12. The Distributional Effects of Carbon Regulation: Why auctioned carbon permits are attractive and feasible

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1. INTRODUCTION

The United States, the European Community, Japan and many other OECD countries agreed to restrict their carbon emissions to, on average, five percent below 1990 levels by 2008 – 2012 (subject to ratification) at the Climate Change Summit in Kyoto in December 1997. Binding domestic regulation is now a real possibility in the US and elsewhere.

Short-term policies in the US, including voluntary agreements, subsidies to energy-efficiency research and information programs, have been implemented since the Rio Conference. None of these is capable of controlling carbon emissions to the levels required. In fact, Department of Energy figures reveal that from 1990 levels U.S. CO2 output had climbed nine percent by 1997. Further, they project that the increase will hit 14 percent by 2000. More effective, efficient policies are necessary for real progress on climate change. How can these best be designed?

CO2 is the major current contributor to climate change. It is released whenever fossil fuels are burned and sequestered in the growth of trees. How can we reduce our consumption of fossil fuels at lowest cost? The major option for the United States, being discussed in Washington, is a tradable permit program, following in the footsteps of the successful acid rain trading program. European countries have traditionally proposed (and some have implemented) carbon taxes. In this paper we consider the distributional implications of these options and how they depend on the allocation of permits. We then show that auctioning permits is feasible. This means that a permit market can mimic a tax on both efficiency and equity grounds.

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The regulatory options we compare are a comprehensive carbon tax and an optimally designed, comprehensive carbon permit system with either auctioned or grandfathered permits. CO2 is a uniformly mixed pollutant with an extremely long lifetime in the atmosphere. For this paper, we assume that the tax or permit system regulates carbon at the level of oil refineries, natural gas pipe lines, natural-gas liquid sellers, and coal processing plants. This creates a comprehensive, administratively feasible system. Carbon emissions in all sectors of the economy will be indirectly controlled. From an environmental standpoint, neither the timing of emissions nor their source is important. Thus, permits are ideally defined in a homogeneous way over time and space. Permits allow a one-time use of one metric ton of carbon. They can be banked indefinitely for use in later years. Ideally permits would be fully tradable internationally. Trade in the secondary permit market is completely unrestricted.

In the US, the political debate over permit markets focuses on how to allocate the permits. Powerful vested interests in the energy sector (electric utilities, coal, and oil companies) are already lobbying that the permits be allocated to them in a way related to historical output. In countries that are considering tax systems, the equivalent debate is over exemptions from the tax. The permit debate only affects distribution. The vested interest group pressure on taxes has major efficiency implications if they lead the tax to be non-comprehensive, as all current carbon taxes are.

In a permit system, periodic auctions of permits are a simple and highly efficient alternative to grandfathering permits to vested interests. As with a carbon tax, auctions have the benefit that the revenue from the auctions can be refunded through tax cuts to all citizens. This 'revenue recycling' means that polluters are effectively buying the right to pollute from the public. If the target of six percent below 1990 emissions by 2010 is implemented, 1 260 million metric tons of permits will be issued each year in the United States (EIA 1997 Annual Energy Outlook). The marginal cost of this target will be in the range $25 to $150 if current estimates of the cost of carbon regulation are correct. If the marginal cost, and hence the permit price, is $100 per metric ton, an efficient auction could raise $126 billion annually. This is around two percent of GNP and around ten percent of federal receipts in 1995. If permits are grandfathered, a ten percent reduction in taxes will be foregone.

An active group of researchers is estimating the aggregate costs of carbon dioxide policy, both domestically and globally, and the optimal aggregate path for carbon emissions. Researchers have worked less on how to achieve those emissions paths. The arguments for carbon permit auctions have not been comprehensively addressed. Parry (1995) addresses the advantages of revenue recycling. Milliman and Prince (1989) have addressed the effects of regulatory form on incentives to innovate. In the context of the Acid Rain Program, Van Dyke (1991) argued that fairness required that SO2 allowances be sold rather than given out for free. Researchers have considered the serious design problems in the SO2 auction and its effects on the operation of the auction and market (Cason 1995; Cason and Plott 1996; Joskow, Schmalensee and Bailey 1997) in previous work on environmental auction design. They have not considered the design issues in carbon permit auctions.

We begin by discussing the arguments in favor of auctioning permits or taxing rather than grandfathering permits. Then we describe how carbon permits should be auctioned. In the case of carbon we conclude that the arguments, for auctions or taxes rather than grandfathering, on efficiency and equity grounds, are overwhelming. The ability to achieve identical efficiency and distributional outcomes with either auctioned permits or taxes provides greater regulatory and political flexibility. We conclude that, in a permit market, bankable, identical permits should be auctioned on a quarterly basis using a standard, ascending-clock design.

2. WHY COLLECT THE SCARCITY RENTS RATHER THAN GRANDFATHERING THEM?

Carbon regulation makes carbon a scarce resource and hence creates scarcity rents. Figure 1 illustrates, in a simple way, how the price of fossil fuels, and of goods directly or indirectly produced using fossil fuel, must rise to reduce the total demand for fossil fuel. This figure assumes only one fossil fuel, and that it is sold directly from producers to the ultimate consumers. $\underline{Q}$ is the carbon cap translated into a fossil fuel cap. The price buyers pay for the representative fossil fuel rises from P_0 to P_D and the price sellers receive falls to Ps. The permit price or tax is the difference between these prices.

These price changes occur under any efficient form of carbon regulation. The constraint on the quantity of fossil fuel (carbon) used creates a scarcity rent, the lightly shaded area in Figure 1. The regulatory design determines who receives these rents.

If permits are auctioned, or a tax is used, the government receives these rents on behalf of taxpayers. Alternatively, in a permit system, the government could give the permits away to specific groups. This alternative is known as ‘grandfathering’. The government could allocate permits on the basis of past usage, on some measure of output, or to politically favored groups. The US has mostly chosen this option. Prominent examples are the Acid rain program, the phasedown of lead in gasoline and the Reclaim program in Los Angeles. The traditional view in the United States is that grandfathering, while inefficient, is chosen because it provides greater political control over the distributional effects of regulation (Stavins 1997). Examples of auctioned permits are new quota allocations in the New Zealand Individual Transferable Quota system for fisheries, the FCC auctions of the telecommunications spectrum in the US, and radio spectrum auctions in New Zealand. In Europe, taxation is generally the instrument chosen for environmental regulation.

We argue that auctioned permits or taxes are superior to any form of grandfathered permits, because they allow reduced tax distortions, provide more potential flexibility in distribution of costs, and reduce the need for politically contentious arguments over the allocation of rents. In addition, grandfathering has no effect on the 'competitiveness' of the industry that receives the permits. We recognize that these arguments do not mean auctions will be chosen in the US or elsewhere. We argue however that they may be more compelling in the case of carbon than they have been in SO2 and other programs, and therefore may overcome the US political economy problems.

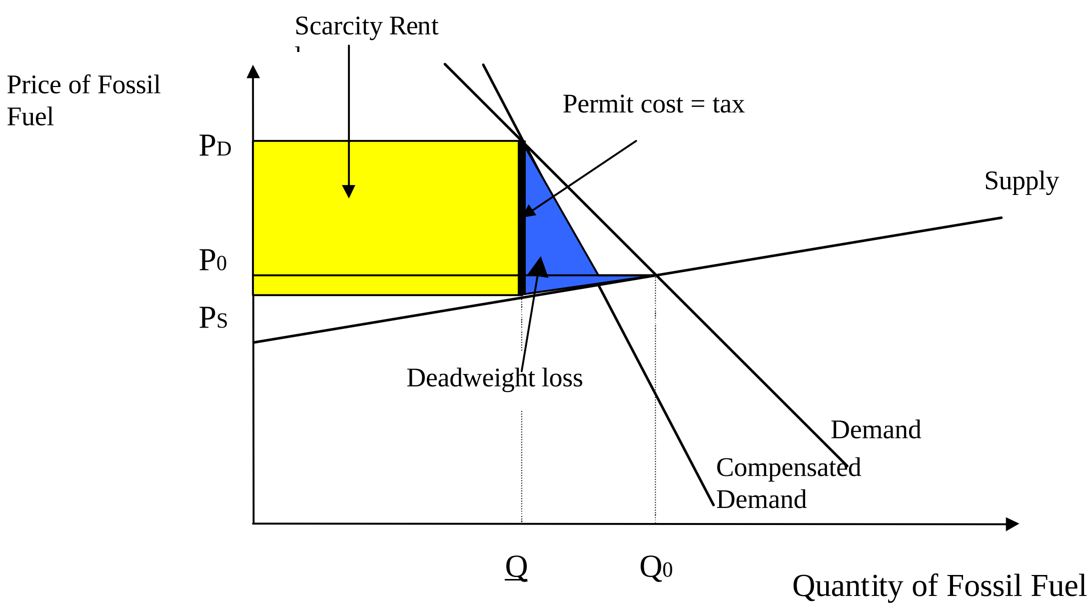


Figure 1. Price, scarcity rent and deadweight loss from carbon regulation

2.1 Reduced Deadweight Loss from Revenue Raising

Carbon taxes and auction revenue can replace distortionary taxes. Distortionary taxation creates a deadweight loss by inserting a wedge between marginal cost and price. The rise in marginal cost from carbon regulation implies a real cost of carbon regulation equivalent to the deadweight loss from distortionary taxation (see Figure 1 above). This unavoidable real welfare cost corresponds to a loss of US output estimated to be on the order of 0.8 percent of GDP which would have been $60 billion in 1995 (Repetto and Austin 1997). At the same time, in the US, the regulation of carbon creates scarcity rents on the order of $126 billion.

Careful use of this scarcity rent can significantly lower total costs. Ballard, Shoven and Whalley (1985) estimate that each additional $1.00 of government revenue, raised through distortionary taxation, costs society $1.30. If we can gain revenue with no additional distortion, by auctioning rather than grandfathering, we can achieve significant efficiency gains. The revenue raised in the auction could be used to cut taxes and reduce the deficit. If the auction raises $126 billion annually, compensating tax cuts could increase US GNP by up to $40 billion. Parry, Williams, Burtraw and Goulder (1997) estimate that, if the emissions reductions are less than 23%, grandfathering permits, and hence losing the value of revenue recycling, would double the cost of regulation relative to a tax or auction system.

One criticism of the efficient revenue raising argument is that government spending is not exogenous. Private sector actors often express concern that government will not use the revenue well. Raising revenue through carbon taxes or auctions may not lead to equivalent tax cuts. Preliminary work by Becker and Mulligan (1997) suggests that more efficient tax systems are associated with larger governments. If this is the case, the efficiency gain from auction revenue will depend on the actual size of the tax cuts and what is done with the additional government spending. With revenue of around $126 billion annually, Congress may be forced to use the revenue in transparent and hence relatively socially beneficial ways.

2.2 The Distributional Effects of Carbon Regulation

The distributional effects have two parts, the effects that arise through changes in prices and returns to factors, and the wealth effects of changing ownership of a resource. Ownership is being transferred from the commons to either the taxpayer, under taxes and auctions, or the recipients of grandfathered permits. The price effects, which are the most complex effects, are the same regardless of the form of carbon regulation. In particular, they are unaffected by whether permits are auctioned or grandfathered. The aggregate distributional effects depend on the sum of price and wealth effects.

2.3 Who Bears Taxes / Regulatory Costs?

Three groups ultimately bear costs: consumers, workers (owners of human capital), and capital owners, especially current owners of physical capital. Consumers suffer loss of consumer surplus, workers suffer a fall in income, and capital owners suffer a fall in the value of their capital. The legal incidence of the regulation does not affect prices or cost bearing.

Increased costs, due to the need to purchase a permit or pay a tax, are passed forward to consumers, and backward to factor suppliers, capital owners and workers. How the prices throughout the economy adjust depends on the elasticities of supply and demand at all levels in the economy. Prices will rise most where behavior is most inelastic. In Figure 1 we illustrate one possibility. The relatively inelastic demander faces a large price increase while the elastic supplier only suffers a small price decrease. Given a set of consumption price changes, consumers will bear costs in proportion to their expenditures on goods produced using fossil fuels.

In the short run, fossil-fuel specific capital stocks such as oil-fired electric utilities, and the human capital and location of workers in industries such as coal mining, will tend to be inelastic. Thus capital owners and workers will suffer high short term costs. How these price changes translate into distributional effects depends on the distribution of ownership of physical and human capital. The effects on physical capital will be diffused across many shareholders when the companies are publicly owned. The effects on workers tend to be heavily concentrated in relatively few individuals and communities.

In the long run, capital is mobile and workers will make appropriate choices of education and location. This will lower their costs as well as total costs. How long this requires depends on the rate of obsolescence of capital and how quickly individuals and communities can adjust. The outlook for some coal mining areas is not promising. After capital and labor have adjusted, consumers bear the ongoing costs of carbon regulation.

3. WHAT DOES THE EMPIRICAL EVIDENCE SHOW?

All current US models of carbon tax incidence assume that the tax is fully passed through to consumers. Jorgenson, Slesnick and Wilcoxen (1992) use a general equilibrium model to consider the lifetime incidence of carbon taxes through all possible channels. Dowlatabadi, Kopp and Tschang (1994) allow for partial equilibrium responses to energy prices but consider only effects on fuel prices not on products that indirectly involve fuel use. Casler and Rafiqui (1993) consider the relative expenditure shares directly devoted to energy across the expenditure distribution. They also use an input-output framework to estimate indirect incidence through the purchase of goods produced using energy. Poterba (1990) looks simply at the relative expenditure shares on energy products.

All the models agree that the impact of the tax will be relatively, but not dramatically, regressive. The indirect effects tend to reduce the regressivity. Consumer incidence varies significantly by region. The Midwest bears the highest costs; the Pacific States bear the lowest. These models say nothing about loss of capital income and therefore loss of capital value. To do this a model would need to identify the mobility of capital in specific industries, and the owners of capital. None of the models say anything about the effects of carbon regulation on labor markets.

A number of studies of distributional effects have been done for other OECD countries using a variety of methodologies. These include Cornwell and Creedy (1996) in Australia, and in Europe, Johnson, McKay, and Smith (1990), OECD (1995), Smith (1992), and, in this volume, new work by Barker and Köhler. The weak regressivity of carbon regulation appears to hold across countries and modeling techniques.

Identifying the cost distribution is a non-trivial exercise. The empirical evidence suggests that costs will be slightly regressive across consumers. Theory suggests that carbon regulation will reduce the income of shareholders in parts of the energy sector, and will have impacts on immobile workers in the energy sector. Clearly more research is needed to clarify these relative effects on individuals.

3.1 How do the Distributional Effects Depend on the Choice of Auctioned Permits/ Taxes vs. Grandfathered Permits?

The effect of regulation through consumer prices and factor returns distributes costs in the same way in a tax or auctioned permit program as in a grandfathered program. All efficient forms of regulation lead to a distribution of costs that is determined by general equilibrium cost incidence, factor endowments and consumption patterns. Those heavily dependent on fossil fuels in their consumption patterns or for capital or wage income will bear more costs. Groups that respond significantly and rapidly to the pressure to reduce fossil fuel use will be rewarded by lower shares of costs. The wealth effects from grandfathering and the use of tax/auction revenue determine how the ultimate distribution of costs varies among the options.

Auction/tax revenue can be used in a multitude of ways benefiting many different groups. Labor, consumption, payroll or capital gains taxes could be cut. The deficit could be reduced. Expenditure could be targeted at afflicted workers and communities to compensate and assist during the transition to a less carbon intensive economy. Only the political process and the normal constraints on redistribution limit the flexibility of compensation under auctions. In addition, the revenue-recycling benefits reduce total costs.

In contrast, grandfathering permits redistributes wealth only to shareholders. Only those who directly receive permits gain because it produces a pure wealth effect. Grandfathering is usually used to compensate some current owners of specific capital. These owners can be adequately and more efficiently compensated, through targeted tax breaks. These not only provide direct compensation, but also increase the efficiency of the industry by reducing tax distortions. It would be theoretically possible to grandfather the permits to a wide range of workers, consumers and capital owners. This would be costly and complex to administer however, and would forsake the efficiency benefits of a tax/auction program that returns the revenues through broad based tax cuts.

Taxes and auctioned permits are more likely to lead to equitable outcomes than grandfathered permits. Cost bearing is widely spread and, in the long run, all costs are borne by consumers. Therefore compensation should also be widely spread. Poorer people tend to be workers and consumers more than they are shareholders, so they are unlikely to benefit from grandfathering.

3.2 ‘Competitiveness’ and Grandfathering

Within Europe, many believe that if US firms are grandfathered carbon permits rather than having to buy them in auctions, they will have a competitive advantage vis a vis European firms which are likely to face carbon taxes. Some in the US believe the same. This is based on a misunderstanding of permit markets and grandfathering.

Grandfathering gives permits to firms based on past behavior, not current or future. If a firm increases its production to export more, and uses more carbon in doing so, it must either pay more tax, or it requires more permits. If permits are auctioned, it will need to buy more or draw down banked reserves. If permits are grandfathered, it will need to use up some of the stock it holds. In every case, the opportunity cost of increasing output is the cost of the permit or equivalently, the tax. If the firm reduces production, it saves the opportunity cost of the permit price, it avoids the tax or need to buy permits, or can sell the permits it was grandfathered. The grandfathering of permits makes the owners of the firm wealthier, but does not change their marginal production costs.

In fact, the US economy as a whole will be disadvantaged if grandfathering is used because of the loss of efficiency gains that could be achieved through revenue recycling. This will lower US productivity and make it harder for US firms to compete.

3.3 How to Design Carbon Permit Auctions

Government often has two goals when designing an auction, first to allocate the permits efficiently, and second to maximize its revenue. Fortunately, these goals are closely aligned. An efficient auction will raise substantial revenues.

3.4 What is a 'Carbon Permit'?

With carbon permits it is easy to define the items being auctioned. Each permit is for one metric ton of carbon usage. Oil refineries, natural gas pipelines, natural-gas liquid sellers, and coal processing plants require permits. All permits are the same after their date of issue, and permits are bankable; that is, a permit issued for the year 2000 can be used in any later year. There is no environmental loss in making permits bankable. Current carbon emissions are reduced to the extent that permits are banked. Given the long life time of CO2 in the atmosphere, short term voluntary banking is unlikely to have significant impacts on CO2 concentrations.

Permits can and should be auctioned not only for the current years but also for future issue years. Thus, some permits for 2012 could be auctioned in 2008 even though they cannot be used to offset carbon emissions until after 1 January 2012. Early auctions would facilitate the development of an active futures and options market, thus improving risk allocation.

The homogeneity and bankability of permits makes the auction and secondary market very liquid. The more liquid the issue is, the lower is the transaction cost. Illiquidity not only costs the seller money, but it also reduces auction efficiency. Illiquidity increases the risk that some bidders may have market power in certain circumstances.

Market power should not be a concern in an auction for carbon permits. Even in an upstream program, there would still be more than 1,700 permit buyers. Most importantly, even the largest buyers would constitute just a tiny fraction of the market, as is seen in Table 1. Table 1 shows the shares of permits each part of the energy sector would have demanded if an upstream permit market had been introduced in 1995. No one firm will control more than 6% of the market. In addition, in the active secondary market many more buyers will participate as speculators. It is inconceivable that any party would be successful in exercising substantial market power in the US market for carbon permits. This may not be true in smaller countries with more concentrated industries. Still, substantial distortions from market power are unlikely even with only a few traders (Tietenberg 1985), and will disappear completely with trading among developed countries.

3.5 Ways to auction many identical items

Auctioning many identical items is a common, relatively well understood situation. In the permit market setting, a seller is offering a fixed supply of identical items. The buyers submit bids at auction to express their willingness to buy various quantities at various price levels. Auctions need to be held frequently enough to reduce cash flow problems and ensure that firms will have a good idea of their likely needs. Quarterly auctions, as in Treasury auctions, would suffice. Of course, with an active secondary market, firms can buy almost any quantity of permits at any time.

We first discuss the more familiar sealed-bid auctions. We then explain the advantages of ascending-bid auctions, and specifically the standard ascending-clock auction.

3.6 Sealed-Bid Auctions

In sealed-bid auctions, the bidders simultaneously submit demand schedules. The auctioneer adds these demand schedules to form the aggregate demand curve.

Table 1. Carbon permit needs across US firms - direct permit market players

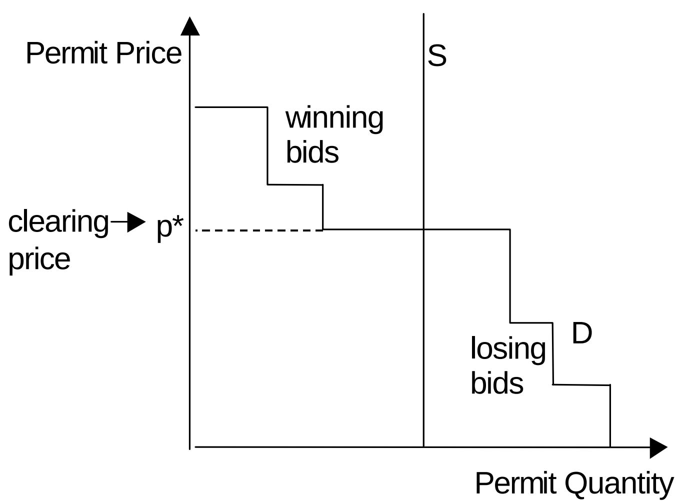
Carbon User	Total Carbon produced in 1995 (million metric tons)	% of permit market
Oil Industry[2] (175 refineries)	436	31.1 %
Largest Oil Company (Chevron)	31.1	2.3%
Second largest (Exxon)	28.7	2.0%
Largest 10 oil companies	226.7	16.2%
Coal Industry[3] (550 coal preparation plants)	610	43.5 %
Largest Coal Producer (Peabody Holdings)	79.3	5.6%
Largest 3 companies	158.6	11.2%
Natural Gas Industry[4] (250 natural gas pipeline companies and 725 natural gas processing plants)	356	25.4%
Total	1402	100%

[2] U.S. Department of Energy, Energy Information Administration. (1996)
[3] U.S. Department of Energy, Energy Information Administration (1997)
[4] U.S. Department of Energy, Energy Information Administration

A sample demand curve appears in Figure 2. The intersection of the aggregate demand curve and the supply curve determines the clearing price. All demands above this clearing price are filled, those at the clearing price are rationed, and those below are rejected.

The two most common pricing methods are uniform pricing and pay-your-bid pricing. Under uniform pricing, each winner pays the clearing price p* for each permit. With pay-your-bid pricing, each winner pays its bid. The two approaches lead to quite different bidding behavior. With a uniform price, bidders with market power may bid below their true value in an attempt to influence the market price. With pay-your-bid pricing, the bidder attempts to guess where the clearing price is likely to fall and then bids slightly above it. Bids in excess of the clearing price are money left on the table. With uniform pricing, predicting the clearing price is less important, since every winner pays the clearing price regardless of how high it bids. Permits will not be fully efficiently allocated under either pricing rule. Buyers will not always truthfully reveal their valuations. This strategic bidding leads to inefficiency (Ausubel and Cramton 1996).

Figure 2. Sample demand curve



Comparing these sealed-bid auctions is difficult, even in the setting with private values. The inefficiency from uniform pricing depends on the extent of market power. When no bidder has significant market power, uniform pricing is nearly efficient in a private value setting. Relative to pay-your-bid pricing, uniform pricing has the benefit that everyone pays the same price. Uniform pricing is strategically simple for small bidders and they benefit from the demand reduction by the large bidders. This encourages participation by small bidders. In contrast, pay-your-bid pricing exposes small bidders to strategic risk, since they may be less able to gauge the probable level of the clearing price. Hence, among the sealed-bid auctions, a uniform-price auction probably is best for the case of carbon permits.

3.7 Ascending Auctions

A primary advantage of ascending auctions is a reliable process of price discovery. Both price and allocation are determined through a process of open competition. Each bidder has every opportunity to improve its bids, changing losing bids into winning bids. In the end, all buyers have good information about price and those willing to pay the most win the permits. An ascending process is especially desirable when bidders' valuations depend on information held by others. Then the bidding process reveals information, which improves the bidders' valuation estimates. In the early years of carbon regulation, when elasticities are uncertain, and the feasibility and cost of new technologies is changing rapidly, improved information will have major efficiency impacts. Despite its failures, one benefit of the government conducted SO2 auction, in the US Acid Rain program, was to focus attention on the permit price and reveal information (Joskow, Schmalensee and Bailey (1996)). The auction price was much lower than expected but ended up being a much better predictor of future permit prices than any of the model estimates.

Multi-unit ascending auctions can be conducted in two basic ways: with demand schedules or with an ascending clock. The demand schedule approach is a multi-round version of the sealed bid auction. Iterations stop when no bidder is willing to improve its bids. Pricing can be either uniform or pay-your-bid as in sealed bid auctions. Here, however, the market power problems arising from the use of a uniform price are exacerbated by the undesirable ability to use bids to signal during early rounds. The strategic risk arising from pay-your-bid pricing is diminished by the price discovery process. Thus, of the two, the pay-your-bid is preferred. The ascending-clock auction, however, is simpler and even more efficient in this situation.

3.8 Ascending-Clock Auction

In each round, the bidders submit the quantity they are willing to buy at the price indicated by the clock. The clock is increased if the total quantity bid exceeds the quantity available. The bidding continues until the quantity available exceeds the quantity bid. The permits are then allocated at the prior price, and are rationed for those who reduced their quantity in the last round.
An activity rule is needed to promote reliable price discovery. The activity rule forces the bidders to bid in a way that is consistent with a downward sloping demand curve. This prevents bidders from holding back initially and then submitting large bids after the other bidders have revealed their information. The activity rule in this case is simply that each bidder cannot increase its quantity as prices rise.

This design shares all the price discovery advantages of all ascending auctions, avoids the undesirable bid signaling which is possible with uniform-price ascending auctions, and has several additional advantages relative to the pay-your-bid ascending auction. Because a buyer only bids a single quantity, rather than a schedule, it is easier to implement. It yields a single market-clearing price yet avoids the mechanism for collusion under a sealed-bid uniform-price auction. Rapid convergence is guaranteed, since the price increases by one bid increment with each round of bidding.

It is still not perfectly efficient, if there is market power, because buyers shade their bids to lower the price. They will shade them differently depending on their size. Large bidders win too little and small bidders win too much. However, in this setting where market power is apt to be slight, the inefficiencies from a standard ascending-clock auction are likely to be insignificant.

In conclusion, auctioning carbon permits is simple and efficient. As a result of communications advances, ascending auctions are now easy to implement through the Internet. We prefer the ascending-clock auction, primarily because of its advantages in price discovery, but a sealed-bid uniform-price auction will also operate well.

4. CONCLUSION

Different forms of regulation will suit different countries. To control climate change, and comply with the new commitments under the FCCC, two efficient instruments can be used, taxes and permits. Because the climate agreement is framed as a quantity not price control, and because it has such a long time frame, the usual price/quantity distinction between taxes and permits is not so critical. Other distinctions remain. The political economy of taxes contrasts strongly with that of permits, particularly in the United States. Taxes and permits require slightly different administrative, and private sector, infrastructure. They have different inter-temporal and risk sharing qualities.

The focus of this paper has been on the revenue and distributional effects of carbon taxes and carbon permits. Carbon taxes raise revenue in an efficient way. In their most commonly used forms, taxes and permits have very different distributional effects. Carbon taxes, with compensating tax cuts or public expenditures are considerably more equitable than grandfathered permits. However, as we have shown, auctioned permits can achieve the same equitable distribution and can provide an equally efficient revenue source. In addition, we have shown that auctions are feasible.

The ability to use auctioned permits broadens the menu of instruments available to the regulator. In a country where taxation is politically unacceptable, or the specific political economy requires some amount of grandfathering to buy off vested interests, or the high level of private sector involvement of a permit market is desired, auctions allow the equity and efficiency benefits of a tax to be achieved within a carbon permit market. This may allow a country such as the US to regulate efficiently despite the political resistance to taxation. Even if permits were partially grandfathered in the short run, the mechanism to move toward broader distribution of costs through auctions would be available and could be phased in gradually.

In Europe, recognition of the possibility of auctioning the majority of permits may allow some countries to adopt permits rather than taxation. They may be able to buy off powerful interests with some grandfathered permits, while replacing the tax with auctioned permits in other sectors. This may solve some of the political problems that currently lead to exclusion of some important sectors from carbon taxes. Short term losses from grandfathering may be rapidly outweighed by the efficiency advantages of a comprehensive regulation.

Finally, as the world moves toward some form of carbon trading among developed countries, and in the future developing countries, domestic permit trading may facilitate more efficient international trading. Countries that have begun regulation with taxation may be able to move relatively seamlessly to an auctioned permit system without serious concerns about redistribution. Recognition of the true effects of grandfathered and auctioned permits relative to taxes may reduce the concerns about competitiveness, which currently plague international trading negotiations.

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