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# Allocation of $CO_2$ Emissions Permits: A General Equilibrium Analysis of Policy Instruments[1]

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What are the effects of different ways of allocating $CO_2$ emissions permits under a tradable permit scheme? Numerical simulations show that using the permit revenue to lower existing taxes implies by far the lowest welfare cost but also a large reduction in employment in energy-intensive sectors and substantial stranded costs. Grandfathering the permits compensates owners for losses on stranded investments but comes at a welfare cost and does not mitigate the adjustment imposed on the economy. Finally, distributing the permits according to market shares reduces the degree of sectoral adjustment but also comes at a high welfare cost. © 2000 Academic Press

## 1. INTRODUCTION

The concern for climate change presents policymakers with a serious challenge: Abatement of greenhouse gasses not only may prove very costly but it also affects many different interests. Politicians worry about the environment and cost-efficiency, and also about workers in particular industries and about stranded costs. Our analysis shows that introducing a system of tradable emissions permits may address several of these political concerns simultaneously.

Economists have long argued for using "market-based" instruments, such as taxes or tradable permits, in environmental policy rather than the more commonly used "command-and-control" regulation. The market-based instruments can, in principle, minimize the overall cost of a given environmental target by equalizing marginal abatement costs across sources. The program with $SO_2$ permit-trading enacted in the United States under the Clean Air Act amendments of 1990 is so far the most extensive example of a new market-based direction in environmental policy. The success of this and other similar policy designs provides some basis for the belief that environmental policy is changing course toward instruments that to a greater extent exploit the efficiency of markets.

Efficiency will only be one concern for policymakers, and the design of any future $CO_2$ policies will also reflect other concerns such as worker displacement and stranded costs. A tradable permit system may in practice be preferred to a

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uniform tax on $CO_2$, precisely because it entails an opportunity to address such concerns by means of permit disbursements.[2] For example, compensating affected firms by "grandfathering" permits to the electric utility industry was an important element for the political feasibility of the Clean Air Act.[3]

Similarly, a host of factors, including distributional effects and the clout of various interest groups, will affect the political feasibility of a given rule for allocating $CO_2$ permits. As distributional and political economy issues typically have received little, if any, attention in numerical analysis of $CO_2$ abatement policy, the results have only provided limited insights. The aim of this paper is to quantify effects on some political concerns that are important for the design of a tradable permit scheme. Specifically, we analyze the effects of three alternative permit allocation methods that all achieve the Danish national target, a reduction in Danish $CO_2$ emissions to 80% of the 1988 level by the year 2005.

Current Danish $CO_2$ policies combine command-and-control regulation, e.g., technology mandates, with non-uniform taxes on $CO_2$ emissions. Consequently, incentives to reduce emissions differ widely throughout the economy. Svendsen [24] argues that these policies are inadequate to achieve the abatement target and instead proposes a tradable permit scheme to replace the current policies. This would, he argues, eliminate the current non-uniformity of marginal abatement costs and reduce total abatement costs.

We analyze this proposal and compare the following three permit allocation rules. One is where the government auctions the permits and uses the revenue to reduce taxes on labor income. The second is where the permits are grandfathered, i.e., given away once and for all to incumbent firms. The third is the output-based allocation method, where permits are given to firms in proportion to their market share on a rolling basis. We implement the three instruments in a numerical general equilibrium model calibrated to represent the Danish economy and estimate effects of the Danish $CO_2$ target on efficiency, $CO_2$ leakage, employment, and stranded costs.

Using the permit revenue to lower existing taxes implies by far the lowest welfare cost, but it also implies a large negative shock to domestic energy-intensive production. This implies significant stranded costs and a large reduction in employment in energy-intensive industry. Giving the permits to incumbent firms (over)compensates owners for losses on stranded capital investments, but this comes at a higher welfare cost and does not mitigate the adjustment imposed on the economy. Finally, giving the permits to firms in proportion to market shares and sectoral emissions reduces the adjustment that the economy goes through, but it also comes at a high welfare cost.

Cramton and Kerr [5] analyze the distributional implications of allocating $CO_2$ permits through auctions rather than through some form of grandfathering. They argue that auctioning is superior because it increases efficiency by reducing existing tax distortions, provides greater incentives for innovation, gives more flexibility in distribution of costs, and reduces the need for politically contentious

[2] See Stavins [23] for a discussion of the political economy lessons that can be learned from the $SO_2$ permit-trading program. Stavins points out that wherever tradable permits have been adopted, the initial allocation of permits has always been through grandfathering rather than through auctions or other methods.

[3] Burtraw [4] makes this point and stresses the trade-off between efficiency and compensation that policymakers faced in the design of the $SO_2$ program.

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