add a time dimension to the tax or to the tax credit. The parallel to phasing out or reducing quantities in tradable permits can be mimicked by increasing the tax. Shifting the value of the property right granted over time, a design not normally considered in the tradable permits literature, is a more common concern with tax credits. The lump sum tax credit can drop to zero at some point which would be a temporary tax credit that effectively nationalizes or seizes the property right at a point in time. If the tax credit is not conditional on environmental performance, neither a permanent nor a temporary credit would be expected to impact the firm's decision to invest in environmental control. This may be viewed as economically desirable where the firm has better information about the rate of return across internal investment opportunities.

In fact, at least the Czech and Slovak Republics provide a temporary but conditional tax credit within the current pollution tax system. This credit is fixed fraction of the tax bill and continues only for the time that an environmental investment is occurring, hence the conditionality of the credit. In contrast to the unrestricted credit, the conditional and temporary credit only affects the decision of whether or not to invest in pollution control. It is possible to think of this credit as compensating for an implicit price of pollution that is too low to induce some investment behavior. The conditional tax credit makes it more likely that investments will be undertaken but may distort the firm's decision making with respect to other investment opportunities due to the conditionality of the credit. While there are clearly incentives to stretch out the construction of environmental improvements, some additional analysis can highlight the role that a tax credit can play in investment decisions. Ultimately however, it is an empirical question as to whether the size of the tax credit is sufficient to alter investment behavior. The lower are the tax rates, the less likely to affect behavior is the temporary tax credit. Consider the following representation of the present value net benefit of investing in pollution control equipment when a

temporary environmental tax credit is allowed until time T (noting that cost elements should be net of any process cost savings):

	(A)		(B)		(C)		(D)
Present Value =	Tax cost saving	+	tax credit	-	fixed cost	-	operating cost

iii) $$\text{Present Value} = {}_T\int^{\infty} \Delta Q \tau e^{-rt} dt + {}_0\int^{T} \beta Q_0 \tau e^{-rt} dt - C_0 - {}_T\int^{\infty} C(\Delta Q) e^{-rt} dt$$

where: ΔQ is the change in pollution
Q_0 is the initial level of pollution
β is the fraction of taxes avoided during the time of the tax credit, $0 \leq \beta \leq 1$.
$C(.)$ is the cost of control
r is the discount rate
τ is the tax rate
t is time with T being the date of beginning operation

Given some discreteness to the environmental control technologies, if it is not profitable to invest in control technologies without the temporary (and conditional) tax credit B, then A-C-D < 0. Whether the tax credit, B, is large enough to change the sign of the present value (and hence the investment decision in this framework) is an empirical question. However, evaluating the integral provides some indication of the importance of the tax credit in practice.

Evaluating the integrals and rearranging terms leads to the following restatement:

iv) $$\text{Present Value} = \left\{\frac{[\Delta Q \tau - C(\Delta Q)]}{r} e^{-rT} - C_0\right\} + \frac{\beta Q_0 \tau}{r}(1-e^{-rT})$$

The first set of terms in equation iv is the present value of an environmental investment in the absence of a tax credit; the set is assumed to be negative. The value of an infinite annuity, either costs or benefit, is adjusted in the initial term for the delay in both receiving the tax savings and incurring the operating cost. The last term , the value of the tax credit, is the value of an infinite cost saving annuity where β is the fraction of initial taxes that are forgiven and T is the duration of the temporary tax credit. As T goes to infinity, as it becomes more becomes permanent, the expression approaches the infinite annuity value.

How does a temporary tax credit work in practice in Central and Eastern Europe? In the Czech Republic, a credit equal to forty percent of the existing taxes can be received during the time of construction and lasting until operation. Proposals exist to raise the credit to 90 percent. Such projects can take several years.

How behaviorally significant is this form of a tax credit? Table 1 below provides some insight by tabulating the proportion of a permanent tax credit that can be received from a temporary credit with complete forgiveness of taxes (β equals 1) to time T at a particular interest rate r. Consider first the best

situation for a firm: a permanent tax credit, one lasting to infinity, where ß, the fraction allowed as a credit, is equal to 1. In that case the value of the tax credit is full annuity value--ten times the current tax if the tax rate is ten percent. Whether this is enough to change behavior depends on the discreteness of control costs and the amount by which the net benefits in equation iii are negative. Although discounting favors the tax credits allowed in the first few years, Table 1 indicates that at 10 percent interest, a 5 year temporary tax credit is worth almost forty percent of a permanent tax credit. About twenty years is necessary for a temporary tax credit to capture 95 percent of the value of a permanent reduction at a discount rate of 15 percent. If regulations allow only a fraction, ß, of the taxes to be received as a credit, then the present value is smaller by that fraction. In the Czech Republic, a forty percent, 5 year temporary credit at 15 percent interest is worth about 21 percent (.53*.4) of the value of a full, permanent credit.

Table 1
Proportion of Permanent Credit Received by a Temporary Credit Lasting Through Year t

Year	1-exp(-rt)	1-exp(-rt)
	r=.1	r=.15
1	0.10	0.14
5	0.39	0.53
10	0.63	0.78
15	0.78	0.89
20	0.86	0.95
Infinity	**1.00**	**1.00**

Conclusion

This section has investigated some design issues about taxes and tradable permits in the context of pre-existing conditions in Central and Eastern Europe. It was shown that the distributional impacts of higher taxes can be mitigated by tax credits that mimic the distributional impact of tradable permits. Countries in the region may choose to build on their existing tax structure either in a tax system or a mixed system with taxes and trading although the latter is not discussed here[1]. The potential to link existing State Funds to tax credit policies may increase the efficiency by which money is allocated. Existing policies in some Central and Eastern European countries that allow temporary tax credits were discussed to potentially structure discussions about their empirical importance.

[1] See Roberts and Spence (1976) for the theoretical development of a mixed system of trading and taxes and Farrow (1996) for a discussion of the possible implementation of a mixed system in Central and Eastern Europe.

3.0 EFFICIENCY AND EQUITY

The general presumption in the preceding section is that there are no efficiency impacts from lump sum distributions in a first best world without distortions in the economy. However, two strands of literature have asked about the joint efficiency and equity implications of alternative economic instruments. The first literature deals with a partial equilibrium but long run setting and asks about the equilibrium number of firms in the industry (e.g. Baumol and Oates, 1988; Spulber, 1985.) A second and rapidly growing literature (e.g. Bovenberg and deMooij, 1994; Goulder, 1995; Parry, 1995, 1996; Goulder, Parry and Burtraw,1996; and Fullerton and Metcalf, 1996) deals with a general equilibrium setting in which pre-existing taxes may alter the efficiency results of a partial equilibrium analysis. These issues are discussed below with considerably greater attention to some of the new material in a general equilibrium setting.

Tax credits and the number of firms

Some economists such as Baumol and Oates (1988) and Spulber (1985) have indicated concern about the long run implications of lump sum credits. The argument is that granting property rights to the firm will allow more firms to stay in the industry than would occur without the grant of the property right because existing firms earn higher profits (rent) from the credit than without the credit. For a moment accepting that theoretical possibility, with the implication of rent being more fully investigated in a general equilibrium setting below, a second question is its relevance to policy. Just as econometricians should ask both whether a variable is statistically significant and also whether its magnitude is important to decision making, so too can one ask how relevant the point is to the choice of economic instruments in a policy setting even if the point exists in theory.

Issues that appear to decrease the importance of this issue are:

- In western economies, there does not seem to be significant evidence that environmental regulations have caused firms to exit the industry (Tobey, 1990; Cropper and Oates, 1992). Given some symmetry, it may be unlikely that rents of the same order of magnitude would prevent exit.
- In western economies, the grandfathering of tradable permits in practice has the same impact as a tax credit on the entry and exit of firms. If such practices are acceptable for tradable permits (a topic investigated below) they should be acceptable for tax credits.
- In Central and Eastern Europe where employment and firm survival during the transition are major social issues, the potential theoretical result of more firms surviving on the margin is likely to be viewed as a desirable design element of the policy.

Instrument choice and design: General equilibrium analysis

The efficiency impact of granting a valuable asset to firms is also the core of the new general equilibrium literature on the public finance implications of instrument choice. This new literature currently draws strong policy recommendations regarding the choice of instruments and the way in which they are implemented. While the efficiency implications of distributionally equivalent policies

such as grandfathered permits and tax credits appear to be equal in the general equilibrium literature, whether *any* efficiency gains occur with grandfathered permits or tax credits is now in question. Issues related to optimal taxation, such as structured by Sandmo (1975) and the potential substitution of less distorting environmental taxes for more distorting taxes on other inputs like labor, popularized by Repetto, et. al. (1992) are two driving forces in this literature. In general, the presumption is to tax the goods in inelastic demand or supply. Such is the basis for theoretical proposals to tax natural resource rent[2]. The newer literature questions whether efficiency gains can occur without revenue recycling in which environmental taxes are collected (or quotas sold) and the revenue recycled to reduce other types of taxes. An example of current conclusions in this literature is:

> If the marginal environmental benefits from pollution reductions are below a certain threshold value, then any amount of pollution abatement through non-revenue-raising policies like emission quotas (*or tax credits)* is efficiency-reducing. (Goulder, Parry and Burtraw, 1996)

This section uses a recent model by Fullerton and Metcalf (1996) to illustrate some of the early conclusions in this literature and investigate their possible relevance to Central and Eastern Europe. The purpose is to identify areas where the choice among alternative instruments based on equity issues of political economy, as discussed above, may fail to pass economists fundamental test of whether efficiency improvements occur. Two methods are used. The first method accepts the assumptions in the new public finance literature but investigates their implications. The second methods drops a key assumption, that government expenditures remain constant, in order to obtain a significant recasting of prior results.

The basic question asked by the new literature is whether introducing an economic instrument, such as taxes or tradable permits (quotas), provides an increase in efficiency when:

- pre-existing taxes as on labor are used to fund the government provision of public goods.
- economic instruments are either used to raise revenue (a default tax, or auctioned permits) or not (tax credits, grandfathered permits)
- general equilibrium conditions exist in a perfectly competitive economy
- labor supply is responsive to tax rates,
- government expenditures are constrained to be constant.

The central tenor of the literature that is that unless revenue is raised from the environmental policy and used to offset labor taxes, then environmental policies may not increase efficiency since the policy will lead to higher prices, declines in production, reduced labor use, and higher labor taxes (to offset the decline in labor while keeping government expenditures constant.) The result, as in Bovenberg and Goulder (1996), Fullerton and Metcalf (1996), Parry, Goulder and Burtraw (1996), and Parry (1995) is that efficiency may actually decline.

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[2] Such a proposal did not pass the concerns of senior staff of the Department of Treasury, the Office of Management and Budget and the Council of Economic Advisors when offered as a solution to their observation during deliberations on the National Energy Strategy that gasoline taxes are distorting.

The relevance of this initial result to Central and Eastern Europe can be discussed by identifying four policy cases where the policy implications of the new literature can be quite different. The cases are presented in Figure 1 where the two defining dimensions are the pre-existence of environmental regulation (or not) and the privatization of industry (or not). Block 1 of the Figure can be considered an economy in major transition, one with neither privatized firms nor pre-existing environmental regulations. This may be true for something like carbon taxes in some Central and Eastern European countries. Much of the current literature uses the case of an economy without pre-existing environmental distortions and with a privatized production sector, identified as the shaded area – Block 3. Carbon taxes in western economies may exemplify such policies. As the Figure makes clear however, several other cases are perhaps even more important in Central and Eastern Europe, and also relevant to the United States. For instance, consider Blocks 2 and 4 where pre-existing environmental regulations are the norm and not the exception in both the U.S. and Central and Eastern Europe. In the latter cases, each country is also in a different stage in its privatization process as identified in Block 4.

Figure 1: Characterizing Policy Cases

Privatized Firms	Pre-existing Environmental Regulation: No	Pre-existing Environmental Regulation: Yes
No	1 Some new regulatory areas in Central and Eastern Europe	2 Many Central and Eastern European cases
Yes	3 Typical example in literature: carbon taxes in West	4 Many U.S. and also some Central and Eastern European cases

The following sections investigate these cases by first taking the results of Fullerton and Metcalf as given and then by modifying some of the assumptions. Links to conditions in Central and Eastern Europe are briefly discussed.

Efficiency - Equity Trade-Off:

Fullerton and Metcalf derive an equation that defines the change in welfare as a fraction of national income to be related to the rate of change in the output of a pollution producing good, Y. Equation v

below reproduces their result (their equation 24) for production where there is fixed pollution per unit of output[3].

$$\text{v)} \quad \frac{dU}{\lambda L} = \{ t_l (1 - t_\pi)\Delta - \mu (Y/L)\} \hat{Y} = -\psi \hat{Y}$$

Where: U is utility, the measure of welfare

l is marginal utility of income

L is total labor also interpreted as national income

t_l is the rate of labor tax

t_π is the rate of profit (rent) tax

Δ a complex function of parameters of the system representing the size of the labor supply distortion from taxes,

μ the marginal social damage from pollution

Y the pollution producing good with $\hat{Y}$, the rate of change: dY/Y

ψ the parametric expression of the previous terms

In general, environmental policies are expected to reduce pollution which, in this version with fixed pollution per unit of output, leads to a decline in the output of Y. Consequently the second term in the brackets when multiplied times the decline in production is positive and represents the increase in welfare due to reducing pollution. The first term however, is the general equilibrium loss caused by impacts on the labor supply from higher labor taxes to maintain government expenditures. The first term can be shown to be positive resulting in a negative value when multiplied times the decline in production. The central issue is whether the entire expression in brackets is positive or negative as it determines the sign of any welfare change due to a policy.

Fullerton and Metcalf extend the previous literature by including a profit tax, t_π, which is a rent tax in the zero profit equilibrium. Then $1-t_\pi$ is the fraction of rent that a producer is allowed to keep. Rent can be generated by a tax credit or a quota that is given to the firm. As the left hand side of equation v is a measure of efficiency and it is a function of the initial allocation of property rights to the firm based on the rent they are "allowed" to keep, $1- t_\pi$, there is a clear trade-off between equity and efficiency. Fullerton and Metcalf, in part following Parry and others, then substitute plausible point values into equation v to conclude that in most cases they examine, economic instruments that do not raise revenue to reduce other taxes will lead to a decline in welfare. Specifically, they conclude:

> "For any of these parameter combinations (where the private sector is allowed to keep all the rent), ...the net effect on welfare is always negative. If the environmental policy leaves scarcity rents in private hands, then the very first step toward correcting an uncorrected externality reduces welfare."

[3] A similar expression is obtained for the case of variable pollution per unit of output.

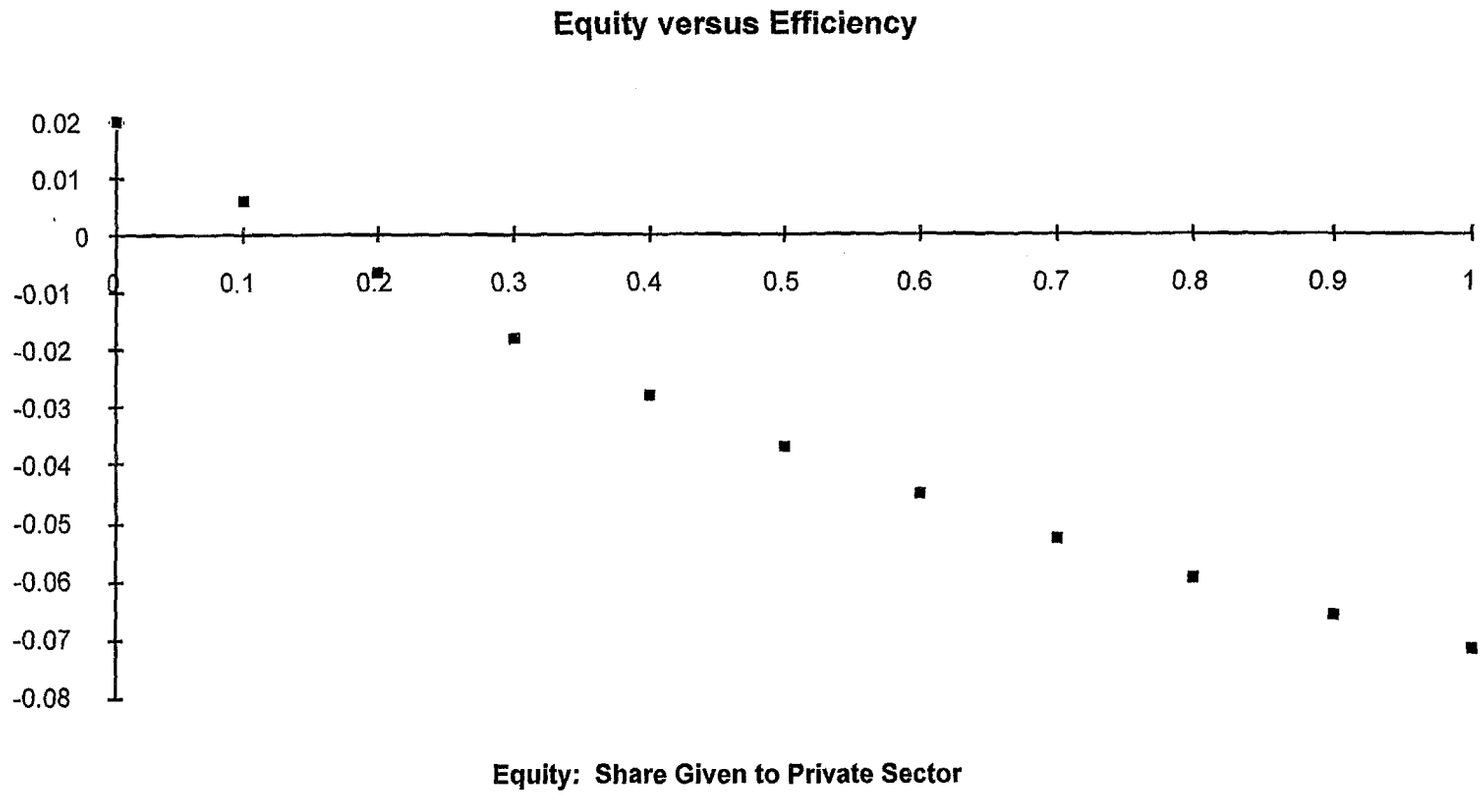
They go on to note the equivalent result for a policy that imposes an environmental tax but which uses the revenue for a lump sum transfer, equivalent to the tax credit structure discussed in Section 2.

Using their data, Figure 2 below charts this trade-off between equity (1- t_π) and efficiency. Using their parameter values, welfare is only increased if the private sector is allowed to keep about 15 percent of the rent or less. Taking their results as given, it suggests that policy entrepreneurs can only use up to 15 percent of the rent to reach agreement from the private sector and still expect to have some increase in efficiency in the economy.

Given the complexity of the macro-economic system and the simplifications necessary for a general equilibrium model, it is useful to investigate the sensitivity of their results to the parameterizaton of the system in which many parameters are not known with certainty. To investigate the uncertainty in parameter values, a simulation was carried out by defining a distribution for each parameter . In general, a triangular distribution was specified with the most likely value being the one used by Fullerton and Metcalf and the range as discussed in the text. As this author is not as familiar with the empirical literature they review, other people may come up with somewhat different distributions where additional judgment was involved. The result of 1,000 simulations using different values of the profit tax rate (t_π) resulted in Figure 3 below where the 95 and the 100 percent bounds of the simulations for each value are plotted[4]. Different from Figure 2, the X axis now measures the amount that of rent that is taxed away from the firm instead of the amount that is kept. For instance, when the rent is entirely taxed away (t_π equals 1) welfare is increased in all simulations. While this is consistent with their results, the simulations for other values of the profit tax reveal a more complex picture. For any value of t_π there is a chance that welfare will increase. In fact, for this characterization of the parameter distributions, the 95 percent bound always includes some positive values. This result can be interpreted as failing to reject a hypothesis of welfare increasing at the 95 percent level of confidence no matter how much rent is left with the private sector. Consequently the negative results of the general equilibrium literature would not apply for many combinations of parameter values; the policy and efficiency implications depend importantly on parameter values.

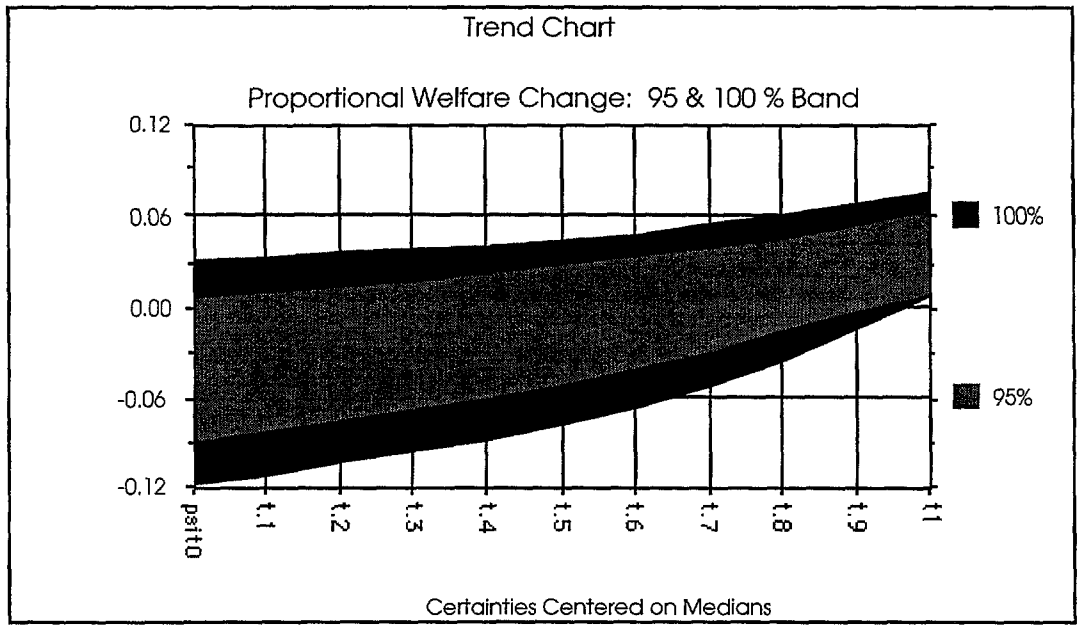
[4] The program Crystal Ball was used to simulate the equation using the parameter assumptions listed following the references.

Figure 2


Equity versus Efficiency
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Equity: Share Given to Private Sector

13

Figure 3



Privatization

The privatization of the economy is one of the major actions defining the economies in transition in Central and Eastern Europe. The extent of the privatization process varies from country to country and from industry to industry. The issue of pollution taxes and trading however, is generally focused on the large stationary sources of air or water pollution many of which remain to be privatized. If an industry is not yet privatized, then another avenue exists for the Government to tax the rent from pollution tax credits or grandfathered quotas. If the Government defines such credits or quotas prior to privatization, then the expected rents become part of the asset value that is paid for by the buyer and received by the Government when it is privatized. Although not explicitly modeled in the Fullerton and Metcalf framework, the suggestion is that selling the entire firm in a market transaction can be equivalent to taxing a significant amount if not all of the rent given the firm through tax credits or grandfathered permits. Consequently the negative results of the general equilibrium literature are likely not to apply when privatization has not yet occurred.

This policy option is represented by Blocks 1 and 2 in Figure 1. The subject of implementing trading prior to additional privatization is known to be discussed in Slovakia and may well apply in other countries in Central and Eastern Europe.

Pre-existing tax on environmental goods

Regulations on pollution exist throughout Central and Eastern Europe and indeed, are likely to exist throughout the world. Many proposed applications of tradable permits or tax credits are proposed as changes to an existing system of regulation. The changes are typically proposed so as to reduce the cost

to the economy of more expensive command and control regulations while achieving the same level of pollution control. Such a policy situation occurs in Boxes 2 and 4 in Figure 1. Do such pre-existing environmental regulations change the conclusion of the general equilibrium literature?

When pre-existing environmental regulations exist and tradable permits or taxes are considered as a replacement, there is typically no change in the level of pollution control. The welfare impacts then reduce to the negative impacts on the labor markets. Formally however, Fullerton and Metcalf explain that their model excludes the possibility of cost savings from an economic instrument as all firms are homogenous. As a first step to a more complex analysis however, it is possible to compare two policies, say regulation and a tax or tradable permit system, that have different impacts on the cost of control of pollution. In the context of the Fullerton and Metcalf model, this would be a difference in impact on the input price of pollution. Each policy is compared to the baseline of no environmental regulation.

Equation vi below follows directly from material in Fullerton and Metcalf[5]. If the level of pollution control between command and control regulation and an economic instrument is the same then the change in welfare becomes a function of the amount of cost saving from the economic instrument. Define the proportional cost saving as α and use "e" to denote an economic instrument and "c" for command and control. Then the relation between the pollution control cost with the two policies is: $P^e = \alpha P^c$ where $0 < \alpha < 1$. The difference in welfare between the two policies, holding government expenditures constant, is:

$$\text{vi)} \quad \frac{dU^e}{\lambda L} - \frac{dU^c}{\lambda L} = t_1 \left\{ \frac{(1-t_\pi{}^e)(1-t_1)(\eta-\varepsilon)\phi}{1-t_1-\varepsilon t_1} \right\} (Z/Y)\, \hat{P}^e$$

$$- t_1 \left\{ \frac{(1-t_\pi{}^c)(1-t_1)(\eta-\varepsilon)\phi}{1-t_1-\varepsilon t_1} \right\} (Z/Y)\, \hat{P}^c$$

where:
- λ: marginal utility of income
- η: income elasticity of labor supply
- ε: uncompensated wage elasticity of labor supply
- ϕ: aggregate expenditure share of all goods with externalities
- Z: pollution

substitute $\hat{P}^e = \alpha \hat{P}^c$ and for the moment assume $t_\pi{}^e = t_\pi{}^c$, then

$$\text{vii)} \quad \frac{dU^e}{\lambda L} - \frac{dU^c}{\lambda L} = t_1 \{.\} (Z/Y)\, \hat{P}^c (\alpha - 1)$$

---

[5] Insert their equation 19, linking changes in labor to price, with equation 9, and assume that the change in pollution is the same with either policy so that pollution changes net out in the change in welfare.

For the same level of taxation, $t_\pi{}^e$ equal to $t_\pi{}^c$, the change in welfare from switching to an economic instrument from a more expensive regulation is clearly welfare improving. The general equilibrium change is equal to α - 1 (a negative number) times the original, negative, general equilibrium impact of the regulation where α - 1 is the proportional cost saving of the economic instrument. Thus if the cost saving was 25 percent ($\alpha = .75$), the welfare improvement is of the same proportion.

This increase in welfare creates the possibility, in the context of the Fullerton and Metcalf model, of giving additional equity to the firm for the improvement in efficiency. A policy entrepreneur might want to know the lower bound to the tax rate that yields an efficiency improvement. This is found by setting equation vi equal to zero, allowing profit taxes to differ but still assuming a proportional cost savings relation, and solving. That break-even point occurs when the ratio of the equity grants is equal to the cost ratio or alternatively, to the inverse of the ratio of the cost of control. The expression can also be solved for $t_\pi{}^e$.

viii) $\alpha = (1 - t_\pi{}^c)/(1 - t_\pi{}^e) = \hat{P}^e / \hat{P}^c$

Consequently, there is a preliminary indication that if there are environmental regulations and an economic instrument results in cost savings, then the general equilibrium impact may be reduced proportionally. This saving to the economy would be likely to exceed the partial equilibrium estimates of cost savings from the introduction of an economic instrument. It is possible to make a larger grant of rent to the firm than is potentially implicit in some command and control regulations and still achieve an increase in welfare.

Constraining Government Expenditures: dG=0

A common practice in the general equilibrium literature is to hold government expenditures constant by imposing the constraint that dG=0, where G are government expenditures. A major policy decision such as holding Government expenditures constant is not however, the responsibility of the analyst except as a sensitivity analysis. Holding expenditures constant also fails to reflect much of the current policy debate. Removing this constraint reveals an important economic trade-off that is obscured when the constraint is imposed. It is possible to carry through the derivation of the Fullerton and Metcalf model without imposing the constraint. A major difference is quickly apparent. Fullerton and Metcalf, in a result extending but consistent with others in the literature, cite their first major result[6] as:

ix) $\frac{dU}{\lambda} = t_1\, dL - \mu dZ$

This equation, less parameterized than equation v, defines the welfare enhancing impact of reducing pollution (the second term on the right hand side), since pollution, Z, is expected to decline. The expression also includes the welfare decreasing impact, the first term, of "the exacerbation of a pre-

[6] The original equation (equation 9) divided both sides of the equation by L, which is both total labor and national income.

existing labor supply distortion. The overall effect on welfare depending on the change in labor supply and on the relative size of these two terms." (Fullerton and Metcalf)

This equation changes when government spending is not held constant in the theoretical model. It can be shown that removing the government constraint still leads to a positive term (damages avoided from pollution) and a negative term (general equilibrium cost), but the interpretation of the negative term is quite different. The revised equation, when government expenditures are not held constant, becomes[7]:

$$\text{x)} \quad \frac{dU}{\lambda} = \gamma dL_G - \mu\, dZ$$

where: L_G is labor in the government sector

γ is the marginal social product of labor in the Government sector
other terms as previously

The change in welfare is still composed of two terms. The welfare enhancing impact of reducing pollution remains the same. But what is the cost? Interpreting γ as the marginal social benefit of government labor, the first term is the opportunity cost of reducing the government labor defined as the product of the decline in government labor and the marginal social benefit of Government labor. The sign and size of the term is debatable as there is not an economically necessary presumption that the Government is operating at the optimal level and there is significant policy concern about the marginal benefits of governmental labor.

Removing the constraint that Government expenditures stay the same thus rephrases the cost of pre-existing distortions in the model. The cost of the environmental improvements carried out by the private sector are the lost uses of government labor funded by the tax revenue. Depending with whom you are speaking and in what country, the government "cost" element might be positive or negative and it may be difficult to refute either proposition on economic grounds. Consequently the negative results of the general equilibrium literature regarding the costly impacts of economic instruments which do not reduce other taxes need not apply if governmental expenditures are unconstrained. It would be an interesting empirical question as to whether the relative size and sign of the marginal social benefit of government labor differs in the U.S. and Western Europe compared with Central and Eastern Europe. Assuming government labor is less productive in Central and Eastern Europe would indicate that the general equilibrium cost of transferring rents to the private sector are smaller.

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[7] To obtain the result from Fullerton and Metcalf, expand the definition of G from NL_G to $h(NL_G)$ to represent a non-linear governmental production function of the public good. Then their equation 5 without dG=0 has a new term, $U_G h' N dL_G$. Define γ as $U_G h' N/\lambda$ to be the marginal social benefit of government labor (parallel to the definition of marginal social damages from pollution.) This results in an intermediate expression for the change in welfare of: $dU/\lambda = t_l dL - \mu dZ + (\gamma - 1) dL_G$. Note that since $P_X = P_L = 1$ in Fullerton and Metcalf, then $t_l dL = t_l P_L dL$=lost government revenue. Without dG=0, the amount of labor lost in government (since there is no capital in the model) is the lost revenue divided by the wage. Then $t_l dL = dL_G$. Substitute this result into the intermediate welfare expression to obtain equation x above.

Conclusion

Economics based policy advice, whether in the U.S., Central and Eastern Europe or elsewhere should consider local, pre-existing conditions that affect implementation. In Central and Eastern Europe, pre-existing conditions somewhat favor tax systems over trading, although mixed systems are also a distinct possibility. The income distributional impacts of pollution taxes or trading, which are usually thought to favor trading, can in fact be made equal through the use of tax credits. The design of tax credits can affect the efficiency of State environmental fund investments and can mimic various kinds of time dependent policies.

Concern has been increasing however, about the interaction of equity and efficiency impacts in the design of economic instruments for environmental protection. The latter part of this paper suggests that the partial or whole allocation of environmental property rights to firms, including any associated rent, may not be as questionable as the current literature suggests. With particular regard to Central and Eastern Europe, the following issues all appear to strengthen the conditions under which grants of property rights to the private sector can still lead to welfare improvement:

- Pre-existing environmental regulations,
- Future privatization,
- Lack of a constraint to maintain government expenditures and
- Parameter uncertainty.

These issues are however, far from closed. To the extent that environmental economic policy advisors seek to practice a modified Hippocratic Oath: "Above all, Do Not Reduce Efficiency," there is a demand to clarify the conditions under which economic instruments improve efficiency relative to what actually and potentially exists.

Assumptions

Assumption: tl

Triangular distribution with parameters:

Minimum	0.25
Likeliest	0.40
Maximum	0.50

Selected range is from 0.25 to 0.50
Mean value in simulation was 0.38

Assumption: ε

Triangular distribution with parameters:

Minimum	0.15
Likeliest	0.30
Maximum	0.30

Selected range is from 0.15 to 0.30
Mean value in simulation was 0.25

Assumption: η

Triangular distribution with parameters:

Minimum	-0.30
Likeliest	-0.30
Maximum	0.00

Selected range is from -1.00 to 0.30
Mean value in simulation was -0.20

Assumption: sigma q

Triangular distribution with parameters:

Minimum	0.75
Likeliest	1.00
Maximum	1.25

Selected range is from 0.75 to 1.25
Mean value in simulation was 1.00

Assumption: phi

Triangular distribution with parameters:

Minimum	0.20
Likeliest	0.33
Maximum	0.50

Selected range is from 0.20 to 0.50
Mean value in simulation was 0.34

Assumption: mu

Triangular distribution with parameters:

Minimum	0.05
Likeliest	0.10
Maximum	0.35

Selected range is from 0.05 to 0.35
Mean value in simulation was 0.17

Assumption: Y/L

Uniform distribution with parameters:

Minimum	0.15
Maximum	0.25

Mean value in simulation was 0.20

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