Confronting the Adverse Industry Impacts of CO_2 Abatement Policies: What Does it Cost?

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Over the past decade, policy analysts have investigated several domestic policies to reduce carbon dioxide (CO_2) emissions and thereby address the risk of global climate change. One approach is a carbon tax. Another is a system of carbon permits or "caps," whereby supplies of carbon fuels or emissions of CO_2 are restricted to the amounts implied by the number of permits allocated to firms by the government. A third approach is the application of energy efficiency standards to industrial equipment and household appliances.

Economists tend to embrace the carbon tax, largely because it is seen as the most cost-effective approach to reaching the desired reductions in CO_2 emissions. Economists also find certain tradable carbon permits systems attractive in terms of cost-effectiveness—particularly systems under which permits are auctioned to firms rather than distributed free of charge. Yet these relatively cost-effective policies gain little political support. Indeed, carbon taxes and auctioned tradable carbon permits have been described as "political nonstarters."

The political resistance to these policies has many sources, but one key factor seems to be that their cost impacts are not spread evenly across the economy. These policies would place a large share of the economy-wide burden of regulation on the workers, managers, and stockholders of a few key energy industries. According to most studies, a carbon tax or system of auctioned carbon permits would significantly reduce profit and employment for producers of fossil fuels as well as industries that rely heavily on these fuels as inputs in the production process, such as electric utilities and petroleum refining. The uneven distribution of costs inhibits political feasibility, because the affected industries are well organized and can exert considerable political opposition.

Enhancing political feasibility might seem to require policies that avoid placing exceptionally large cost burdens on key energy industries. Yet, as discussed below, alternative policies that spread the burden more evenly can involve higher costs to the economy as a whole. Can CO_2 policies be designed that avoid placing especially large costs on key energy industries, without significant loss of cost-effectiveness, that is, without significant increases in overall costs to the economy? In this paper, I examine this challenge, drawing on recent work that I have undertaken in collaboration with Lans Bovenberg of Tilburg University (the Netherlands). Our initial findings suggest that the challenge can be met.

Winners, Losers, and Political Feasibility

Policies to reduce CO_2 emissions produce “winners” as well as “losers.” Under a carbon tax, for example, future generations would benefit to the extent that the tax helps reduce or prevent harmful changes to climate patterns around the globe. In addition, many producers, workers, and households in the current generation would benefit as well. For example, such a tax could boost employment and profits in industries that produce alternatives to conventional fossil fuels. Much of the rationale for a carbon tax derives from the idea that these benefits are likely to be greater in the aggregate than the costs that they might impose on others.

But the prospect of aggregate net benefits—what economists call an “efficiency improvement”—does not guarantee political feasibility. Even if benefits to winners exceed the costs to losers, the losers may be more mobilized politically and thus can dominate the outcome, thereby blocking political enactment. In particular, if the potential costs are concentrated (so that costs to each member of the losing group are substantial) while the potential benefits are diluted (so that gains to each member of the winning group are small), then the potential losers may be more likely to mobilize politically and thus may have a more powerful voice in the political process. In such circumstances, efficiency-improving policies will fail to be enacted.

This type of situation seems to apply to the carbon tax and to tradable carbon permits systems whereby the permits are initially auctioned rather than distributed free of charge. It may partly explain the significant resistance to these policies by the most politically mobilized stakeholders. How can alternative policies be designed to avoid this problem?

At first blush, the solution to this problem may seem simple: Simply offer financial compensation to address potential losses of profit or employment in the industries that might suffer serious hardship. Compensation could come, for example, in the form of tax cuts and transitional unemployment assistance. But compensation schemes can be costly. To the extent that the government uses up some of its revenues to pay compensation to certain industries, it will have to raise more revenue from ordinary taxes (such as income and sales taxes) to finance its other goods and services. These taxes create their own inefficiencies that reduce overall economic performance. Thus, offering compensation does not simply transfer wealth or resources from one group to another; it often reduces the overall level of output or income in the economy. It thus becomes important to consider not only how policies can be designed to avoid serious adverse impacts on key industries but also whether avoiding these impacts comes at a very high price to the economy as a whole.

Our initial research on these questions has generated potentially encouraging results. We find that it is possible to design CO_2 abatement policies that avoid significant financial costs to key energy industries without adding significantly to economy-wide economic costs. Through partial exemptions to the carbon tax, a very modest amount of "grandfathering" (or free allocation) of CO_2 emissions permits, or relatively modest tax breaks to the most vulnerable industries, the government can promote desired reductions in CO_2 emissions without harming profits of the most vulnerable energy industries and without significantly raising the cost to the economy as a whole.

Ways to Avoid Adverse Impacts on the Most Vulnerable Industries

Most discussions of a carbon tax center on an "upstream" tax, that is, a tax imposed at the point where carbon first enters the economy. This type of carbon tax is levied on fossil fuel suppliers and importers of fossil fuels, and the tax rate is proportional to the carbon content of fossil fuels. Similarly, under an upstream carbon permit policy, permits are given out to domestic fossil fuel suppliers and importers of fossil fuels. Each permit confers the right to bring a certain amount of carbon into the economy. Because CO_2 emissions are proportional to the carbon content of fossil fuels, limiting the supply of carbon entering the economy ultimately limits the amount of CO_2 that results from the combustion of fossil fuels or fossil fuel products.

An upstream carbon tax raises costs to fossil fuel producers and, to the extent that these costs are shifted forward, leads to higher prices for these fuels. An upstream permits system also leads to higher fuel prices because it restricts the supply of these fuels. Higher fuel prices, in turn, encourage consumers and industrial users to shift their demands toward goods and services that rely less on fossil fuels in their production. This system promotes reduced combustion of fossil fuels or refined products from these fuels, which implies reduced emissions of CO_2 relative to what otherwise would occur.

Each of these policies would cause fossil fuel producers to lose profits; these losses can be substantial. However, alternative policies can ease or entirely eliminate these losses.

A Modified Carbon Tax

Under the standard carbon tax, fossil fuel suppliers pay a tax on every unit of fossil fuel supplied. If each producer were granted an exemption from the carbon tax for some fixed amount of supply of fuel, then the burden of the carbon tax on firms would be lower. (The size of the exemption could differ by firm or fuel, depending on historical supplies and other considerations.) As long as fossil fuel producers still face the tax “at the margin” (that is, for the last units supplied), the modified carbon tax will have the same effect on fossil fuel prices, fuel supplies, and CO_2 emissions as the standard carbon tax while reducing the burden on the fossil fuel suppliers. However, while this modified tax helps fossil fuel suppliers, it offers no relief to “downstream” users of carbon, who do not pay the carbon tax in the first place. Additional measures (such as targeted tax breaks) would to be invoked to help vulnerable downstream producers, such as electric utilities and petroleum refiners.

Free Allocation of CO_2 Permits

An upstream CO_2 permit policy can be designed to avoid significant reductions in profit. Profit losses can be trimmed or avoided through the free allocation (as opposed to auctioning) of some or all of the permits. As with the standard carbon tax, under a permit policy in which all permits are auctioned, firms must pay for every unit of output supplied; they must purchase a permit that entitles them to each unit of output. In contrast, under a system of freely allocated permits, firms do not pay for each unit of output; instead, they pay (by purchasing additional permits) only for units of output beyond the level to which they were entitled in their initial permit allocation. Firms pay for output at the margin, but some “inframarginal” output or pollution can be supplied without charge. Hence, this policy imposes smaller costs on the regulated industries. Indeed, as discussed later, in some cases this policy could *benefit* the regulated industries by raising their profits substantially. Like the modified carbon tax, a carbon permit policy with free allocation to fossil fuel suppliers does not help downstream users of carbon. To help the most vulnerable downstream users, the government could offer these permits to such users (who would then sell the permits to upstream suppliers) or offer alternative forms of compensation, such as tax relief.

Corporate Tax Cuts

A third way to prevent concentrated costs on energy industries is to offer financial compensation through tax relief, such as corporate tax cuts. Such tax cuts could be directed to fossil fuel suppliers and to the most vulnerable downstream industries.

The Trade-off between Overall Economic Efficiency and a More Even Distribution of Costs

There are several ways to lessen or eliminate the adverse impacts on profits in key energy industries. But studies have suggested that avoiding these adverse effects on profits could raise the costs of CO_2 abatement considerably relative to the costs under the most cost-effective policies (the standard carbon tax or a system of auctioned carbon permits). The cost-effective policies bring in substantial revenue. In contrast, the modified carbon tax forgoes considerable revenue, and the system of freely allocated carbon permits brings in no revenue. Bringing in revenue enables the carbon tax to exploit a cost-reducing "revenue-recycling effect." This beneficial efficiency impact arises when revenues are used to finance cuts in rates of preexisting distortionary taxes such as income and sales taxes. The modified carbon tax exploits this effect less, and the policy of freely allocated carbon permits cannot exploit this effect at all. Thus, the government will be unable to exploit the revenue-recycling effect to the degree that it could under the standard policies, and the overall economic costs are higher.

The Good News

My recent work with Bovenberg does not contradict the idea of a trade-off: Our results support the idea that avoiding profit losses raises overall economic costs. However, we find that the cost increase is relatively small.

The basis for this finding is the observation that the potential revenues from CO_2 abatement policies are very large relative to the losses of profit that would occur in energy industries under the "standard" policies. Thus, only a small fraction of the potential revenues need to be sacrificed to fully compensate the most vulnerable firms. Under a modified carbon tax, the sacrifice is directly proportional to the size of the tax exemption for a portion of the fossil fuels supplied. Under a carbon permits scheme, the sacrifice occurs to the extent that some permits are given out free (or grandfathered) rather than auctioned. Under policies involving compensation through reductions in corporate tax rates, the sacrifice increases with the size of the tax cut. In all cases, the sacrifice is small, because the exemption, grandfathering, or corporate tax cut forgoes a small fraction (less than 15%) of the potential carbon revenues.

Table 1 offers a glimpse of how large the potential revenues from a carbon tax (or set of auctioned permits) might be compared with the potential losses of profit. (The values are intended to give a rough idea of the magnitudes involved; a more complex set of calculations is necessary to address the issues seriously. The numerical findings in the next section derive from a more comprehensive examination of the issues.) Gross output from the coal industry is about

$29 billion. A carbon tax of $25/ton, if introduced in 2000, would bring in about $11 billion in revenues in that year. This estimate is based on the idea that the tax would raise prices by about 57% and that coal output would fall by about one-third. By comparison, if the tax reduced after-tax profits in the industry by 30%, then it would cost the industry about $90 million. This cost to the industry, while large in absolute terms, is less than 1% of the value of the potential carbon revenues. Thus, only a small fraction of the revenues that potentially could be collected from the coal industry would have to be forgone to preserve the industry's profits.

Table 1. How Large Are Potential National Carbon Revenues Compared with Potential Profit Losses in the Coal Industry? Illustrative Calculations for the U.S. in 2000.

Potential national carbon revenues (in billions of 1997 dollars)	
Gross output of coal industry under status quo[a]	29.28
Estimated gross output after $25/ton carbon tax (assumes 33% reduction)[b]	19.62
Estimated potential carbon tax revenues ($25 per ton carbon × 0.0228 tons of carbon per $1 of fuel × $19.62 billion)	11.18
After-tax profits (in billions of 1997 dollars)	
After-tax dividends plus retained earnings under status quo[c]	0.33
Loss in earnings from $25/ton carbon tax (assumes 30% reduction)[d]	0.10
Loss in earnings as a percentage of potential carbon revenues	0.9

[a] Based on gross output in 1997, as published in Table 15 of U.S. Department of Commerce (1998). Gross output was projected to 2000 assuming a 2% real growth rate.

[b] Underlying assumptions: 55% price increase and a price elasticity of demand of 0.6.

[c] Based on average before-tax profits for 1990–97, as reported by U.S. Department of Commerce (1998). These figures were converted to after-tax values assuming an overall effective corporate tax rate of 35%.

[d] The detailed numerical model described in the text projects a loss of earnings of about 28%.

Why is the potential profit loss (or required compensation) small in relation to potential carbon revenues? Much of the cost of standard abatement policies—a carbon tax or auctioned carbon permits—is not borne by fossil fuel suppliers but instead is shifted to downstream firms (industrial users of fossil fuels) and to households that consume fossil-based consumer goods. In addition, the most vulnerable downstream firms, electric utilities and petroleum refiners, also shift a large share of their added costs to consumers. The cost borne by fossil fuel suppliers, electric utilities, and petroleum refiners is significant in absolute terms, but it appears to be small relative to the total amount of potential carbon revenue. Hence, the relative increase in cost to the economy is fairly small.

Numerical Findings

Bovenberg and I have been examining these issues using a general equilibrium numerical economic model of the U.S. economy with international trade. The model considers the interactions among the household, production, and government sectors as well as between various industries. The model generates paths of equilibrium prices, outputs, and incomes for the U.S. economy and the rest of the world under specified policy scenarios.

The model combines a fairly realistic treatment of the U.S. tax system and a detailed representation of energy production and demand. It enables us to examine interactions between energy-oriented environmental policies and the tax system. A distinctive feature of the model is its attention to the dynamics and rigidities associated with the installation and removal of industrial plants and equipment. This feature is crucial for understanding how new policies affect profits in various industries. (A detailed description of the model can be obtained from the author upon request.)

Table 2 displays results for policies that involve a $25/ton carbon tax or carbon permits that require approximately the same reductions in CO_2 emissions. It shows the effects on prices, output, and after-tax profits for 2002 (2 years after implementation) and 2025.

Standard Carbon Tax

The impacts of a standard carbon tax (that is, a $25/ton carbon tax with recycling of the revenues through cuts in the marginal rates of personal income taxes) are shown in Table 2. This policy is functionally the same as a policy involving tradable CO_2 permits, whereby the permits are competitively auctioned and the number of permits issued is such as to yield a market price of $25/ton. This carbon tax (or auctioned permit) policy does not include any provisions to soften the impacts on energy industries. Under this policy, the coal industry experiences the largest percent changes in prices and output. Coal prices rise by about 54% by the time the policy is fully implemented (2002), and the price increase is sustained at slightly above that level. The price increase implies an output reduction of about 23% in the long run. The other major impacts on prices and output are in the oil and gas, petroleum refining, and electric utilities industries.

Although the carbon tax is imposed on the oil and gas industry, the price increase is considerably smaller than in the coal industry, reflecting the lower carbon content (per dollar of fuel) of oil

Table 2. Industry Impacts of CO_2 Abatement Policies, 2002 and 2025.

	Percentage changes from reference case			
	Standard carbon tax	*Carbon tax with industry-specific corporate tax cuts*	*Carbon permits, partial grandfathering*	*Carbon permits, 100% grandfathering*
Gross of tax output price				
Coal mining	54.5, 57.0	54.3, 55.9	54.5, 57.0	54.5, 57.0
Oil and gas	13.2, 8.3	13.2, 8.3	13.2, 8.3	13.2, 8.3
Petroleum refining	6.4, 5.1	6.3, 4.7	6.4, 5.1	6.4, 5.1
Electric utilities	2.5, 5.5	2.5, 5.1	2.5, 5.5	2.4, 5.5
Average for other industries	–0.6, –0.7	–0.6, –0.6	–0.6, –0.7	–0.6, –0.6
Output				
Coal mining	–19.1, –23.3	–18.9, –21.9	–19.1, –23.3	–19.0, –23.3
Oil and gas	–2.1, –4.4	1.5, –0.4	–2.1, –4.3	–2.0, –4.2
Petroleum refining	–7.8, –5.3	–7.8, –5.0	–7.8, –5.3	–7.8, –5.4
Electric utilities	–3.0, –5.4	–2.9, –5.0	–3.0, –5.4	–3.0, –5.5
Average for other industries	–0.1, 0.1	–0.1, 0.1	–0.1, 0.1	–0.1, –0.1
After-tax profits				
Coal mining	–32.3, –25.5	–19.9, –12.0	–16.6, –10.4	542.7, 526.9
Oil and gas	–2.3, –3.9	–6.6, –9.1	1.3, –1.8	21.4, 9.4
Petroleum refining	–9.1, –3.6	–5.5, –0.9	–9.1, –3.6	–9.1, –3.8
Electric utilities	–7.4, –4.8	–5.2, –2.7	–7.4, –4.8	–7.5, –5.0
Average for other industries	–0.7, –0.7	–0.7, –0.7	–0.7, –0.8	–0.7, –0.9

Note: The carbon tax rate applied under the first two policies is $25/ton. Under the permits policies (the remaining two columns), the level of abatement is such as to yield a permit price of $25/ton. All policies are revenue-neutral. Policy-generated revenues (after compensation via corporate tax cuts, if applicable) are recycled through reductions in marginal rates of the personal income tax.

Source: Author's model (see text).

and gas compared with coal. The petroleum refining and electric utilities industries also experience significant increases in prices and reductions in output, reflecting the significant use of fossil fuels in these industries. The reductions in output are accompanied by reductions in annual after-tax profits.

Table 3 shows the impact of the carbon tax on equity values. In the model, equity values are the present value of after-tax profits (net of new share issues). Thus, the percent changes in equity values indicate the average percent changes in profit in the short, medium, and long term. The largest equity value impacts are in the coal industry, in which such values fall by about 28%.

The reductions in equity values in the oil and gas, petroleum refining, and electric utilities industries are much smaller but still substantial, in the range of 4.5–5.4%. The impacts on equity values of other industries are relatively small.

Table 3. Equity Value Impacts and Overall Economic Costs of CO_2 Abatement Policies.

	Standard carbon tax	*Carbon tax with industry-specific corporate tax cuts*	*Carbon permits, partial grandfathering*	*Carbon permits, 100% grandfathering*
Equity values of firms in 2000 (% change from reference case)				
Agriculture and noncoal mining	0.2	0.1	0.1	0.0
Coal mining	–27.8	0.0	0.0[a]	1,005.4
Oil and gas	–5.0	0.0	0.0[b]	29.2
Petroleum refining	–4.5	0.0	–4.5	–4.7
Electric utilities	–5.4	0.0	–5.4	–5.7
Natural gas utilities	–0.4	–0.3	–0.4	–0.8
Construction	1.5	1.8	1.5	1.0
Metals and machinery	–0.4	–0.6	–0.4	–0.5
Motor vehicles	0.2	0.2	0.2	0.1
Miscellaneous manufacturing	–0.1	–0.2	–0.1	–0.2
Services (except housing)	0.2	0.2	0.1	–0.1
Housing services	0.4	0.4	0.4	0.1
Total	–0.1	0.1	0.0	1.1
Efficiency cost ($)				
Per ton of CO_2 reduction	60.0	46.9	64.4	95.1
Per dollar of tax revenue	0.42	0.30	0.50	NA

Source: Author's model (see text).

[a] 4.3% of permits need to be grandfathered.

[b] 15% of permits need to be grandfathered.

The efficiency costs (which represent overall economic costs) listed in Table 3 are gross, rather than net, measures of economic impact because our model does not account for the benefits associated with the environmental improvement from reduced emissions. The standard carbon tax policy implies an efficiency cost of approximately $60/ton of emissions reduced, or $0.42 per dollar of discounted gross revenue from the carbon tax.

Policies that Address Distributional Concerns

Let us now consider policies in which distributional constraints are considered as the results for a $25/ton carbon tax accompanied by industry-specific corporate tax rate cuts sufficient to prevent equity values from falling in the coal, oil and gas, petroleum refining, and electric utilities industries (Tables 2 and 3). Any revenues from this policy remaining after financing the corporate tax cuts are used to finance cuts in the personal income tax, as under the previously considered policy. Table 2 shows that the impacts on prices and output under this policy are quite similar to those under the standard carbon tax. However, the profit or equity value impacts are very different—a consequence of the targeted cuts in corporate income tax rates.

What does this compensation cost? Model results suggest that this compensation does not add anything to the overall economic cost. Indeed, the overall economic cost is *lower* with this compensation than in the case of the standard carbon tax. As indicated in Table 3, the overall cost per ton is about $47 under this policy, whereas the cost would be $60/ton under the standard carbon tax. The reason is that, according to our analysis, the corporate income tax is an especially distortionary tax, which involves greater efficiency costs than the personal income tax. The compensation schemes introduced under this policy lead to reductions in this especially distortionary tax. (Other efficiency considerations apply here, including the potential of industry-specific corporate tax cuts to produce inefficiencies in the way productive capital is allocated across industries.)

Results are also presented from policies that involve carbon permits. To make these policies comparable with the carbon tax policies, the number of permits issued is such as to generate a permit price of $25/ton. The amount of abatement under these policies is very close to the amount under the carbon tax policies already considered.

In the “partial grandfathering” case, just enough permits are freely allocated (or grandfathered) to ensure that equity values do not decline in the fossil fuel industries (oil and gas production and coal mining). The impacts on prices and output are very similar under this policy to the effects under the previous policies (Table 2). However, because this policy enables fossil fuel producers to supply a portion of their output without charge, profits do not fall. As shown in the table, only small percentages of the permits need to be grandfathered: 4.3% of the coal industry’s permits, and 15% of the oil and gas industry’s permits. Together, these numbers imply that, overall, 10% of *all* of the permits issued (to domestic producers and to importers of fossil fuels) need to be grandfathered. Most of the permits can be auctioned, and thus the sacrifice in revenue is small. As a result, the added efficiency cost of neutralizing the impacts in these industries is fairly small as well. For example, the efficiency cost per ton of CO_2 reduction is $64.4, only 7% higher than the cost under the standard carbon tax.

The "100% grandfathering" permit policy involves free allocation of 100% of the CO_2 permits. This policy substantially overcompensates firms, causing equity values to rise substantially. In particular, the model predicts that coal industry equity values would rise by 1,200%! Because this policy sacrifices much more revenue, the efficiency cost is much higher: about $95/ton of CO_2 reduction, 58% higher than under the standard carbon tax.

In recent years, many policy discussions have focused on two tradable permit alternatives—auctioning all permits, and grandfathering all permits—but these cases are polar. Other, intermediate options might strike a better balance between the concern for cost-effectiveness and the desire to attend to distributional consequences and their implications for political feasibility. Under a program in which about 10% of the permits are grandfathered and the rest auctioned, for example, concerns about industry impacts (and political feasibility) can be met without greatly adding to the cost of CO_2 abatement.

Conclusions and Caveats

Overall, our results suggest that the potential adverse impacts on key energy industries can be avoided at fairly low cost. Under a standard carbon tax or carbon permit policy, key energy industries can shift a significant share of the burden of regulation to downstream industries and final consumers. The potential losses of profit are therefore small in relation to the potential revenues from CO_2 abatement policies. As a result, the amount of revenue sacrificed to avoid losses of profit in these industries is relatively small. Additional policy experiments support this idea. We obtain similar results when policies involve higher carbon taxes (up to $50/ton) and more extensive CO_2 abatement.

Some caveats are in order. First, our analysis focuses on the United States. The results might not transfer to nations with different characteristics of energy demand and supply or with different preexisting taxes or regulations.

Second, our research so far has considered only the fossil fuel, petroleum refining, and electric utilities industries. It is also important to consider impacts on other industries that might be especially vulnerable.

Third, the focus of this research is on preventing profit losses. It does not consider the expense of compensating labor for costs associated with job losses. This issue deserves close attention. Clearly, labor can have a significant political voice, and attending to employment impacts is highly relevant to political feasibility. A detailed analysis of this issue has yet to be carried out. However, the potential cost of compensating workers is suggested by the following. Suppose that the average worker rendered unemployed under the standard carbon tax policy of Table 2 would require the equivalent of 2 years of salary to be compensated for lost earnings and other costs associated with unemployment. Under this assumption, the results from the numerical model suggest that the cost of labor compensation would amount to about $2.8 billion. In comparison, $15 billion would be needed to compensate capital owners for potential profit losses under the standard carbon tax. Thus, compensating workers would not raise the policy costs by a very large fraction. It should be kept in mind that these values are an initial, rough estimate. In addition, it is important to note that unemployment can cause serious local economic disruptions; the costs of such disruptions are over and above the costs of compensating unemployed workers.

Finally, it should be recognized that the determinants of political outcomes are complex and difficult to gauge. Political feasibility depends on factors beyond maintaining profits and offering compensation for induced unemployment. Although the modified CO_2 abatement policies described here are likely to enhance political feasibility, they surely do not guarantee it.

Notwithstanding these qualifications, these results come as good news for people who wish to improve the political feasibility of CO_2 abatement policies. The price tag for doing so may not be high.

Suggested Reading

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