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Climate change policy's interactions with the tax system[☆]

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ABSTRACT

This paper presents a range of insights from recent literature on how climate-change policies and other environmental policies interact with the fiscal system. It explores four issues associated with fiscal interactions. First, it examines how these interactions influence the prospects for a “double dividend:” both an environmental improvement and a reduction in the costs of the tax system. Second, it analyzes how the use of revenues from a carbon tax or from a cap-and-trade system involving auctioned emissions allowances influences these policies' economic costs. Third, it addresses the question whether carbon taxes or cap-and-trade programs represent more efficient sources of government revenue than other, more traditional revenue sources such as income, sales, or payroll taxes. Finally, it analyzes how fiscal interactions affect the choice between CO_2 emissions-pricing instruments (carbon taxes and cap and trade) and other climate policy instruments.

1. Introduction

A major challenge of climate policy is figuring out how to achieve reductions in emissions of greenhouse gases at low cost. Economists tend to prefer emissions pricing, whether in the form of a carbon tax or through cap and trade, which effectively establishes a price of emissions through the price of emissions allowances. Although the attractions of emissions pricing are gaining increased recognition, this policy approach continues to encounter considerable political resistance.

Recent research suggests that taking account of fiscal interactions can significantly change one's perspective on the costs of emissions pricing — both in absolute terms and relative to the costs of other, non-price approaches to climate change. In particular, fiscal interactions can cause some forms of emissions pricing to be less cost-effective than other, non-market instruments that economists have traditionally disparaged as more costly. Moreover, in some circumstances these interactions can cause otherwise attractive emissions-pricing policies to be efficiency-reducing; that is, their aggregate net benefits (the monetized value of the environmental gains minus the non-environmental costs) can be negative. Once fiscal interactions are taken into account, the specific design of an emissions-pricing policy – for example, the extent to which the allowances under a cap-and-trade program are auctioned as opposed to freely allocated – can make a dramatic difference to policy costs.

This paper presents a range of insights that have emerged from literature on how environmental policies interact with the fiscal system. Section 2 provides a foundation by describing two important types of fiscal interaction. One is a “revenue-recycling effect” associated with the return to the private economy of any revenues generated by an environmental policy instrument. The other is a “tax-interaction effect” that addresses impacts of environmental policy instruments on the returns to factors of production. Section 3 explores whether fiscal interactions allow for a “double dividend” from a carbon tax (or other environmental tax): that is, whether a carbon tax might not only improve the environment but also lower the costs of the tax system. Section 4 shows how fiscal interactions make the design of climate policy instruments especially important. These interactions imply, in particular, that pricing the environmental externality is not enough to assure that the policy will yield an efficiency improvement. Certain design decisions – such as the method of recycling of revenues raised by the carbon tax (or auctioned emissions allowances) – can determine whether the policy yields benefits in excess of the costs. Section 5 addresses the question whether “green” revenue sources (such as a carbon tax or auctioned emissions allowances) are more efficient sources of government revenue than other more traditional revenue sources such as income, sales, or payroll taxes. Section 6 explores how fiscal interactions affect the choice between emissions

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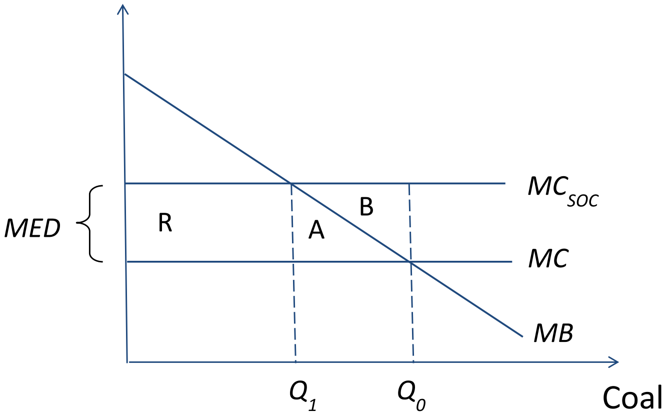

Fig. 1. Simple analysis of benefits and costs of an environmental tax.

pricing (carbon taxes or CO_2 emissions allowances) and other climate policy instruments. Section 7 concludes.

2. Key fiscal interactions: The revenue-recycling and tax-interaction effects

To consider fiscal interactions, it is useful to start with the basic economics textbook diagram offered in Fig. 1. The figure uses coal as an example of a commodity whose production generates a significant external cost. Hence marginal social cost (MC_{SOC}) exceeds marginal private cost (MC) by an amount reflecting the marginal external cost or damage (MED). Since our focus is climate change policy, we will concentrate on the externality associated with the release of CO_2 from coal combustion and the associated impacts on climate and well-being. It may be noted that other externalities are associated with coal combustion, including adverse health effects from emissions of local pollutants such as nitrogen oxide and sulfur dioxide.

In the absence of intervention, and assuming a competitive market for coal, the market equilibrium is at Q_0, where the marginal social cost from production exceeds the marginal benefit (MB) from the use of coal. The typical prescription is to put a tax on coal that reflects the marginal external damage. In a competitive market, this would cause private costs to rise and match the marginal social costs, and lead to the new equilibrium at Q_1, where the marginal social costs and marginal benefits are equal.

This policy yields an environmental benefit of A + B (the avoided environmental damage). The diagram also indicates that this will cost society something. In particular, society will lose consumer surplus represented by A + R, as consumers (the utilities) will have to pay more for coal. On the other hand, the tax revenue R is worth something. If it is recycled back to the economy (rebated to the private sector), the private sector gets back the value R. Alternatively, it could be used to finance new government spending. If the benefit–cost ratio for the financed project is about one, this spending has a value of about R. Thus, the textbook diagram suggests that, ignoring environmental benefits, the overall cost to the economy is A. This policy offers net social benefits of B, since the environmental benefit (A + B) exceeds the cost (A).

The analysis presented thus far ignores fiscal interactions (except to acknowledge the fact that the tax revenue is returned to the economy). Starting about two decades ago, a number of economists started to consider closely the associated fiscal interactions. Many of the initial suggestions by economists were that the simple textbook analysis understated the social benefits from the tax policy. They emphasized that when tax revenue R is returned to the private sector, it can have a social value greater than R. They pointed out that, rather than provide for lump-sum payments, the coal tax revenue could be used to finance reductions in the marginal rates of existing distortionary taxes such as income or sales taxes. Since the deadweight loss or excess burden of these taxes is a positive function of their tax rates, lowering these tax rates could reduce the distortionary cost of these taxes. This efficiency improvement from cutting existing tax rates, termed the revenue-recycling effect, would represent a social benefit that was ignored in the simple textbook analysis.[1]

Indeed, attention to the revenue-recycling effect caused some to suggest that this environmental policy might be a zero- or negative-cost option, even before accounting for the environmental benefits. That is, the efficiency improvement from revenue-recycling might fully offset the cost A that applies before this efficiency component is considered. If so, the tax policy would confer a "double dividend:" not only yield an environmental benefit but also allow for higher non-environmental well-being by lowering the cost to the private sector of the tax system.[2] Environmental improvement could be a free lunch. The prospect of the double dividend generated considerable attention and excitement among policy analysts and some politicians.

But then some other economists began to cast doubt on these relatively optimistic conclusions. They drew attention to another effect that works in the opposite direction, magnifying some of the costs of the environmental tax. Their reassessment started with the point that, like all taxes on goods and services, a tax on coal is an implicit tax on factors of production. This is because the coal tax increases the prices of goods and services generally, which lowers the real wage and real return to capital. For a given nominal wage, for example, the increase in the overall price of goods and services constitutes a reduction in the real wage. Through this mechanism, the environmental tax is an implicit tax on labor.[3]

Why should this matter for the overall costs of the coal tax? It wouldn't matter much if there were no pre-existing taxes on labor or capital. But in the presence of such taxes (such as income, payroll, or sales taxes), it does matter. Fig. 2 brings out the issues. Existing taxes such as income, payroll, or sales taxes create a wedge between the marginal value of labor supplied and private marginal cost of labor supply. In the figure, τ_0 represents the tax wedge implied by these existing taxes. With this tax wedge, the market equilibrium labor supply is at L_1, below the most efficient level L_0. The excess burden associated with these existing taxes is given by the shaded triangle in the diagram.

Now suppose that, in this situation, a carbon tax is introduced. This implicit tax on labor raises the labor supply curve further, to S_2. This leads to a further reduction in labor supply; the new equilibrium labor supply is L_2. Associated with this further reduction is an additional excess burden or efficiency loss. This is given by the hashed trapezoidal area in the diagram.

This additional efficiency loss is termed the tax-interaction effect. It is the efficiency cost that stems from the carbon tax's functioning as an implicit tax on labor (or, more generally, on factors of production). It may be noted that the tax-interaction effect is more pronounced the higher are the pre-existing taxes on factors (or, in the diagram, the more distorted the labor market is initially).

3. Is a "double dividend" achievable?

How do the opposing revenue-recycling and tax-interaction effects balance out? Can the revenue-recycling effect fully offset the tax-interaction effect? That would imply that the overall cost of the revenue-policy is less than or equal to the "primary cost," or area A in the original diagram.

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[1] Early articles pointing out this effect include Pearce (1991), Oates (1993), and Repetto et al. (1992).

[2] Here I am referring to what is often termed the "strong" double dividend. The literature also defines a "weak" double dividend. The condition for the weak form is that a given environmental tax policy must involve lower costs when the revenues are recycled through cuts in pre-existing distortionary taxes than when revenues are recycled in a lump-sum fashion (for example, via fixed rebate checks). Goulder (1995) offers further analysis of the weak form.

[3] Early studies emphasizing this issue include Bovenberg and de Mooij (1994), Parry (1995), and Goulder (1995).

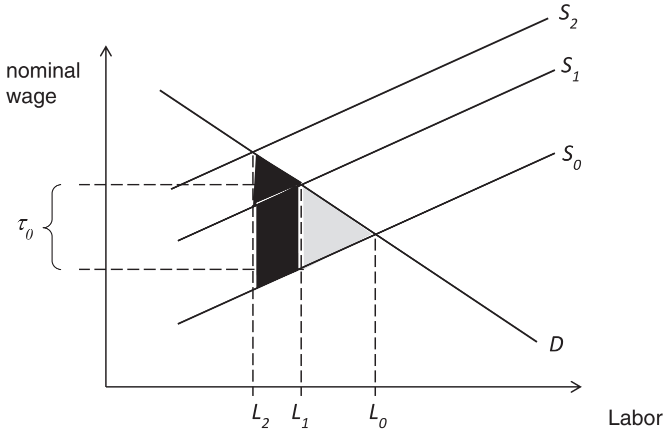

Fig. 2. The tax-interaction effect.

Table 1
Circumstances conducive to the double-dividend.

- Inefficient relative taxation of capital and labor
- Inefficiently light taxation of resource rents
- An informal labor market and associated inefficiently low taxation of informal labor income
- Significant positive relationship between environmental quality and labor productivity

An even more optimistic outcome would arise if the revenue recycling effect were large enough to offset both the tax-interaction effect and primary cost. In this case, the overall cost of the revenue-neutral policy would be negative. This is the case where the revenue-neutral policy yields the double dividend mentioned above: it not only yields environmental benefits but also lowers the cost of the tax system.

Is the double dividend likely? Work by several researchers – including Lans Bovenberg, Ian Parry, Roberton Williams, and myself – indicates that under relatively simple and "neutral" conditions, the double-dividend does not arise: the revenue-recycling benefit is not enough to offset both the primary cost and the tax interaction effect.[4] Under these conditions, the carbon tax is not a free lunch. However, even if it's not a free lunch, it still might be a meal worth paying for! The environmental benefits might well exceed the non-environmental costs.

Why might it be difficult to get the double dividend? The basic intuition is that the environmental tax is narrower than the tax it replaces. If one disregards the environmental dimension – and this is appropriate if one is focusing on the second, non-environmental dividend – it would be hard to justify replacing a broad tax with a narrow one. The narrower the tax, the greater the opportunities to adjust behavior and escape it. Such adjustments imply efficiency losses.

Further intuition is offered by the following. Consider a very simple setting: a closed economy with one factor of production — labor. Also, apply a static analysis — a one-period model. Finally, suppose that the initial situation is one in which the only tax was a tax on labor, say a labor income tax.

Now consider the impact of introducing a new tax at the margin in this setting, a uniform tax on consumer goods. Let the revenue from this new tax be recycled in the form of equal-revenue cuts in the pre-existing labor tax. In this case, the tax-interaction and revenue-recycling effects cancel. The reason is that in this simple world a commodity tax and a labor tax are really the same thing. The incremental commodity tax works to lower the real wage by raising *P*, the price index for goods and services. At the same time, revenue-recycling lowers the explicit tax on labor, which works to raise the real wage by increasing the after-tax nominal wage, *W*. The two effects cancel: the real wage is unaffected. Hence this revenue-neutral tax swap doesn't change labor supply or involve any cost to the economy. Indeed it has no economic or environmental impact. It doesn't cost the economy anything, but it doesn't yield any environmental improvement, either.

Now consider an alternative revenue-neutral tax policy, one that is more applicable to environmental protection. In the same setting as before (with one primary factor and a pre-existing labor tax), consider the impact of introducing a narrower tax rather than the broad-based commodity or income tax. Instead we introduce an environmentally motivated tax on a specific consumer good, like gasoline. As before, we recycle the revenue by cutting the existing labor tax. As in the previous case, the policy is revenue-neutral, but in this case the new tax is on a specific good.

In this case the tax-interaction and revenue-recycling effects do not cancel. As before, the new tax raises *P* while revenue-recycling raises the after-tax nominal wage *W*. But here a new "distortion" is produced. I put "distortion" in quotes because it's not a distortion if one accounts for the environmental benefits — but right now we're considering whether there's a cost in the other, non-environmental, dimension. There is an extra cost in this case because the gasoline tax "distorts" the price of gasoline relative to other commodities. Ignoring the environment (which is what we do when we focus on the second dividend), this hurts efficiency. Putting aside the environmental benefits, this revenue-neutral tax swap makes the tax system more costly because it introduces a cross-commodity distortion. The increase in the relative price of gasoline is a virtue in terms of the first dividend, but it works against the second.

The result has disappointed some advocates of green tax reform. It would be much easier to promote revenue-neutral green tax reform if it could be relied on to be a zero-cost option. However, the situation isn't entirely gloomy. In real-world economies, the double dividend can occur in some circumstances. The following are necessary conditions for the double dividend:

(1) The initial tax system must be inefficient along some non-environmental dimension, and
(2) The revenue-neutral tax reform reduces this non-environmental inefficiency.

These are necessary but not sufficient conditions. The reduction in the non-environmental inefficiency associated with revenue-recycling effect must be large enough to overcome both the tax-interaction effect and the primary cost.

Table 1 lists some of the circumstances that are conducive to the double dividend. The first pertains to the relative taxation of capital and labor. In some economies there is relatively inefficient relative taxation of capital and labor. Studies of the U.S. tax system provide much evidence that the marginal excess of burden of taxes on capital is significantly higher than the marginal excess burden of labor taxes. In such a setting, if the government introduces an environmental tax, say a carbon tax, and devotes the revenue to cutting capital taxes, the discrepancy is reduced. If the associated non-environmental improvement in the efficiency of the tax system is large enough, the double dividend is obtained.[5]

The second circumstance listed refers to the relative taxation of resource rents and other factors. In analyzing the prospects for a double dividend, Bento and Jacobsen (2007) start with the observation that a significant share of the burden of a carbon tax falls on

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[4] See, for example, Bovenberg and de Mooij (1994), Parry (1995), Bovenberg and Goulder (1997), Schöb (1997), Bovenberg (1999), and Williams (2002).

[5] For a detailed analysis of this issue, see Bovenberg and Goulder (1997).

resource rents. When a carbon tax is introduced and its revenues are used to finance cuts in labor taxes, the tax burden is shifted away from labor toward resource rents. Since the resources yielding these rents are inelastically supplied (that is the reason they generate rents), this shift works toward an improvement in the efficiency of the tax system. If the associated efficiency gain is large enough, the costs of the tax system can be reduced.

A third situation relates to informal labor markets. Because the informal sector faces no labor tax, there is a pre-existing distortion in the economy: labor in the informal sector is under-taxed relative to labor in the formal sector. A green tax can reduce this inefficiency by effectively raising the tax on informal labor and thereby reducing the disparity in the taxation of formal and informal labor. A carbon tax is a tax on both forms of labor because it raises the prices of goods purchased by both forms of labor. It thereby lowers the real wage to both forms of labor. If the revenues from the green tax are recycled through cuts in the tax on formal labor the net effect is that the wedge in the relative taxation of formal and informal labor has been reduced, and efficiency is improved. If the associated efficiency gain is large enough, the costs of the tax system can be reduced. Moreover, overall employment can increase.[6]

The fourth situation relates to the connection between environmental quality, health, and productivity. If, by improving the environment, an environmental tax makes workers healthier and more productive, then the tax can create gains in the labor market that can offset the costs described earlier. The double dividend can arise.[7]

The first three circumstances listed in Table 1 relate closely to the two conditions listed above: there is a pre-existing inefficiency in the tax system along some non-environmental dimension, and the carbon tax helps reduce this inefficiency. This improvement in efficiency needs to be strong enough to overcome the previously mentioned disadvantages of the carbon tax relative to the taxes it might replace. The fourth circumstance – a direct and positive connection between environmental quality and labor productivity – is a bit harder to subsume under the two conditions listed above. Instead of invoking a pre-existing non-environmental inefficiency, it draws attention to a new channel through which the carbon tax can contribute to the double dividend: namely, the channel connecting environmental quality and labor productivity.

A number of studies have employed general equilibrium simulation models to assess the double dividend. The simulations substantiate the theoretical claim that the double dividend will not arise in the absence of other, non-environmental inefficiencies in the initial situation. On the other hand, several studies confirm the potential for a double dividend when the revenue-neutral tax policy is designed to reduce the non-environmental inefficiencies. Lans Bovenberg and I managed to obtain the double dividend via a carbon tax with revenues devoted exclusively to cuts in prior capital income taxes.[8] However, we only obtained this result under unrealistic assumptions about capital supply elasticities (which magnify the inefficiency in the initial relative taxation of capital and labor). Under more plausible elasticities, the improvement in the relative tax treatment of capital and labor was not enough to offset the disadvantage of the carbon tax associated with its narrowness. Parry and Williams (2013) obtained the double dividend when the revenues are used to compensate for the revenue loss associated with the removal of initial tax-deductibility home mortgage payments and health insurance.

4. Fiscal interactions amplify the importance of policy design

4.1. The importance of exploiting the revenue-recycling effect

Economists often emphasize the idea that the choice of the type of policy instrument is critical to achieving emissions reductions at low cost. For example, they stress the importance of choosing emissions pricing instruments such as emissions taxes or cap-and-trade over more conventional approaches such as mandated technologies or emissions quotas.

Once fiscal interactions are taken into account, choosing emissions pricing over more conventional approaches does not guarantee cost-savings. Emissions pricing, whether in the form of a carbon tax or a system of tradable CO_2 allowances, can be very cost-effective or quite costly (and more costly than the conventional alternative), depending on the particular design. Introducing an emissions-pricing instrument can even lead to a loss of efficiency — the value of the environmental benefits can fall short of the non-environmental costs. Thus, while the choice of type of instrument is important, fiscal interactions imply that the particular design of the chosen instrument is critical as well.

Fig. 3 brings out the underlying issues. The figure is based on recent theory, though I will not present here the theory-based equations that underlie it. (See Parry (1997), Parry et al. (1999), and Goulder (1998) for technical analyses.) The horizontal axis in the figure is the extent of carbon dioxide abatement. Think of abatement as a function of the carbon tax rate or the price of emissions allowances. As you move from left to right in the figure, the increased abatement reflects an increase in the price of emissions.

Primary cost (area A in Fig. 1 above) rises with pollution abatement. The tax-interaction effect also increases with abatement. It has a positive intercept: given positive pre-existing factor taxes, the first unit of abatement has a strictly positive tax-interaction effect. When revenues from the emissions-pricing policy are recycled through cuts in the rates of pre-existing taxes, the revenue-recycling effect arises. The darker black line represents the overall cost at different levels of abatement: primary cost plus the tax-interaction effect minus the revenue-recycling effect. Except at the origin, this line lies above primary cost, in keeping with the idea that the revenue-recycling effect does not completely offset that tax-interaction effect.

The location of the dark black line in the figure is in keeping with the previous claims that under standard conditions the double dividend does not arise. To get the double dividend, the revenue-recycling effect would need to outweigh both the tax-interaction effect and primary cost. In that case, the dark line would be below the horizontal axis.

The figure can help illustrate the importance of policy design. One key design issue is whether and how to return any revenues generated by emissions pricing. Suppose the climate policy is a carbon tax with revenue dedicated to financing cuts in income tax rates. In that case, the policy engages the revenue-recycling effect. The overall cost is suggested by the black line. If instead the revenues are recycled lump-sum, for example in the form of a rebate to households, then there is no revenue-recycling effect. In this case, the overall cost is represented by the top line in the figure. The cost is considerably higher. The nature of revenue-recycling is very important to policy cost.

The cost difference can be very large. Parry and Williams (2010) show that the effects for reasonable sizes of carbon taxes are to raise the costs by over 35% if you return the revenues lump-sum rather than use the revenues to cut preexisting taxes. Despite the potential cost-advantages of recycling in the form of marginal tax rate reductions, some actual carbon tax policies involve lump-sum reductions. Under the carbon tax program implemented in the Canadian province of British Columbia in 2008, a large fraction of the revenues from the tax is recycled through rebate checks to households. This form of revenue-recycling may have had political attractions, but it

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[6] See Bovenberg and van der Ploeg (1998) and Koskela and Schob (1999) for analyses of the impacts of revenue-neutral green taxes on employment.

[7] For an analysis of this case, see Williams (2002).

[8] See Bovenberg and Goulder (1997).

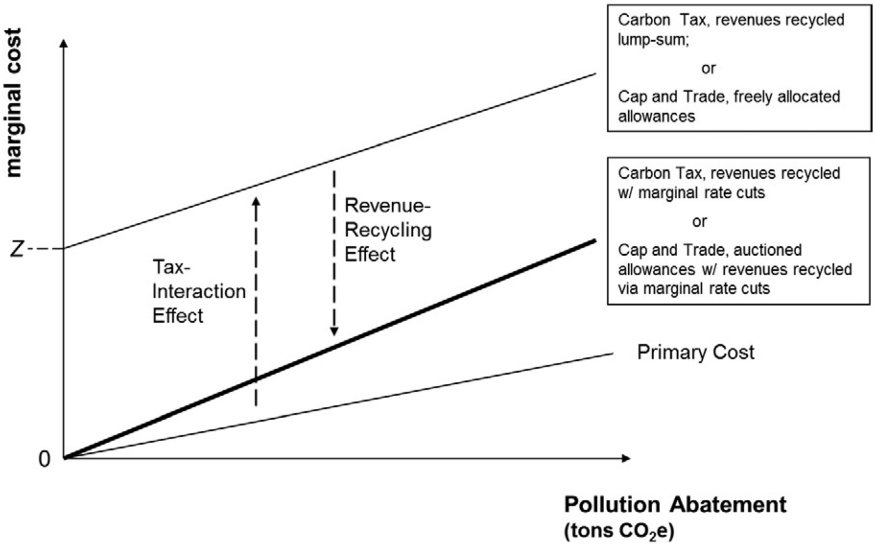

Fig. 3. Marginal costs of pollution abatement with general equilibrium effects.

almost certainly implies higher overall policy costs than would be the case if the revenue-recycling effect had been exploited; that is, if carbon tax revenues had been used to finance cuts in marginal tax rates.

The revenue-recycling effect is also critical to the costs of cap and trade. Consider first a cap-and-trade system in which all of the allowances are auctioned, and the revenues from the auction are used to finance cuts in the marginal rates of pre-existing taxes. As with a carbon tax, cap and trade introduces a tax-interaction effect, since it raises the prices of goods and services in general and thereby serves to lower real factor returns, abstracting from revenue-recycling. As before, the tax-interaction effect starts out at a strictly positive value (assuming positive pre-existing taxes) and increases with pollution abatement, that is, with the stringency of the cap. If the auction revenues are used to finance cuts in prior taxes, the policy also yields a revenue-recycling effect, which helps contain the policy costs. The dark black line represents the overall cost of the policy.

A cap-and-trade system with a different design would involve very different policy costs. If all of the allowances are given out free rather than auctioned, or if the allowances are auctioned but the revenues are recycled lump-sum, there is no revenue-recycling effect. In these cases the costs are considerably higher. The top line applies.

Exploiting the revenue-recycling effect is not only important for cost-effectiveness; it can even determine whether emissions pricing achieves an increase in efficiency — that is, whether it yields (monetized) environmental benefits in excess of the costs!

To see this, consider again Fig. 3. The point marked by *Z* in the figure is the intercept of the line for the tax-interaction effect. *Z* represents the magnitude of the tax-interaction effect for an initial amount of CO_2 abatement. Parry et al. (1999) estimate a value of about \$5.00 for *Z*. This number is important because it implies a critical value for environmental benefits. If the environmental benefit per ton at the margin from reducing emissions is below \$5.00, then any amount of reduction in emissions from cap and trade or a carbon tax will involve costs greater than the benefits if the revenue-recycling effect is not engaged. This would be the case with free allocation of allowances under cap and trade. When allowances are given out free, the marginal costs start at \$5.00 a ton and increase as abatement expands. Thus, unless the marginal benefits from CO_2 abatement are at least \$5.00 per ton for CO_2, a cap-and-trade program with free allocation is going to be efficiency-reducing: environmental benefits will fall short of cost.

On the other hand, if the cap-and-trade system involves recycling of the auction revenues through marginal rate cuts, the gross costs start at the origin, as indicated in the figure. Although the costs rise with the scale of abatement, they will be less than the value of the environmental benefits up to a point.

These considerations also have implications for the optimal carbon tax rate. The optimal (net-benefit-maximizing) environmental tax rate is the one that equates marginal costs and marginal benefits from abatement. Suppose the revenues from the carbon tax are recycled through cuts in marginal rates of existing taxes. Then, as indicated in Fig. 3, for any value of marginal benefits, there exists a level of abatement that equates these benefits with marginal costs (given by the solid black line). Assuming that abatement is directly related to the carbon tax rate, the optimal tax rate will be positive. If, in contrast, the carbon tax revenues are recycled lump-sum, the result is different. In this case, if marginal environmental benefits are below some critical value – the value represented by Z in the figure – then for any level of abatement the marginal costs would exceed the marginal benefits. Under these circumstances any positive carbon tax would be efficiency-reducing, and thus the optimum (conditional on lump-sum recycling) involves refraining from introducing the tax![9]

The general point is that the decision whether to exploit the revenue-recycling effect can determine the sign of the efficiency change associated with a given level of abatement or environmental tax rate. This underscores the notion that, after taking fiscal interactions into account, the design of policy instrument can be as important as the type of instrument chosen.

Goulder et al. (2010) have explored these issues numerically using a general equilibrium model of the U.S. That study examined how the impacts of a cap-and-trade system differ depending on the design of the system. Table 2 displays results from that study. In all cases considered, the overall cap was the same. The cap was imposed in 2009, required a reduction in emissions of about 3% within the first five years, and became increasingly stringent so as to require a 42% reduction after 20 years. The cap-and-trade systems considered differed in terms of the reliance on auctioning versus free allocation, and in the way any revenues are returned to the private sector.

The bottom row of the table shows the differences in GDP costs. The figures in that row represent the cost as the percentage change in the present value of GDP over the interval 2009–2030. Under

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[9] Bovenberg and Goulder (1996) examine this issue in detail.

Table 2
Implications of alternative emissions allowance allocation methods for profits and GDP.

Industry	100% auctioning		Profit-preserving free allocation				100% free allocation
	Marginal rate cuts	Lump-sum rebates	Marginal rate cuts		Lump-sum rebates		
Percentage change in profit[a]							
Coal mining	−28.7	−28.0	0	(3.2)	0	(3.2)	178.8
Coal-fired electricity generation	−28.4	−27.8	0	(3.2)	0	(3.2)	177.2
Petroleum refining	−4.7	−4.3	0	(0.7)	0	(0.7)	29.4
Chemicals	−3.2	−2.9	0	(2.4)	0	(2.4)	20.7
Primary metals	−3.5	−3.0	0	(0.8)	0	(0.8)	22.2
Railroads	−2.5	−2.0	0	(0.6)	0	(0.6)	15.6
Electric transmission/generation	−2.5	−2.0	0	(2.5)	0	(2.5)	15.5
Natural gas distribution	−2.8	−1.4	0	(0.3)	0	(0.3)	17.5
All industries above	−5.0	−4.5	0	(13.7)	0	(13.7)	31.6
All other industries	0.1	0.4	0.2		0.4		0.4
All industries	−0.2	0.0	0.2		0.4		2.7
GDP cost[b]	0.472	0.808	0.516		0.806		0.788

Source: Goulder et al. (2010).

[a] Percentage change in the present value of profit over the interval 2009–2030.

[b] Percentage change in the present value of GDP over the interval 2009–2030.

100% auctioning, GDP falls by .47% relative to the business-as-usual (no cap and trade) case when revenues are recycled through marginal rate cuts. GDP falls much more – by .81% – when auction revenues are returned lump-sum. The much higher costs in the lump-sum case reflect the absence of the revenue-recycling effect. The revenue-recycling effect is also absent in the case of 100% free allocation, which is displayed in the far-right column. Since the policy yields no revenue in this case, there is no opportunity for revenue-recycling. Here the costs are similar to the case of 100% auctioning with lump-sum recycling.

4.2. Trade-offs between cost-effectiveness and political feasibility

Design choices have important implications for firm profits. Table 2 also reports, for various industries, the percent change in the present value of profits over the same interval (2009–2030) under the different cap-and-trade policy designs. The cap on emissions causes firms to reduce output; this helps bring total emissions within the constraint implied by the cap. This restriction in output leads to higher output prices. When allowances are given out free, the higher prices yield rents that are retained by firms. This is why firms' profits under 100% free allocation are higher than in the absence of cap and trade. In contrast, when allowances are auctioned, the potential rents are obtained by the government in the form of revenues from the (competitive) auction. In this case, firms do not retain the rents and they experience losses in profits.[10]

The impacts on GDP and profits imply a trade-off between cost-effectiveness and political feasibility. Cost-effectiveness is enhanced through auctioning combined with recycling through cuts in marginal tax rates. However, profits of key industrial stakeholders are maintained or expanded through free allocation, which is much less cost-effective.

The cases of 100% auctioning or 100% free allocation are polar cases. The government has other, intermediate options: cap and trade can involve a mix of both types of allocation. The middle columns of Table 2 show the impact of an intermediate case. Here we examined what share of allowances would need to be given out free in order to preserve the profits of the most carbon-intensive industries. The numbers in parentheses indicate the share of total allowances that need to be given to the various industries in order to preserve the profits in those industries. To preserve profits in all of the listed carbon-intensive industries, the total allowances needed to accomplish this goal is 13.7% — a relatively small share of the total. This means that maintaining profits in these industries is consistent with auctioning over 86% of the allowances. Because a large percentage of the allowances can be auctioned, this profit-preserving case is not much more costly than the most cost-effective case of 100% auctioning, so long as the auction revenues are recycled in the form of cuts in marginal income tax rates. The cost is .52% of GDP, as compared with .47% in the most cost-effective case.[11]

4.3. Trade-offs between cost-effectiveness and distributional equity

Fiscal interactions also suggest a potential trade-off between cost-effectiveness and distributional equity. Consider this trade-off in the context of cap and trade. As indicated above, the most cost-effective cap-and-trade program is one in which all of the allowances are auctioned and the revenues are devoted to cuts in marginal tax rates. However, some might be concerned about the implications for such a policy in terms of distributional equity. Cap and trade would disproportionately raise costs of living for the lowest income households, for whom carbon- (or energy-) intensive goods and services occupy a larger share of the budget. Using the revenue from cap and trade to finance proportional cuts in marginal income tax rates would do little or nothing to undo this regressive impact.

One alternative is to focus the marginal rate cuts toward the households with lower incomes. Yet many of the lowest-income households are not part of the tax system and would be difficult to reach this way.

Another option is to use the gross revenues from cap and trade (with auctioning) to finance equal rebates to all households. Under such a design, every household would receive some fixed amount as a lump-sum. This way of recycling would do much more to offset the regressive impact of emissions pricing, since the rebate is larger relative to income for the lower income households. This may be attractive in terms of distributional equity, and indeed many policy analysts and

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[10] For a detailed analysis of this issue, see Bovenberg and Goulder (2001) and Goulder et al. (2010).

[11] This discussion has focused on exogenously specified free allocation as a way to preserve profits. Another approach – and one that has gained considerable attention recently – is free allocation based on the level of production. This approach is often referred to as output-based updating. Under this approach, a firm's share of the total freely allocated allowances depends on its production level, perhaps in the prior year. A cap-and-trade system with output-based updating maintains a price on emissions at the margin while effectively subsidizing output. To the extent that allowances are given out free, output-based updating fails to exploit the revenue-recycling effect, just as in the case where the extent of free allocation is specified exogenously. However, output-based updating can be employed to help maintain competitiveness of carbon-intensive, trade-exposed industries while encouraging those industries to reduce the carbon intensity of production. For analyses of output-based updating, see Fischer and Fox (2007) and Fowlie (2012).

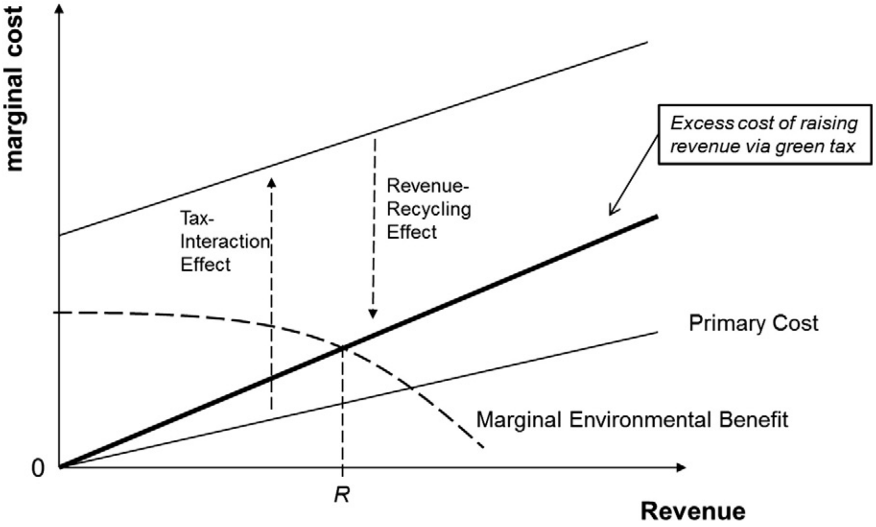

Fig. 4. Efficiency of raising additional revenue through green taxes.

decision makers have favored this approach. However, the analysis just presented indicates that there can be a very large efficiency cost for this method of recycling. One way to address the trade-off between cost-effectiveness and fairness is to pursue a hybrid approach: to devote a portion of the gross revenues toward some form of a rebate to the neediest households (thereby addressing distributional concerns), while devoting another share toward cuts in marginal income tax rates (thereby achieving some of the benefits in terms of cost-effectiveness). This aims to balance the competing concerns of cost-effectiveness and distributional equity.

5. How efficient is emissions pricing as a source for increased government revenue, relative to other revenue sources?

Now put aside case of a revenue-neutral policy, where the government is bringing in some revenue from cap and trade or an emissions tax and returning the revenues to the private sector. Consider instead the case where the government raises additional revenue to finance public-sector spending. In the U.S., concerns about growing debt have prompted many interested parties to search for new revenue sources. Some claim that a carbon tax or a cap-and-trade system with auctioned allowances is an especially good source for this needed additional revenue. They might claim that, in light of the environmental benefits, introducing a carbon tax or cap-and-trade system is a more efficient way to raise additional revenue than increasing “ordinary” taxes such as income, sales, or payroll taxes. Here I will include both a carbon tax and cap-and-trade system under the general label of “green tax,” since the two environmental policies have the same features relevant to the present discussion. And I will use the label “ordinary tax” to apply to income, sales, or payroll taxes. Is it more efficient raise additional revenue from green taxes than from ordinary taxes?

At first the answer might seem obvious. Optimal tax theory claims that in a world with environmental externalities, the optimal tax system involves both green taxes and ordinary taxes. From Sandmo (1975), the seminal paper on this issue, along with related optimal tax analyses, one might conclude that at least some of the additional needed revenue should come from a green tax.

However, the context here is different from the one to which optimal tax theory applies. In the situation we consider here, the government is not starting with a tax system that is optimal and the objective is not to reach the optimum. Here we are considering a realistic case where the tax system initially is sub-optimal and where the goal is simply to improve the efficiency of the tax system by incrementing either a green tax or some other tax.

Still, the answer to the question is that indeed it is more efficient to rely on green taxes rather than other taxes for the additional revenue — provided that the environmental tax is not “too large.” Fig. 4 illustrates this idea. The figure looks much like Fig. 3, except that the horizontal axis represents revenue from the green tax, rather than emissions abatement. On the assumption that a higher rate for the green tax leads to an increase in both revenue and abatement, the general shapes of the curves in the figure will be similar to those in Fig. 3.

For the moment, put environmental benefits aside. Recall that the revenue-recycling effect is the cost-saving at the margin from lowering ordinary taxes from their initial values. Hence it also represents the cost (at the margin) from raising ordinary taxes in order to gain additional revenue. And thus the difference between the costs of the green tax (with no recycling) and the ordinary tax is simply the revenue-recycling effect. Hence the dark line in the figure is the excess cost (ignoring environmental benefits) of raising revenue through the green tax instead of the ordinary tax. If there were no environmental gain from green taxes, it would be more costly to raise the additional revenue through such taxes.

However, once the environmental benefits are taken into account, the conclusion is different. Note that the thicker dark line emerges from the origin. Thus, for the first increment of revenue raised, the costs of the green tax are the same as those of the ordinary tax. The handicap of the green tax relative to the other tax starts at zero and rises with the amount of revenue raised (or amount of abatement achieved). This means that, for any strictly positive value of marginal environmental benefits, there is a range in which the cost disadvantage of the green tax (excluding environmental benefits) is more than offset by the green tax's advantage in terms of the environmental benefits. This will be the case so long as the amount of revenue raised is not too large. Suppose that the marginal environmental benefits from the emissions reduction are as suggested by the horizontal dashed line in the figure.[12] In this case, obtaining additional revenue via the carbon tax is less costly (at the margin) than raising it through the income

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[12] The dashed line is concave in keeping with the assumption that marginal costs of abatement increase with the extent of abatement. Under these circumstances, as the environmental tax increases, emissions reductions per unit of tax revenue will fall, implying that the environmental benefits associated with given increases in revenue are declining at the margin.

tax up to point *R*. Beyond that point, at the margin it is more costly to raise the revenue through green taxes.

6. How do fiscal interactions affect the choice between emissions pricing and other climate policy instruments?

In recent years there has been a lot of effort to devise some very interesting and original additional instruments besides simple command-and-control instruments like mandated technologies. One instrument gaining considerable attention and enjoying implementation in several U.S. states is a renewable portfolio standard (RPS), a type of intensity standard. An RPS requires that the fraction of power purchased by utilities represented by renewable sources (such as wind or solar power generation) not fall below the standard.[13] Thus, the RPS is a way to promote expanded demands for green power.[14]

Like a carbon tax, an RPS would encourage electric utilities to substitute away from fossil-generated electricity to non-fossil sources. However, economists tend to regard RPSs as inferior to a carbon tax in terms of cost-effectiveness, for two reasons. One is that under the RPS the incentive to switch to renewables ceases once the utility has met the standard. In contrast, the carbon tax provides a durable incentive. Second, under the RPS the utility is not taxed on the emissions from the brown power that it continues to purchase. In contrast, under the carbon tax the utility pays for the implied carbon emissions in the fossil-based electricity it continues to buy. As a result, the price of electricity is not pushed up as much under an RPS as under a carbon tax. In terms of cost-effectiveness, this is a limitation of the RPS because it means that the RPS does not fully engage the electricity conservation (demand reduction) as a channel for reducing emissions. It is not getting the price of electricity up to marginal social cost.

Thus, economists have not ranked the RPS at the top in terms of cost-effectiveness.[15] However, once again fiscal interactions change the picture. Once one accounts for fiscal interactions, the RPS can start to look better. The fact that the RPS raises electricity prices less than the equivalent carbon tax is a disadvantage in terms of stimulating conservation, but this is a virtue in that it implies a smaller tax-interaction effect. Since it raises electricity prices by less, it leads to a smaller increase in the overall price index. Hence it has a smaller impact on real returns to factors of production and thus a smaller tax-interaction effect. In current work, Goulder et al. (2013) show that this advantage can offset much of the other disadvantage of the RPS. In fact, this work shows that under some conditions – particularly when the initial tax system is very highly distorted, when the extent of the required emissions reductions is quite small, and when the carbon tax is narrowly focused on the electricity sector – the RPS can be more effective than the comparably scaled carbon tax.

Thus, the case for the RPS is somewhat stronger, once one accounts for tax interactions. At the same time, it should be recognized that only under some restrictive conditions is it likely to be more cost-effective than a carbon tax. The carbon tax can be applied economy-wide, and thereby pick more of the low-hanging fruit. In addition, even in the case of a carbon tax applied (like the RPS) only to the electricity sector, the carbon tax is more cost-effective when the required reductions in emissions are substantial; in this case the carbon tax's advantage in terms of promoting conservation dominates its disadvantage from generating a larger tax-interaction effect.

7. Conclusions

Climate change policy initiatives interact with the fiscal system. Recent research reveals that these interactions fundamentally influence the cost-effectiveness, distributional equity, and political feasibility of policy changes. This paper has presented several key findings from the recent literature.

The recent work reveals conditions under which a revenue-neutral carbon tax can produce a double dividend — both reduce greenhouse gas emissions and lower the costs of the tax system. By identifying the relevant conditions – involving the initial inefficiency of the tax system and some particular ways of recycling the revenues from the tax – the analysis helps improve the prospects for achieving this attractive outcome.

Recent studies also show that the design of a given climate policy instrument can be as or more important than the choice of type of instrument. Choosing a market-based instrument (such as cap and trade) offers no guarantee of achieving greater cost-effectiveness than a more conventional instrument (such as a mandated technology). Indeed, it offers no guarantee of an efficiency improvement. A great deal depends on whether the chosen policy yields revenues and how those revenues are returned to the private sector.

Analyses of fiscal interactions show that, taking environmental benefits into account, it is more efficient to raise new revenues with emissions pricing (a carbon tax or a cap-and-trade system with auctioned allowances) than through increments to existing distortionary taxes — so long as the scale of the revenue requirement is not too great.

Economists have tended to favor emissions pricing over other instruments for achieving greenhouse gas reductions. But recent research also indicates that fiscal interactions can improve the relative attractiveness of certain non-price climate policy instruments — in particular, the non-price instruments that produce relatively small tax-interaction effects.

Fiscal interactions complicate the analysis of the impacts of climate-change policies. The added complexity makes policy analysis more challenging. At the same time, the insights from the recent research help provide a useful compass for policy makers, indicating how the interactions can be exploited productively. The judicious combining of climate policy and tax policy instruments expands opportunities for addressing climate change while meeting other important social objectives.

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[13] Variants of the RPS (including the “clean electricity standard” proposed by President Obama in 2010) would also allow utilities to gain credit for purchases of natural gas, which is considerably less carbon-intensive than coal.

[14] In the U.S. today, 23 states have instituted RPS programs. In California, an RPS is included within the state's multi-faceted economy-wide climate change program, the Global Warming Solutions Act, which was promulgated in 2006.

[15] Like an RPS, a low-carbon fuel standard requires that the share of refiners' total fuel purchases represented by low-carbon fuels not fall below some stipulated minimum. Holland et al. (2009) show that, just as the RPS does not cause electricity prices to rise to electricity's social cost, the low-carbon fuel standard does not cause the price of the blended gasoline to rise to the social cost of gasoline production. The authors show that this inhibits the standard's ability to achieve reductions in gasoline use and greenhouse gas emissions.

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