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Pollution Taxes in a Second-Best World

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Pollution Taxes in a Second-Best World

It is a pleasure to address this group today. I have decided to spend my time discussing recent issues involved in setting environmental taxes in a second-best world. This is an area that has seen an explosion of research and new insights over the past decade and also an area with which many EU countries (as well as candidate EU countries) have been grappling. The basic message of my talk (if there is one) is that the policy prescriptions that most of us learned when studying environmental policy in isolation (that is, in partial equilibrium) often must be significantly adapted once one moves to a general equilibrium framework with pre-existing distortions. Put this way, there is nothing novel here; it is simply a restatement of the Theorem of the Second Best (Lipsey and Lancaster (1956-1957)). This, however, risks trivializing the literature of the past decade. As a contributor to that literature, I'd prefer not to do that. More to the point, there are some very interesting results that bear discussion.

I. Optimal Taxation of Environmental Damage

Let me begin by noting a concept that gained considerable currency in the late 1980s and early 1990s. It is the idea of the "Double-Dividend Hypothesis." The "double-dividend hypothesis" suggests that increased taxes on polluting activities can provide two kinds of benefits. The first dividend is an improvement in the environment, and the second dividend is an improvement in economic efficiency from the use of environmental tax revenues to reduce other distortionary taxes.[1] This is a relatively uncontroversial idea though it led some policy analysts to policy prescriptions that could not be supported by the theory. Some policy analysts argued that if the optimal tax rate on environmental damages in a first-best world equals social marginal damages (the prescription due to Pigou (1932)), then it must be the case that the tax rate should be *higher* in a world with distortionary taxes if we could use that revenue to lower those taxes. After all, so goes the argument, we're getting an additional benefit from the tax. Therefore, we should rely more heavily on this instrument. This is incorrect for the simple reason that an environmental tax brings with it its own distortions (aside from its environmental impact).

This can be illustrated with a simple diagram taken from Fullerton and Metcalf (1998). The model is a simple one. A single factor of production (labor) is used to produce a clean good (C) and a dirty good (D). The factor is paid its value of marginal product. Consumers can choose to supply labor or consume leisure, using their labor income to purchase the two commodities. Consumers obtain lower utility as pollution rises. Finally government must raise a given amount of revenue for a fixed government use. Its tax instruments include a tax on wage income or a tax on the good producing pollution.

Figure 1 illustrates the equilibrium prior to the imposition of an environmental tax (here a tax on D). There is only a tax on wage income initially. In figure 1, labor is

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[1] Pearce (1991) appears to be the first person to use the "double-dividend" terminology in print. See Fullerton and Metcalf (1998) for a history of this concept dating back to Tullock (1967).

measured along the horizontal axis. The real wage is measured along the vertical axis. Prior to any environmental policy, the equilibrium occurs at L^0 where $W_n^0 = (1-t_w)W_g$. The triangle A measures the deadweight loss arising from the tax on labor.

Now let's consider the imposition of an environmental tax (here a tax on the dirty good). Two things happen. First, the new environmental tax revenue allows for a reduction in the labor income tax rate and a consequent increase in the real net wage. This revenue effect has been termed the *revenue-recycling effect* by Bovenberg and Goulder (2002), drawing on terminology from Parry (1995). But in addition, the general price index (a function of the prices of the two commodities) rises since the dirty good will now be more expensive, what Bovenberg and Goulder term the *tax-interaction effect*. Bovenberg and de Mooij (1994) show that this latter effect more than offsets the revenue effect leading to a reduction in the real net wage from W_n^0 to W_n^1 and a consequent fall in labor supply from L^0 to L^1. With that fall in labor supply comes an increase in deadweight loss equal to the trapezoid B in the figure. The punch line is that while there are benefits from the environmental tax (reduced pollution) there are also costs (exacerbated distortions in other markets). In rough terms, we're adding DWL onto the wide end of a DWL triangle.

In Metcalf (2003), I develop a simple analytic general equilibrium model to investigate the optimal tax structure further. In particular, a representative agent obtains utility from two goods, one of which is associated with pollution (the dirty good). The agent also obtains utility from leisure and disutility from pollution. Labor is the only factor of production and is used to produce the two private commodities and a fixed amount of a government good. Following much of the previous research, I assume that utility over C and D is weakly separable from leisure and environmental quality and that this sub-utility function is homothetic. If the government raises revenues from commodity taxes, the optimal relationship between the optimal tax rates is

$$t_D^* = t_C^* + \left(1 - \varepsilon t_C^*\right)\tau \qquad (1)$$

where ε is the uncompensated labor supply elasticity and τ is the social marginal damages from pollution (measured in private income). First note that if there is no environmental problem, then the optimal commodity tax rates would be equal. This follows from our assumption of weak separability and homotheticity in consumption. Therefore, we can view the difference between t_D and t_C at the optimum as a Pigouvian tax increment. In other words, if the optimal tax rate on the clean good is 20 percent and that on the dirty good 25 percent, then the Pigouvian tax increment (required to achieve the optimal level of pollution) is five percent.

Equation (1) yields three useful bits of information in the presence of environmental damages. First, suppose that environmental tax revenues are sufficient to cover government expenses without a tax on the clean good ($t^*_C = 0$) . In this case, the tax on D (as well as the difference, t_D-t_C) exactly equals τ. This is the Pigouvian rule in a first-best situation. Second, even if a tax on C is required, the first best rule still holds so long as ε equals zero. Third, if neither of these conditions hold, then the Pigouvian tax increment $\left(t_D^* - t_C^*\right)$ falls short of τ so long as εt_C is positive. In other words, those who argued that the existence of a double-dividend means that the Pigouvian tax should exceed social marginal damages were incorrect.

Bovenberg and de Mooij (1994) along with Parry (1995) were the first to point this out. As Bovenberg and de Mooij note

> In this way, high costs of public funds crowd out not only ordinary public consumption but also the collective good of the environment. (p. 1088).

This statement is not precisely correct and I return to this point below. But the broader point that Bovenberg and de Mooij were making is very much correct: that the distortions associated with an environmental tax are of first-order importance in the face of other pre-existing distortions and cannot be ignored as they could if there were no other taxes in effect. Returning to the figure, the DWL associated with the environmental tax is a trapezoid added on to the side of a DWL triangle. If the DWL triangle does not exist (no pre-existing distortion), there is no increment to the triangle to worry about. Note also the importance of the *uncompensated* labor supply elasticity (ε). As Ballard (1990) has noted, compensated elasticities are relevant for differential incidence analyses while uncompensated elasticities are relevant for balanced budget incidence analyses. The point is that there are income effects with balanced budget policy changes. While we are in fact undertaking a differential tax incidence analysis, the change in environmental quality has effects analogous to income effects making the uncompensated elasticity the relevant parameter of interest.

II. Prices versus Quantities: Some Comparative Statics[2]

The statement from Bovenberg and de Mooij that I quoted above has led to some confusion among economists. Some have interpreted it to mean that in a second-best world, the optimal amount of environmental quality would fall. This, in turn, has led some analysts to worry that policy makers might rely on this new second-best literature to weaken laws protecting the environment. One must draw a careful distinction between "price" questions ("Is the optimal tax on pollution higher or lower than social marginal damages?") and "quantity" questions ("Is the optimal level of environmental quality higher or lower in the presence of other distortions than it would be in a world with no other distortions?").[3] The simple model that I sketched out above can be useful to understand that distinction. Imagine that government is setting tax rates optimally according to equation (1).[4] And now imagine that the government needs some additional revenue. How does the need for more revenue affect:

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[2] This section draws heavily on Metcalf (2003).

[3] The importance of this distinction has been pointed out in the public goods literature by Atkinson and Stern (1974).

[4] Equation (1) and the budget constraint are sufficient to pin down the actual tax rates.

(1) the optimal Pigouvian tax increment $t_D^* - t_C^*$ and

(2) the optimal level of environmental quality (E) which is a function of the aggregate supply of the dirty good?

Assuming that social marginal damages and the factor supply elasticity are (to a first order approximation) constant, we can differentiate equation (1) to get the answer to our first question:

(2) $$d(t_D - t_C) = -\varepsilon\tau dt_C$$

Under reasonable conditions and ruling out any Laffer tax effects, it is easy to show that $\text{sgn}(dt_D) = \text{sgn}(dt_C) = \text{sgn}(dG) > 0$. With $dt_C > 0$, equation (2) indicates that the Pigouvian tax increment falls as G rises (so long as $\varepsilon > 0$). An increase in required distortionary tax revenues does not favor increased taxation of the dirty good relative to the clean good.

The intuition underlying this result is quite simple. Sandmo (1975) showed that the optimal tax on a polluting good is a weighted average of a Ramsey efficiency component and marginal environmental damages (MED). As government revenue needs increase, the weight on the Ramsey component rises and the weight on the environmental component falls. With separability between leisure and consumption goods, the optimal Ramsey components on the two goods are equal. Thus an increase in the Ramsey weight leads to a decrease in the difference between the two tax rates (i.e. the Pigouvian tax increment).

Having answered the "price" question, I now turn to the "quantity" question. Note that the diversion of resources from the private to the public sector directly affects the environment to the extent that public services themselves may pollute more than the mix of private goods reduced. For example, if public services are entirely clean, the expansion of the government sector will likely lead to a cleaner environment since the increased government output has no impact on the environment. To avoid this demand side effect, I assume that government spends its revenue on the same mix of clean and dirty goods as does the private economy.[5] In Metcalf (2003) I show that environmental quality falls if

(3) $$\pi_C \sigma \left(\frac{dt_C}{1+t_C} - \frac{dt_D}{1+t_D} \right) + \frac{dL}{L} > 0.$$

The parameter π_C is the share of consumer expenditures on the clean good and σ is the elasticity of substitution between the clean and dirty good in consumption. Some simple algebra shows that the first expression in equation (3) is positive. Regarding the second

[5] This is the approach taken in Harberger (1962) to rule out demand side effects in his classic analysis of the incidence of the corporate income tax.

term, labor supply will fall as the real wage falls so long as labor supply is not completely inelastic. In this model, the real wage will fall since the general price index rises (with the increase in the tax rate on both the clean and the dirty good).

Now we can understand the forces that affect environmental quality. The first term in (3) is a commodity substitution effect. As the Pigouvian tax increment falls, consumers will substitute from C to D. The strength of this effect depends on the elasticity of substitution in consumption (σ). This substitution effect will work towards reducing environmental quality. The second term is a leisure substitution effect and reflects the fact that the increase in taxation will lead to a substitution away from both produced goods towards leisure. Since leisure (in this model) is a clean commodity, this effect serves to improve environmental quality. Whether an increase in government spending financed by increased taxes leads to a fall or rise in environmental quality depends on the relative size of the two substitution effects.

While the model here is quite simple, the basic point is more general. Decreases in the Pigouvian tax increment as public revenue needs rise will affect environmental quality through the commodity substitution channel. But additional channels also affect the supply of environmental quality. In this model, the second channel is a leisure demand channel. A more realistic model would include other factor markets as well as additional commodity markets. Additional realism and complexity do not affect the central point that knowledge of the direction of changes in optimal environmental tax rates due to changes in the economy is not sufficient for understanding the impact on environmental quality.

Finally, lest I leave you with the impression that Bovenberg and his co-author did not understand this distinction, I should point out that Bovenberg and van der Ploeg (1994) were careful to measure both price and quantity effects in an analysis of various environmental policies they study in a analytic general equilibrium setting.

III. Are Environmental Taxes Environmental Taxes?

In the model above, there was a one-to-one correspondence between the amount of the dirty good and pollution. In most cases, pollution is a by-product of production (or consumption) and there are various ways to affect the ratio of pollution to output (or consumption). It is convenient for the economist to model pollution as an input in production. If Z is pollution, and output (Q) is produced with capital (K) and labor (L), then

$$Q = f(K, L, Z) \tag{4}$$

Pollution abatement can be viewed as substitution out of Z and into K (and possibly L). This is a useful way to model pollution because it highlights the two channels by which a tax can discourage pollution. If we levy a tax on Q, we will discourage the production of Q and therefore reduce the demand for all the inputs in production -- including pollution. If we levy a tax on pollution directly, we will get this output effect as the price of Q inevitably rises in response to the higher cost of production but we will get an additional substitution effect as firms substitute out of Z and into K and L. In other words, they have an incentive to engage in pollution abatement or avoidance strategies.

Unfortunately, most so-called environmental taxes are more often taxes on goods associated with pollution (taxes on Q) rather than taxes on pollution directly. Fullerton (1996) reviews environmental taxes in the United States in the mid-90s and notes that not only are the U.S. environmental taxes not environmental taxes in the textbook sense, they are typically levied at very low rates relative to the value of production and impose high administrative costs. This should not make anyone feel sanguine about the importance of economic input into policy making. A cursory review of environmental taxes in the EU suggests that the EU has not been any more effective at targeting environmental taxes precisely than the United States. Todsen and Steurer (2002) note that transport and energy taxes comprise about 98 percent of EU environmental tax revenues of 228 billion euros in 1999. Specific pollution taxes account for less than 2 percent of EU environmental tax revenues and are only a significant tax instrument (in terms of total collections) in the Netherlands, Denmark, and Belgium.

That this is so is not due to the failure to understand the issue. There are good reasons for why actual taxes might miss the target. First, actual policy may not fully appreciate the importance of hitting the target. Policymakers may have been concerned primarily with equity considerations, trying to ensure that polluting industries are made to pay for pollution -- without realizing that the form of these taxes affect incentives to reduce pollution. Second, actual emissions may be difficult or impossible to measure. In these cases, the best available tax may apply to a measurable activity that is closely correlated with emissions. To reduce vehicle emissions, for example, the gasoline tax may be the best available instrument. Third, the technology of emission measurement is improving over time. Policymakers may be slow to adjust the tax base to reflect the newly-reduced cost of measuring a particular pollutant.

If emissions cannot be monitored at reasonable cost, and policy is limited to a tax on the output of the polluting industry, then how should that tax rate be set? One might think that the imperfection of this blunt instrument would reduce the optimal rate of tax. In Fullerton, et al. (2001), we show that is not the case: the second-best output tax should be set to capture the exact same output effect that would have been captured by the emissions tax. If the unavailable emissions tax would have raised output price by 12 percent, for example, then the output tax should be set to 12 percent.

Finally, we calculated the incremental effects on welfare of slight increases in any pre-existing output tax or emissions tax, and we show the “welfare gap” of an imperfectly targeted environmental tax relative to a precisely targeted one. We found for plausible parameter values that the welfare gain from an initial emissions tax was more than twice the gain from an initial output tax. This cost of missing the target did not depend on the size of the pre-existing output tax, or on the size of the elasticity of substitution in utility, but it did depend on the elasticity of substitution in production. A larger ability to substitute between emissions and other inputs in production substantially raises the importance of hitting the target.

Figure 2 illustrates this result. The horizontal axis indicates the level of an output tax on the dirty good prior to a reform. (There is also a pre-existing labor tax.) The vertical axis then measures the welfare gain (or loss) from a small change in either the output tax (dashed line) or the emissions tax (solid line). There are three points to note. First, the emissions tax everywhere outperforms the output tax. Not surprising since the emissions tax brings both the substitution and output effects to bear on the pollution problem while the output tax only relies on the output effect. Second, the emissions tax is welfare enhancing across the entire range of pre-existing output tax rates. This is by no means a universal result but unless the tax system is seriously out of balance, a small environmental tax should be welfare enhancing. (More on this below.) Finally, there is a large range over which the output tax - levied to reduce pollution - is welfare reducing despite the environmental gains. In other words the increase in distortions in the tax system more than outweigh the environmental benefits.

IV. Environmental Instruments More Generally

After the initial spate of papers following Bovenberg and de Mooij, researchers began to direct their interest more broadly from taxes to emissions quotas, tradable permits, and other regulatory instruments. Goulder, et al. (1997) studied revenue raising versus non-revenue raising instruments in the context of U.S. SO_2 policy. Two results from that study are worth noting. First, they showed that raising revenue is not a sufficient condition for obtaining an efficiency gain over a non-revenue raising instrument.[6] For example, an environmental tax is a revenue-raising instrument but if the revenues are given back lump-sum, it is conceptually identical in its effects to a pollution quota scheme with permits which are given to polluting firms at no cost. (The conceptual equivalence requires a few qualifications: primarily the lump-sum distributions must be the same in both cases). Second, the efficiency advantage of taxes over grandfathered permits declines with pollution abatement. In the limit where there is 100 percent pollution abatement, the two policies are identical. The reason is quite simple. With 100 percent abatement, the pollution tax raises no revenue!

Fullerton and Metcalf (2001) extended the Goulder, Parry, and Burtraw result to show that not only was revenue-raising not sufficient to guarantee a welfare improvement, it was also not necessary. In that paper we provided comparable analyses of various environmental policies and found that the same welfare-raising effects of environmental protection could be achieved by a tax that raises revenue, a CAC technology restriction that raises no revenue, and even a subsidy that costs revenue. Thus, raising revenue is *not* necessary for raising welfare. Instead, the exacerbation of the pre-existing tax distortion is associated with policies that generate privately-retained scarcity rents. Such policies include both the quantity-restricting CAC regulation and the marketable permit policy in which the permits are given to existing polluters. The problem with such policies is that the output price must rise by more than necessary to cover the cost of abatement technologies; indeed we show that price must rise by an

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[6] Strictly speaking this holds for new taxes only.

additional amount equal to scarcity rents that arise as a result of the emissions restrictions. The higher output price reduces the real net wage and exacerbates the labor tax distortion. That higher price is not such a problem if government captures the rents by using a pollution tax or by selling the permits, because then the labor tax can be reduced.

In the framework that Fullerton and I set up, the ability to identify and capture rents is key. Identifying who captures the rents in the absence of government capture is not always straightforward. Busse and Keohane (2003) have written a fascinating paper on the experience from creating and giving away permits from the SO_2 trading program arising from Title IV of the 1990 Clean Air Act Amendments. The restrictions on sulfur dioxide emissions that result from this program create a barrier to entry that generates rents, rents that are capitalized in the value of the tradable SO_2 permits. Busse and Keohane note that there are three candidates for the captors of those rents: the electric utilities, the producers of low-sulfur coal, and the railroads that transport low-sulfur coal. Phase I of the tradable permits program (1995-1999) coincided with the opening up of a large reserve of low-sulfur coal in the western part of the country. That coal provided a low cost alternative to burning high-sulfur coal that required the use of a large number of SO_2 permits. Busse and Keohane note that the western coal mines might have captured the rents by raising the price of their coal. Alternatively, the railroad could capture the rents by raising rail rates. They argue that the railroads captured the rents through what was essentially a two-part tariff consisting of an increase in fixed transport fees and reduced marginal transport costs. While it may not be easy to identify who captures the rents, it is straightforward for the government to capture the rents simply by auctioning the permits.

It should be noted that the choice with tradable permits is not limited to auctioning them or giving them away. Bovenberg and Goulder (2001) carry out a computable general equilibrium analysis of a CO_2 abatement policy carried out with tradable permits where industries are given enough permits to prevent a loss in the value of the firm (what the authors call "equity-value neutrality") and sold the rest. The policy is designed to be equivalent to a $25 per ton carbon tax in the year 2000. They find that only 15 percent of the permits need be grandfathered in the oil and gas industry and only 4 percent in the coal industry. Equity-value neutrality can therefore be achieved at relatively low cost. Policy makers should be mindful of this when industry argues for complete grandfathering to preserve the equity value of the firm. Complete grandfathering is likely to overcompensate firms in a very big way.

V. Tax Distortions and Global Climate Policy[7]

Lastly I turn to the topic of policies to reduce global carbon emissions. At Kyoto,

[7] This section draws heavily on Babiker, et al. (2003)

Annex B[8] Parties committed to reducing, either individually or jointly, their total emissions of six greenhouse gases (GHGs) by at least 5 percent within the period 2008 to 2012, relative to these gases' 1990 levels.

The European Union (EU), as a signatory to the Kyoto Protocol, has accepted a quantitative absolute reduction of 8 percent from 1990 levels of its GHG emissions. Article 4 of the Protocol allows the EU to allocate its target among the Member States. A political agreement on that redistribution was reached at the environmental Council meeting in June 1998, and is referred to as the "Burden Sharing" Agreement (BSA). Table 1 shows the BSA adopted at the environmental Council meeting by Member States on June 1998. The sharing scheme specifies emissions targets for each member country with the objective to reflect opportunities and constraints that vary from one country to another, and to share "equitably" the economic burden of climate protection.

Working with colleagues at MIT, I investigated the degree to which implementation of Kyoto targets through a carbon tax could lead to "weak" or "strong" double-dividends. Goulder (1995) distinguishes a "strong" and "weak" double dividend as follows. A strong double dividend occurs when welfare is increased in response to an environmental tax regardless of the improvement in environmental quality. Given the great difficulties associated with quantifying the economic benefits of an improved environment, a strong double dividend is appealing in that a case can be made for an environmental tax without having to worry about the magnitude of the environmental gains. It is possible for welfare (net of environmental improvements) to increase in response to a green tax reform if the environmental tax revenues are used to lower a particularly egregious distorting tax. This simply points out the obvious fact that any tax reform to replace a highly distorting tax with a less distorting tax is, in general, a good idea.

A "weak" double dividend occurs when the welfare improvement from a tax reform where environmental taxes are used to lower distorting taxes is greater than the welfare improvement from a reform where the environmental taxes are returned in a lump sum fashion. A general consensus has emerged that the weak double dividend is an uncontroversial idea; it just says that lowering a distorting tax is better than simply handing out the money. In my work with my MIT colleagues, I show, however, that in an economy with multiple distortions, a weak double dividend need not occur. Moreover, we argue that climate policies under consideration in response to global warming will likely not provide a weak double dividend in a number of European countries.

The findings are obtained using MIT's Emissions Prediction and Policy Analysis (EPPA) model, a recursive dynamic multi-regional general equilibrium model of the world economy that has been developed for analysis of climate change policy. EPPA is

[8] Annex B refers to the group of developed countries comprising of OECD (as defined in 1990), Russia and the East European Associates.

built on a comprehensive energy-economy data set (GTAP4-E[9]) that accommodates a consistent representation of energy markets in physical units as well as detailed accounts of regional production and bilateral trade flows. The base year for the model is 1995 and it is solved recursively at 5-year intervals.[10] For our project, we used a new version of the model (EPPA-EU) including a breakdown for the European Union so that we could model the BSA. A significant advantage of this approach compared with previous work is that a common method and data set is applied to all countries and the cross-country results are thus comparable.

Table 2 provides our key results from that paper. The first scenario (labeled NRP) returns carbon tax revenues to the representative agent in a lump-sum fashion. Not surprisingly, carbon reductions in this case reduce welfare relative to the reference scenario. The next two columns provide results for different tax reductions. In no case does welfare rise relative to the reference scenario. In other words, a strong double dividend is not possible in any of the EU countries or the United States and Japan as a result of a carbon tax to achieve Kyoto. The use of carbon taxes to reduce labor taxes does give rise to a weak double dividend. Welfare losses under the LRP scenario are always lower than under the NRP scenario. This result is consistent with other studies that have found a weak double dividend when recycling carbon revenues to reduce labor taxes.

Interestingly, the weak double dividend does not hold in all cases when carbon tax revenues are used to lower non-energy consumption taxes (CRP). France, the Netherlands, Spain, and REU are all better off with lump-sum recycling of the carbon tax revenues than if the alternative is to reduce non-energy consumption taxes. The failure of the weak double dividend to hold simply reflects the existence of distorting energy consumption taxes that have not been reduced in this policy experiment. Intercommodity distortions are increased by a selective reduction in consumption taxation; second best considerations mean that the weak double dividend is not a universal phenomenon.[11]

VI. Conclusion

I have only touched on a number of interesting and important issues that have been investigated over this past decade. In particular there are important distributional and political economy considerations that I have ignored. Let me end with a final point. My cursory review should suggest that the complexity of instrument design in a second-

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[9] For description of the Global Trade Analysis Project (GTAP) database see Hertel (1997).

[10] A full documentation of EPPA is provided in Babiker, et al. (2000).

[11] A carbon policy reduces the real net wage by raising the price of energy consumption goods. This reduction exacerbates pre-existing distortions in the labor market One key difference between the LRP and CRP policies is that labor tax recycling mitigates this reduction by explicitly reducing the tax burden on wages. The CRP policy mitigates the reduction by reducing *other* consumption taxes. This mitigation comes at the cost of higher intercommidity tax distortions as the already large tax wedge between energy and non-energy consumption goods increases.

best world means that economists with computer models of the economies of countries and regions will play an important role in guiding policy makers to sensible environmental policy prescriptions. A further insight from my work with the MIT modelers on global climate change has been that there is great variation across countries in the efficiency impacts of different environmental policies. This suggests that one should be cautious about drawing conclusions from studies based on data from the United States, for example, on appropriate policies for Europe. Equal caution may be warranted about drawing conclusions from EU studies about appropriate policies for individual candidate EU countries. Economists studying the economies of the EU candidate countries should -- as much as possible -- carry out country specific analyses to guide them in devising country specific recommendations. While tax harmonization in the EU can be a valuable goal, it is still important to model and allow for the great variation within the EU, a variation that will only increase with the expansion of the Union.

Figure 1. Welfare Losses From Distortionary Taxation

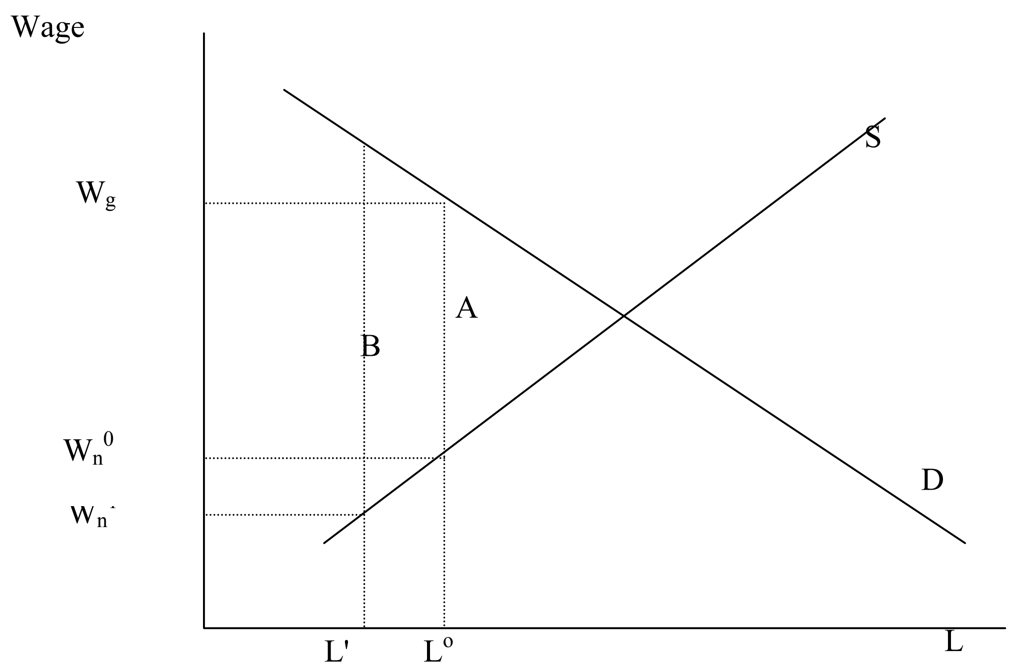

Figure 2. General Welfare Effects of Changes in Emissions or Output Taxes with Pre-Existing Labor and Output Taxes

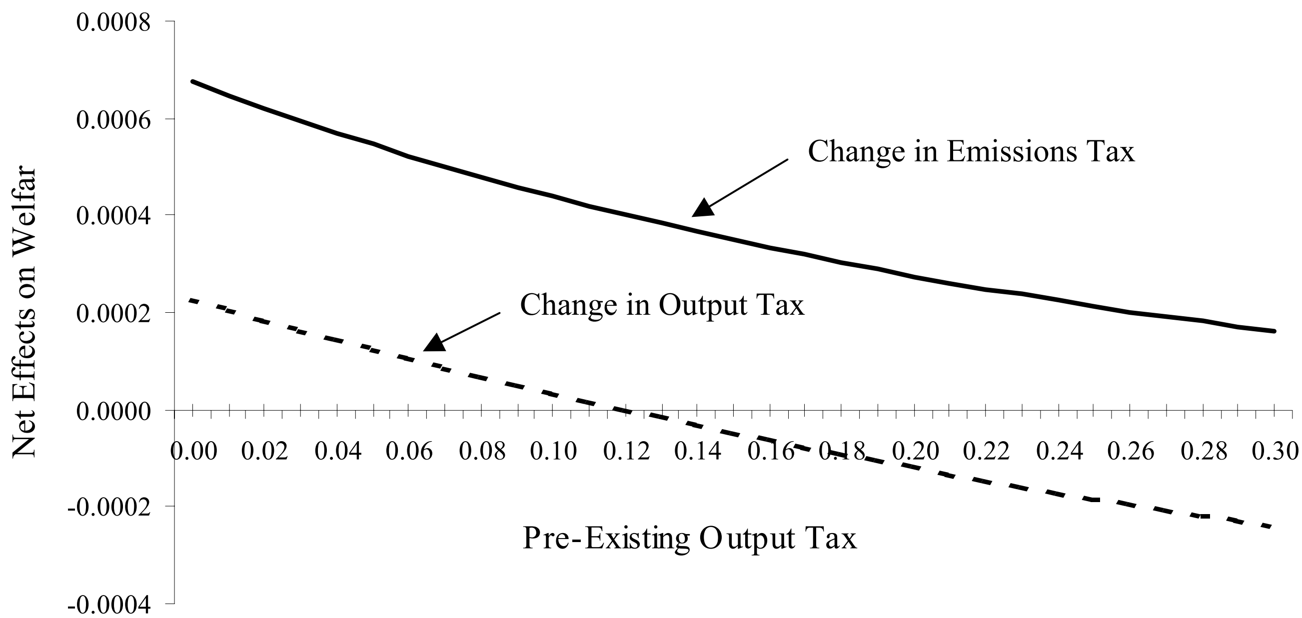

Table 1. Burden Sharing Agreement for 2010	
Country	**Base 1990 = 100**
Austria	87.0
Belgium	92.5
Germany	79.0
Denmark	79.0
Spain	115.0
Finland	100.0
France	100.0
United Kingdom	87.5
Greece	125.0
Ireland	113.0
Italy	93.5
Luxembourg	72.0
Netherlands	94.0
Portugal	127.0
Sweden	104.0
Total European Union	92.0

Source: Babiker, et al. (2003)

Table 2. Welfare Changes with Recycling			
	NRP	**LRP**	**CRP**
USA	-0.65%	-0.49%	-0.57%
JPN	-0.62%	-0.56%	-0.54%
GBR	-1.05%	-0.97%	-0.91%
DEU	-0.77%	-0.69%	-0.55%
DNK	-3.82%	-3.54%	-3.23%
SWE	-3.46%	-3.27%	-3.03%
FIN	-1.86%	-1.67%	-1.45%
FRA	-0.70%	-0.64%	-0.76%
ITA	-1.26%	-1.08%	-1.22%
NLD	-4.67%	-4.45%	-4.87%
ESP	-3.13%	-3.01%	-3.32%
REU	-1.27%	-1.17%	-1.44%
OOE	-1.96%	-1.88%	-1.84%
Average	-1.94%	-1.80%	-1.83%

Welfare changes are relative to the reference scenario. Average is an unweighted average of the changes for the countries or country groups

NRP - Lump-Sum Recycling
LRP - Labor Tax Recycling
CRP - Non-Energy Consumer Tax Recycling

Source: Babiker, et al. (2003)

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