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Greenhouse Gas Auctions and Taxes: Some Practical Considerations

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Executive Summary

Many scholars assert that "cap and trade" is an appropriate strategy for addressing climate change. Some economists have argued that auctions of greenhouse gases should be an integral part of any cap-and-trade mechanism. These economists suggest that auctions can efficiently distribute emissions allowances among firms, and potentially offset some of the deadweight costs with raising government revenues. Many environmentalists argue that revenue from auctions should be used by the government to promote reductions in greenhouse gas emissions. Similar arguments are made for greenhouse gas taxes.

This paper evaluates various arguments for auctions and taxes in light of political realities. I argue that economists are likely to be overly optimistic in their support for auctions and taxes, and that many potential uses of these revenues are unlikely to result in economic benefits. I then offer some general guidance for governments on the role of auctions in a cap-and-trade mechanism and offer recommendations for participating firms. Specifically, I urge the government to compare a realistic set of policy options, while recognizing that the feasibility of different types of mechanisms can change over time. To illustrate one such comparison, I examine auctions and taxes as ways of raising revenue, and find that neither is likely to do particularly well in terms of efficiency based on history. Furthermore, I suggest that the introduction of political economy considerations may lead to an optimal level of pollution control that is *lower* than that suggested by conventional economic analysis.

Key Words: Auctions, Environmental Economics, Climate Change, Benefit-Cost Analysis, Regulation, Political Economy

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1. Introduction

In the last decade, there have been several proposals for addressing climate change. Two proposals that have been featured prominently are "cap-and-trade" and emissions taxes. Such programs can be implemented on a local, national, or international scale and have the potential to substantially reduce the cost of achieving a given environmental objective, such as limiting greenhouse gas emissions.

The cost-effectiveness of these programs depends in part on whether they raise revenue for the government and on how that revenue will be spent. A cap-and-trade program can raise revenue by auctioning off some or all of the allowances. A tax program raises revenues naturally. The enthusiasm for using auctions and taxes, however, has not been accompanied by sober assessments of whether and how the revenues would actually be used. Most of the evidence suggests that at least some of the revenues would not spent wisely, at least from an economic perspective.

Cap-and-trade programs typically involve limiting total greenhouse gas emissions by defining and distributing property rights for these emissions, usually called allowances (Stewart and Wiener, 2003).[1] Such programs have been used successfully in the U.S. to curb sulfur dioxide emissions and limit the amount of lead in gasoline (Hahn, 1989; Stavins, 1998).[2] One key decision in designing a cap-and-trade regime is how to distribute allowances (Burtraw, Palmer, and Kahn, 2005; Posner and Sunstein, 2008). One way is for the government to distribute the allowances for free to affected parties, such as businesses that are required to comply with the regulations. A second approach is to auction some or all of the allowances. The mechanism for distributing allowances—for example, free distribution or auctions—could have significant effects on households, the economy, and the cost of the policy (Orszag, 2007).

Several economists, environmentalists, and politicians have been promoting auctions as a way to distribute greenhouse gas emissions allowances. The economists

[1] One allowance usually refers to the right to emit one ton of carbon dioxide. An allowance can be defined for other gases, taking into account different gases' impact on climate change relative to carbon dioxide.

[2] Another prominent economic option for limiting greenhouse gas emissions is taxes. See, for example, Cooper (2007).

believe that auctions can be a simple mechanism for distributing allowances among firms and that auction revenues can offset some of the deadweight losses of environmental policy (Burtraw, 2008; Parry, Williams, and Goulder, 1999). The environmentalists believe that auction revenues should be used by the government to help address climate change.[3] Politicians may believe that it is appropriate for the government to receive the revenue for using a scarce public resource, such as the environment.[4] Moreover, they may see opportunities to use the revenues from auctions to distribute benefits to their preferred constituencies.

In 2005, the European Union launched Phase I of the largest mandatory greenhouse gas trading scheme in the world, the European Union Emissions Trading Scheme (EU-ETS). This scheme covers about half of the carbon dioxide emitted in the European Union.[5] During Phase I of the EU-ETS, the European Commission mandated that countries distribute at least 95 percent of their allowances for free, and only four countries elected to auction some of the remaining five percent of allowances (European Commission, 2003).[6] For Phase II, which began in 2008, the European Commission increased the maximum percentage of allowances that could be auctioned to 10 percent, and so far, about eleven countries have decided to auction some of their allowances (European Commission, 2005a).[7]

In the U.S., three cap-and-trade programs—the Northeast's Regional Greenhouse Gas Initiative (RGGI), the Western Climate Initiative (WCI), and California's Global Warming Solution Act of 2006—are being developed. As of January 2008, at least nine bills were introduced in Congress that would regulate carbon dioxide on a national level.[8]

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[3] See, *e.g.*, Roosevelt (2008).

[4] See footnote 3 for a list of proposed bills that involve auctions. For example, the Safe Climate Act of 2007 (H.R.1590) would auction 100 percent of allowances and use the auction revenue to support activities that "protect against and mitigate the impacts of climate change." Politicians might support auctions due to perceived problems with free allocation.

[5] The European Commission's website on the EU-ETS, available at http://ec.europa.eu/environment/climat/emission.htm.

[6] These countries were Ireland, Hungary, Lithuania, and Denmark. Denmark has since decided to sell the allowances on the brokered market.

[7] These countries include Ireland, Belgium (Flanders), the United Kingdom, Lithuania, Luxemburg, Poland, Netherlands, Hungary, Germany, Austria, and Italy. See the national allocation plans for Phase II, available at http://ec.europa.eu/environment/climat/emission_plans.htm.

[8] The following nine bills regulate carbon dioxide and involve the use of auctions: S.2191, H.R.3989, H.R.1590, S.1766, S.1177, S.317, S.280, S.1201, and S. 1168. See the Environmental Defense Fund, "Climate Change Bills of the 110th Congress," available at http://www.edf.org/page.cfm?tagID=1075.

In the U.S., some states participating in the Regional Greenhouse Gas Initiative (RGGI) have plans to auction 100 percent of their allowances.[9]

Despite the recent focus on auctions in a cap-and-trade system, carbon taxes still enjoy support in various places. For example, many northern European countries, such as Finland, Norway, and Sweden, have had a carbon tax in place since the early 1990s. In addition, there are two recent bills in the U.S. Congress that call for a national carbon tax.[10]

This paper evaluates various arguments for auctions and taxes in light of political realities. My primary focus is on auctions because of growing interest in this tool (Hepburn et al., 2006). I argue that economists are likely to be overly optimistic in their support for auctions and taxes, and that many potential uses of these revenues are unlikely to result in economic benefits. I then offer some general guidance for governments on the role of auctions in a cap-and-trade mechanism and offer recommendations for participating firms. Specifically, I urge the government to compare a realistic set of policy options, while recognizing that the feasibility of different types of mechanisms can change over time. To illustrate one such comparison, I examine auctions and taxes as ways of raising revenue, and find that neither is likely to do particularly well in terms of efficiency based on history. Furthermore, I suggest that the introduction of political economy considerations may lead to an optimal level of pollution control that is less stringent than that suggested by conventional economic analysis.

Although my analysis identifies some potential issues in the implementation of market-based approaches, it is best viewed as a cautionary tale. Specifically, it is not meant to suggest that society should do nothing about climate change, nor should society eschew market-based approaches in addressing this problem. Even within a cap-and-trade program, I am not suggesting that the alternative to auctions, free allocation, is better. There are serious problems with free allocation that also need to be addressed. Rather, I am simply suggesting that all parties involved in this debate look at the strengths and weaknesses of various instruments for addressing net greenhouse gas emission reductions with their eyes wide open.

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[9] These states include New York, Vermont, Maine, Maryland, and Connecticut.
[10] These are H.R. 2069 and H.R.3416.

The rest of the paper is organized as follows. Section 2 provides an overview of greenhouse gas auction activity. Section 3 evaluates the economic efficiency arguments for auctions, focusing on the efficient allocation of allowances and government use of auction revenues. Section 4 offers guidance for government on designing greenhouse gas auctions and auction participants. Section 5 illustrates some of the problems with making realistic comparisons by comparing auctions with environmental taxes. Section 6 concludes.

2. An Overview of Greenhouse Gas Auction Activity

This section reviews past and proposed greenhouse gas auctions. The purpose is to compare and contrast various auction mechanisms. By examining the design features in auctions, we can gain a deeper appreciation of some of the political and economic issues surrounding climate change policy and climate change auctions.[11] Although auctions have occurred in voluntary cap-and-trade programs, I focus here on auctions in cap-and-trade programs where there is an explicit constraint on greenhouse gas emissions.[12] These include five auctions that were conducted in three countries under Phase I of the EU Emissions Trading Scheme (EU-ETS).

In order to comply with the Kyoto Protocol, the EU approved a specific number of emission allowances for each member state under the EU-ETS based on the member state's national allocation plan (Convery and Redmond, 2007). The national allocation plan outlines the total number of allowances needed for the trading period and the distribution of these allowances among individual industrial plants and electric utilities.[13] One EU allowance represents the right to emit one ton of carbon dioxide. Companies that emit less than the number of allowances they own can sell their excess allowances, while

[11] For earlier, related work in the area of market-based instruments, the reader should see Hahn (1989) and Hockenstein, Stavins, and Whitehead (1997).

[12] Both the U.S. and the United Kingdom have initiated voluntary programs to reduce greenhouse gas emissions in the past. The U.S.'s Chicago Climate Exchange is a voluntary, privately-run cap-and-trade scheme that has been operating since 2003, available at http://www.chicagoclimateexchange.com. The United Kingdom's Emissions Trading Scheme is a voluntary cap-and-trade scheme launched in 2002, available at http://www.defra.gov.uk/environment/climatechange/trading/. The United Kingdom Emissions Trading Scheme included a descending price auction for greenhouse gas reductions in which the government bought greenhouse gas reductions from firms. See, *e.g.*, Smith and Swierzbinski (2007). I also do not include auctions of Clean Development Mechanism credits, though I do discuss the program generally.

[13] See the EU-ETS website information on national allocation plans, available at http://ec.europa.eu/environment/climat/emission_plans.htm.

companies that have trouble keeping their emissions low can invest in energy saving technologies or buy excess allowances.[14]

The EU mandated that at least 95 percent of allowances be freely allocated (*i.e.*, given directly to affected entities for free) in Phase I. Four countries chose to sell some of their allowances, and only three—Ireland, Hungary, and Lithuania— used at least one auction to distribute some of their allowances.[15] Convery and Redmond (2007) estimate that the value of the allowances distributed in Phase I was about €65 to €130 billion.[16] Only a small fraction of Phase I allowances (0.12 percent), however, were auctioned.[17]

Table 1 summarizes information about these auctions. Four patterns emerge. First, the auctions exclusively focus on carbon dioxide (CO2). Second, they all use a similar mechanism for auctioning the allowances—an online, uniform price, sealed bid auction.[18] Third, all three countries elected to use the auction revenue to offset administrative costs of the scheme (Hepburn et al., 2006). Fourth, the revenues were fairly modest, both with respect to what would have occurred with a 100 percent auction, and to other auctions. For example, auctions for spectrum licenses have exceeded $100 billion in at least one case (Klemperer, 2004).

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[14] See EU MEMO/05/84 explaining the EU-ETS, available at http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/05/84&format=HTML&aged=1&language=EN&guiLanguage=en.

[15] Ireland and Hungary each held two auctions.

[16] The price of EU allowances declined dramatically over Phase I of the emissions trading program, which makes it difficult to value the permits with any level of certainty. Convery and Redmond (2007) assume a value of €10 to €20 per metric ton of carbon dioxide. Dollar amounts are in nominal terms unless otherwise stated. I differentiate between tons and metric tons throughout the paper.

[17] The share will increase to four percent in Phase II and perhaps 67 percent in Phase III (European Commission, 2008).

[18] Bids could be emailed in Ireland's first auction, but the auction was not online in the sense that the other auctions were. All auctions were uniform-price auction, where the auctioneer offered a single price to all successful bidders. In the case of the Hungarian and Lithuanian auctions, price was set by the lowest bid accepted by the auctioneer ("clearing price"), while in the Irish auctions, the price was set by the highest rejected bid. The clearing price could not be lower than the minimum price determined by the auctioneer.

Table 1: Greenhouse Gas Auctions Used in EU Emissions Trading Scheme

Year	Country	Gas	Auction Amount	Amount Raised	Clearing Price (per tCO2)	Auction Type	Use of Revenues
2006	Ireland	CO2	0.5M EUAs-0.75%	€13.1M (2)	€26 (1); €6.9 (2)	Uniform price, sealed bid	Offset administrative costs of scheme
2006-07	Hungary	CO2	2.4M EUAs-2.5%	€9.94M (2)	€7.4 (1); €0.9 (2)	Uniform price, sealed bid	Offset administrative costs of scheme
2007	Lithuania	CO2	0.6M EUAs-1.5%;	€0.033M (1)	€0.06	Uniform price, sealed bid	Offset administrative costs of scheme

Notes: EU-ETS Phase 1 refers to the 2005 to 2007 Phase of the European Union's Emissions Trading Scheme. All countries used a uniform price, sealed bid auction. "Year" refers to the year in which the auction(s) occurred. In the column labeled "Amount Raised," the number in parenthesis refers to the number of auctions that were held. Revenues are presented in nominal terms (millions of euros). In the column labeled "Auction Amount," the term "EUA" refers to European Union allowances.
Sources: Press releases on the Lithuanian and Hungarian auctions from Vertis Environmental Finance, available at www.euets.com; press release on the Irish auctions from Ireland's Environmental Protection Agency, available at http://www.epa.ie/. See also Macken (2007) for more information on the Irish auctions.

In general, the EU suggests that member states use auction revenues to offset the administrative costs of the scheme or to purchase Joint Implementation (JI) and Clean Development Mechanism (CDM) credits (European Commission, 2005a).[19] JI and the CDM are two mechanisms aimed at reducing the overall cost of achieving reductions in greenhouse gases. JI allows the 40 industrialized countries in the Kyoto Protocol to finance emissions-reducing technologies in other industrialized countries, crediting those reductions towards their own targets. The CDM is similar, but involves investment by the industrial countries in reducing emissions in developing countries. Japan and Europe are major investors in the CDM, while China, Brazil, and India account for nearly 80 percent of all project-based carbon allowances sold (Lecocq and Ambrosi, 2007).

Despite the common auction design, the auctions had small, but important differences. For example, Hungary required participants to post the total value of their bid two days before the auction and the money was held for eight days after the auction, which resulted in lower participation than in the Irish auctions (Neuhoff, 2007; Kaderjak,

[19] For an insightful political analysis of the EU preferences for the CDM, see Victor (2007).

2007).[20] In line with that, Ireland raised more revenue despite selling less allowances than Hungary. A large part of this difference can be attributed to the timing of the auctions, since there was a decline in the price of allowances over the course of Phase I. The earlier Irish auctions enjoyed a higher market price for the allowances, though design likely contributed (Betz, 2007). I discuss the general role of auction design further in section 3.

The use of greenhouse gas auctions is expected to increase dramatically in the future. In Phase II of the EU-ETS, which began in 2008, 11 countries elected to auction at least some of their emission allowances, bringing the share of allowances distributed by auction up to four percent for this phase.[21]

Member states are still in the early stages of planning Phase II auctions. It is unclear how these auctions will be designed, how much revenue they will raise, and how that revenue will be allocated. It seems reasonable to expect that more money may be invested in JI and CDM projects. In Phase III, as many as two-thirds of the allowances could be auctioned (European Commission, 2008). It is also possible that more gases will be covered.

Greenhouse gas emissions trading, and the related auction use, is not restricted to the EU-ETS. Trading schemes are being proposed in the U.S. and other parts of the world, such as Australia, New Zealand, and China. Table 2 summarizes what is known about proposed programs for limiting greenhouse gases that involve auctions. Many of these proposed trading schemes are in the early stages of development and information on expected auction use is not yet available. Some, however, have already stated that they will make use of auctions. In the Northeastern U.S.'s Regional Greenhouse Gas Initiative (RGGI), which is expected to begin in January 2009, states will auction at least 25 percent of their allowances, with proceeds going to activities that will promote a "consumer benefit or strategic energy purpose."[22] Some states, such as New York, Vermont, Maine, Maryland, and Connecticut, plan to auction 100 percent of their allowances. If all allowances were auctioned, it would likely raise more than a billion

[20] The Irish auctions also had an undisclosed reserve price.
[21] See individual national allocation plans for Phase II, posted on the EU-ETS website, available at http://ec.europa.eu/environment/climat/emission_plans.htm.
[22] See the signed "Memorandom of Understanding," available at http://www.rggi.org/docs/mou_final_12_20_05.pdf.

dollars.[23] Extensive auction design studies have already been completed, with recommendations for designs largely similar to the greenhouse gas auctions in Phase I of the EU-ETS (Holt et al., 2007). If significant auctioning does occur, the way these revenues are used can have a significant impact on citizens and the economy. Many schemes mention subsidizing energy efficient activities. None appear to call for a reduction in pre-existing taxes that are inefficient. Section 3 explores this issue in detail.

[23] See the GHG Coalition for details on this calculation, available at http://www.climatechangecorp.com/content_print.asp?ContentID=4937.

Table 2: Proposed Greenhouse Gas Reduction Programs Likely to Use Auctions

Year	Country	Scheme	Gas	Auction Percent	Earmark	Status
2008	USA, some Canadian provinces	RGGI (CT, DE, MA, MD, ME, NH, NJ, NY, RI, VT)	CO2	Varies by state; some to auction 100%	Likely yes.	Memorandum of Understanding signed
2008	USA, some Canadian provinces	WCI (AZ, CA, MT, NM, OR, UT, WA)	All Kyoto GHGs	No firm commitment to auctions as of Jan 2008	NA	
2009	USA	CA Global Warming Solution Act of 2006 (Assembly Bill 32)	All Kyoto GHGs	Under review by the California Air Resources Board (CARB); possible 100%	NA	Draft should become public by June 2008
2008 - 2013	New Zealand	New Zealand ETS	All Kyoto GHGs	Combination of auctions and free distribution	NA	
2010	Australia	Australian ETS		Undecided	NA	Design finalized by end of 2008
2007 /08, Pilot	China	China ETS		No information	NA	

Notes: "Year" refers to the proposed start year of the scheme. "All Kyoto GHGs" refers to the greenhouse gases that were explicitly mentioned in the Kyoto Protocol: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydroflurocarbons (HFCs), perflurocarbons (PFCs) and sulphur hexafluoride (SF6).
Sources: See program websites: http://www.rggi.org/, http://www.westernclimateinitiative.org/, http://www.arb.ca.gov/cc/cc.htm, http://www.climatechange.govt.nz/, and http://www.greenhouse.gov.au/emissionstrading/index.html, respectively. For information on the China Emissions Trading Scheme, see http://www.planetark.org/dailynewsstory.cfm/newsid/40653/story.htm.

3. Evaluating Economic Efficiency Arguments

Auctions are supported by economists for two reasons related to efficiency. First, they have the potential to allocate the resource being auctioned more efficiently at the onset by ensuring that the resource is allocated to those who are willing to pay the most for it. Ironically, the auctions implemented in the EU-ETS to date were introduced after trading had begun, notably in Lithuania where the auction did not occur until September 2007, just before the end of Phase I. This timing limits the likely price discovery benefits from an auction. These benefits result in part from reduced transaction costs that are incurred in a secondary market or on an exchange.

Second, the revenues from the auction can be used to increase the efficiency of government—by either making the taxation system more efficient or by directing government expenditures to areas where there is a high social payoff. I begin by briefly reviewing the normative work in this area. I then review positive scholarship in this area. Finally, I offer some tentative conclusions about the connection between normative and positive scholarship on how government uses additional revenues.

Direct benefits of auctions

Economists support auctions because they can be an efficient and transparent way to distribute allowances to those who value them most highly (Burtraw, 2008; Ledyard, 2008).[24] Auctions can be designed using straightforward rules, especially in the case of an auction for a single commodity, such as carbon dioxide.[25]

An important virtue of auctions is that they establish a price signal for the value of a commodity. Knowing the price of a commodity can reduce search costs for buyers and sellers, and also increase trading on secondary markets.[26] In theory, the auction price of a carbon dioxide allowance could give useful information about the marginal cost of

[24] In the context of auctions, "efficiency" often refers to the extent to which bidders with the highest willingness to pay win the property or rights being auctioned. When I refer to the efficiency of an auction, I sometimes use a broader definition that also encompasses other factors, such as the extent to which the revenues from the auction are used efficiently.

[25] Auctions can also be complicated when demands for different property rights are independent, as is the case with some spectrum. See, *e.g.*, Klemperer (2004). See Burtraw (2008) for the importance of simplicity and transparency in general.

[26] In the case of the EU auctions, price signals were already established in the secondary markets.

reducing carbon dioxide emissions. In the case of the EU auctions, price signals were already established in secondary markets before the auctions took place.

Achieving the benefits of auctions depends on the auction design. Different auction designs will sometimes yield different levels of expected revenue and different levels of efficiency (Milgrom, 1989). For example, an early laboratory experiment aimed at testing the revenue generating properties of Treasury bill auctions suggested that auctions in which the winning bidder pays the highest rejected bid price generated more revenues than auctions in which the bidder pays his own bid price in selected cases (Miller and Plott, 1982).

Other factors beside the mechanism for determining price can also affect whether auctions allocate a property right efficiently. For example, one key feature not adequately addressed in some spectrum auctions was how a declared bankruptcy could affect the disposition of rights purchased at an auction. In one case, spectrum rights were tied up for more than six years because of such a bankruptcy (Crandall and Ingraham, 2007). Nextwave declared bankruptcy in 1998, two years after winning the largest share of licenses in an FCC spectrum auction. The FCC responded by re-auctioning the licenses, but before the FCC could deliver the licenses to the winners, a court ruled that the FCC's repossession of the licenses was illegal. The licenses were returned to Nextwave and were eventually sold in the secondary market.[27]

Bankruptcy could also be a problem in a cap-and-trade program if policy makers are not careful. In addition to problems associated with bankruptcy in an auction, there can also be problems associated with borrowing permits from the future that can be used today. If a firm that borrowed permits went bankrupt, this raises similar issues to the Nextwave bankruptcy. The rules will need to make clear who should bear the risk in such cases. Mechanisms, such as insurance or deposits, could be introduced to mitigate such risks.[28]

A key potential advantage of auctions is that they can generate revenues. Two ways of increasing expected revenue are to prevent collusion and encourage participation of bidders (Klemperer, 2004). A successful auction does this by paying attention to the

[27] See Crandall and Ingraham (2003) for more details.
[28] The Environmental Defense Fund (EDF) is a proponent of banking and borrowing provisions. See the EDF's policy outlines, available at http://www.edf.org/page.cfm?tagID=1373.

specific market structure for the item being auctioned. The EU-ETS auctions demonstrated how aspects of auction design can either encourage or limit competition. Though both the Irish and Hungarian auctions were open to anyone holding an account with an emissions trading registry of any of the EU member states, the Irish auctions had higher participation that can be partly explained by differences in design. The first Irish auction set a €3,000 deposit requirement for bidders and allowed bidders to bid for lots of 500 carbon dioxide allowances each. The deposit and the lot size was later deemed too small and increased to €15,000 and 1,000 allowances, respectively, for the second auction (Holt et al., 2007). In contrast, the Hungarian auctions required a high deposit and auctioned minimum lots of 1,000 allowances (Betz, 2007; Kaderjak, 2007).[29] Holt et al. (2007) recommended a minimum 1,000 lot size for greenhouse gas allowances for the U.S. RGGI and a medium level deposit to correct some of the issues in the Irish and Hungarian auctions.

In the case of climate change auctions, there are many key factors that will affect their efficiency. As constructed now, these auctions are basically for one period or phase. This may limit the incentives of firms to search for innovative ways of reducing carbon dioxide because they do not know what will happen in subsequent decades. The perceived success of climate auctions that are used in the beginning is likely to effect their design and use in the future.

In addition, firms may have legitimate concerns about the introduction of allowances into the market from third parties that could degrade their value. Such a situation could arise, for example, if there were outright fraud or if allowances from certain activities, such as CDM projects, received more credit initially than they actually deserved. The potential for devaluing the currency of allowances suggests that the auction itself is one part, and not always the most important part, of designing effective institutions for limiting greenhouse gas emissions.

Moreover, it is possible that many of the direct benefits of auctions can be achieved without an auction. Suppose that property rights are well defined and that that they are freely allocated so that there are a reasonable number of demanders and

[29] To participate in the Hungarian auction, participants were required to post the total value of their bid two days before the auction (Kaderjak, 2007). In addition, the government retained the money for eight days after the auction.

suppliers. Furthermore, suppose that the government can effectively monitor and enforce such property rights. In such cases, it is reasonable to presume that institutions, such as exchanges and brokers, will arise to facilitate trade of allowances. Already in the EU, there are at least seven brokers and five exchanges for trading greenhouse gas property rights (Convery and Redmond, 2007).[30] Such institutions may perform better in conjunction with an auction held by the government, but this will not always be the case. The bottom line is that auctions can help to allocate allowances efficiently at the outset, but may not always be necessary (Coase, 1960; Hahn and Noll, 1982).[31]

Indirect benefits of auctions

A potentially significant benefit of greenhouse gas auctions is that they generate revenues for the government. These revenues can be used to help promote beneficial policies in three ways. The first is by substituting more efficient sources of revenue for less efficient sources of revenue, such as the payroll tax or taxes on capital. A second is to use revenues from auctions to finance government investments that yield high payoffs. So, for example, auction revenue might be used to finance research on improving health (Murphy and Topel, 2003). A third way the revenues might be used is to reduce the debt burden.

There is a large literature on the potential benefits of revenue recycling. A core finding of this literature is that auction revenues can substantially increase efficiency if they are used to reduce other, less efficient taxes. Environmental interventions increase distortions in the market. Goulder et al. (1999) find that using the revenues from environmental interventions to reduce pre-existing taxes can offset some of those distortions. Specifically, efficiency gains for society from decreased distortionary taxes are expected to be in the billions. According to Parry and Bento (2000), a revenue neutral carbon dioxide tax of $10 to $20 could create efficiency gains for society of about $20 billion to $30 billion per year under certain modeling assumptions. The gains could be much higher under different assumptions about the marginal excess burden of income

[30] EU-ETS Brokers: CO2e, Evolution Markets, GreenStreamNetwork, GT/SKM Global Environmental Partners, Natsource Europe, TFS, and Vertis Environmental Finance. Exchanges: European Climate Exchange (ECX), European Energy Exchange (EEX), Energy Exchange Austria (EXAA), Nordpool, and Powernext. See Convery and Redmond (2007).

[31] See Stavins, Keohane, and Revesz (1998) for a discussion of the reasons auctions may still perform better.

taxes. Feldstein (2008), for example, finds the marginal excess burden of income taxes to be much higher which would imply much higher gains for reducing these distortionary taxes.

Furthermore, Parry, Williams, and Goulder (1999) argue that whether a policy instrument can raise money for revenue recycling is an important determinant in whether the policy's benefits exceed its costs. For example, they find that the economic costs of a carbon dioxide cap-and-trade program in the U.S. that does not include recycling auction revenue will exceed the environmental benefits if the benefits from reducing carbon dioxide emissions are below about $24 (in 2006 dollars) per ton.[32] Current estimates of the benefits of reducing carbon dioxide emissions are typically below that amount.[33]

While academics have extensively studied how revenues from auctions can be used to make the tax system more efficient, they have not done much research on examining the impact of using such revenues for retiring debt or increasing efficient government investments. Parry (1997) briefly considers such uses of government revenues. He determines that using revenues to reduce the federal budget deficit would also create a revenue recycling effect, except that the economic gains would accrue to future generations, rather than present generations. This is because less would be required in the future for interest payments on the federal debt, which would reduce distortions in the level of employment and investment caused by future taxes.

In the case of government spending, Parry (1997) generally states that the benefit from a specific dollar amount of investment is not likely to be more than that amount, except when the investment is in public goods that would otherwise not be supplied by the private market. In that case, the benefit may be more or less than the invested amount, depending on how individuals value those goods. Meanwhile, spending the revenue through decreased taxes could create benefits that exceed that amount because the benefits filter throughout the economy by encouraging more employment and investment. Hence, the normative literature contends that the rewards through government revenue

[32] I used the Consumer Price Index to update the central estimate included in Parry, Williams, and Goulder (1999). See Parry, Williams, and Goulder (1999) for details and modeling assumptions.

[33] The Intergovernmental Panel on Climate Change (2007) estimates that the benefits of reducing one ton of carbon dioxide are about $12 (in 2006 dollars). Their estimate includes the net economic costs of damages from climate change across the globe and is the average from more than 100 peer-reviewed estimates that they surveyed. Parry, Williams, and Goulder (1999) use a number closer to $7 (in year 2006 dollars). I did not find values for benefits of domestic decreases in greenhouse gas emissions, which are likely to be lower.

raising are best reaped when the revenues are used to lower pre-existing distortionary taxes or to reduce the federal budget deficit.[34]

Political economy of revenue raising

While the economics literature on auctions paints an optimistic picture of how this revenue could potentially be used to increase efficiency, the political economy literature offers a sharp contrast to this optimistic picture.[35] In this section, I examine what we know about the use of new sources of government revenues.

First, new revenues have typically not been used to lower pre-existing taxes. Becker and Mulligan (2003) find that when the government obtains new general revenue, it tends to finance more spending rather than decrease taxes. A reason for this could be related to the "flypaper effect," which describes the phenomenon of state governments spending close to 100 percent of unrestricted grants from the government, rather than using some of the grants to reduce taxes (Hines Jr. and Thaler, 1995). Hines Jr. and Thaler attribute this effect to loss averse taxpayers who do not see money as fungible. While taxpayers would protest an increase in taxes, they are less likely to protest the lack of a potential decrease in taxes.

Second, there is little evidence to suggest that auction revenues will be used to reduce government debt. While some spectrum auction revenues in the United Kingdom and the U.S. are allocated to reducing the federal debt, there is no simple mechanism for enforcing this result because it is virtually impossible to know what the budget would have been in the absence of those revenues.[36] For example the chairman of the Federal Communications Commissions asserted that $7 billion in revenues from a spectrum auction in 2008 would be set aside for deficit reduction.[37] While this may be true, it ignores how such revenues may affect the spending habits of legislators.

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[34] I include using the revenue to address equity concerns in the general government spending category (Metcalf, 1999; Parry, 2004).

[35] Victor (2007), *e.g.*, notes that permits are generally not auctioned.

[36] According to H.R. 2264, The Omnibus Budget Reconciliation Act of 1993 (the bill which authorized the Federal Communications Commission to auction spectrum), all proceeds from auctions are placed in the Treasury, in addition to paying the salaries and expenses of the commission. In the UK, the revenues from the auction of "third generation" mobile licenses were also allocated to pay down the national debt.

[37] See March 20, 2008 statement by Federal Communications Commission Chairman Kevin J. Martin, available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-280968A1.pdf.

There may also be problems with earmarking revenues, though at least this can be monitored. The main problem relates to the percentage of earmarked money that is actually spent accordingly. Some work on lotteries suggests that the lottery revenue, typically earmarked towards some public good such as education, does not necessarily increase spending on the public good (see, *e.g.*, Mikesell and Zorn, 1986; Borg and Mason, 1989).[38] After reviewing the literature on the relevance of earmarking in general, Novarro (2002) concluded that $0.22 to $0.78 of an earmarked dollar is spent in the designated public sector.

Most proposed greenhouse gas schemes that plan to use auctions will allocate some revenues for energy-related investments. For example, Maryland's proposal for the RGGI notes that "Maryland will auction 100 percent of the allowances… [and] the proceeds of the auctions will enhance energy efficiency efforts, including stimulating new technology and alternative fuels."[39] The bills in Congress that seek to establish a U.S. cap-and-trade policy for greenhouse gases illustrate the vast range of activities that could be subsidized, including revenues allocated towards protecting against and mitigating the impacts of climate change, mitigating effects on low-income consumers due to rising energy prices, supporting innovation in reducing greenhouse gases, and rewarding early reductions of greenhouse gases.[40] In the EU-ETS, the European Commission explicitly suggests that auction revenues could be used to generate credits from other countries through Joint Implementation or the Clean Development Mechanism. Research suggests that many of the projects for generating allowances using these mechanisms have serious problems, and may be overstating the amount of credits that are actually generated (see, *e.g.*, Wara and Victor, 2008; Wara, 2007).

In general, the government does not have a history of efficient spending. For example, farm price supports, government support of schools, and government management of highways and airlines are generally regarded as inefficient (*e.g.*, Winston, 2006). Specifically, projects aimed at reducing energy consumption have a mixed record (*e.g.*, Joskow, 2003). Although these projects may please some in the environmental

[38] One study, Novarro (2002), found a positive effect of lottery revenue on the educational spending for which it was earmarked.
[39] See Maryland's RGGI website, available at http://www.mde.state.md.us/Air/RGGI.asp.
[40] Summarized from the text of H.R.1590, Safe Climate Act of 2007.

community, it is not clear whether they will pass a benefit-cost test. Environmentalists may still see them as positive policies, so long as the environment is not actually hurt. In some cases, however, the environment could be hurt. One example is the subsidization of corn-based ethanol, which was supposed to be helpful in reducing greenhouse gas emissions, but may actually increase these emissions.[41]

Why might government spending be less efficient than private spending? The answer is that the government is subject to political pressures that are different from pressure faced in the private sector (Winston, 2006; Becker, 1983). So, while the government can supply basic public goods, such as increases in knowledge through basic research, it often (not always) spends money inefficiently.

Based on recent history, it is likely that auction revenues would be used to increase the overall size of government, or they will be earmarked for the particular activity in question. In the case of auctions for greenhouse gases, this means that revenues may be earmarked to help defray administrative expenses of the program, as happened in Phase I of the EU-ETS. They may also be used to encourage related efforts, such as promoting energy efficiency or generating other kinds of greenhouse gas reductions. There is little basis for assuming that auction revenues will be used to reduce inefficient taxes or substantially increase the net benefits of government expenditures, though these possibilities cannot be ruled out.

4. Guidance for Government and Participating Firms

This section explores some lessons for governments designing greenhouse gas auctions and firms wishing to participate in these auctions.

Lessons for the government

The government should keep three points in mind in designing and implementing auctions for greenhouse gases. First, it is not only the auction design that matters for efficiency, but the more general market structure. Second, the details of the auction design do matter for efficiency. And third, it is important to compare realistic alternatives

[41] Studies such as Crutzen et al. (2007), Searchinger et al. (2008), and Fargione et al. (2008) specifically find that increased corn ethanol production may increase greenhouse gas emissions substantially.

when assessing the likely economic benefits that may accrue from auctions or, more generally, from the market for limiting greenhouse gases.

The overall cap-and-trade market design for limiting greenhouse gas emissions is of paramount importance. There are several key issues to be addressed including a clear definition of property rights; a method for monitoring and enforcement; a method for changing targets over time and expanding the number of included gases; possible price floors and ceilings; and ways of extending the geographic scope of the program (see, *e.g.*, Stavins, 2007). The key point, noted earlier, is that auctions are only one of many components that can contribute to an efficient market design.

Moreover, just as auction design is likely to be constrained by politics, so too will the design of markets to limit greenhouse gas emissions (Barrett, 2003). Countries must voluntarily agree to greenhouse gas reductions (Wiener, 1999). Political leaders today may be willing to sign some kind of agreement limiting emissions, but they will not be able to bind future decision makers easily. That is not to say that long-term binding agreements may not emerge, but it will take time, and the process of getting there is not likely to be smooth in the case of climate change.[42]

Governments need to be realistic about what auctions can and cannot do in the short term. If the system in which an auction is imbedded is not efficient or clearly defined, auctions cannot solve these problems. At the same time, auctions may allocate the resource more efficiently than other alternatives in the short term. Until governments can offer a stable set of rules for reducing greenhouse gases in which a significant fraction of the world's businesses and governments participate, it is unreasonable to expect a result that approaches a cost-effective solution (Nordhaus, 2008).[43]

Although auctions may not be the most important component of market design for greenhouse gas emissions, the details of the auction design do matter for efficiency. Other things equal, the auction should strive for simplicity and transparency. Rules should be put in place to help prevent collusion. In addition, to help address problems

[42] Governments may face pressure from companies involved in the trading systems who will want long-term certainty for their investment decisions (European Commission, 2005b).

[43] Indeed, many of the systems that have been implemented over the past decade are best viewed as pilot experiments, or a group of investments, in which countries and/or regions try to figure out ways to solve this daunting collective action problem. Because the starting point for design can affect the evolution of designs over time, it is important to address some of the key details at the outset, such as the appropriate type of auction mechanism.

related to possible bankruptcy, governments should consider asking firms to supply some form of up-front payment or insurance in the event of default.

Governments may need to consider auctioning differing types and amounts of emission allowances as programs to reduce greenhouse gases are expanded. These auctions can be designed with reasonably straightforward rules. Sometimes a more complicated auction may be needed to help increase the efficiency of the auction or the revenues that are raised. Ausubel and Cramton (2004) argue that auctioning many divisible goods can be effectively addressed by using simultaneous clock auctions. In each period of this auction, bidders submit demands for the different goods. The price for those goods where there is excess demand is then increased by some amount. The process stops when demand is equal to supply for all goods. Prices and allocation are then determined by the clearing prices and bids in the final period. An advantage of this kind of auction (in comparison to a sealed-bid auction) is that it helps with price discovery. It also helps to maximize revenues.

Finally, the government should be realistic in comparing different alternatives. As noted above, economic efficiency is likely to be constrained by politics (Noll, 2006). For example, it should not be assumed that the revenues from the auction will necessarily be used efficiently. Governments should know that most of the efficiency gains that are touted by economists in support of using auctions depend on an appropriate use of the revenues, which typically involves decreasing other distortionary taxes. If some kind of revenue recycling provisions are not written into the regulation or law in a way that is implementable, these efficiency gains are likely to be lost, though auctions may still be preferable to free allocation on other grounds.[44]

Choosing realistic alternatives to compare from the set of politically feasible options is not always straightforward. Nonetheless, it is important to try to compare how different regulatory approaches are likely to perform in practice, as opposed to in theory (Latin, 1985; Hahn and Stavins, 1992). So, for example, if a market-based program

[44] Consider the following numerical example, which illustrates the efficiency trade-off between auctioning and free allocation. Suppose a $1 raised from an auction reduces the excess burden by $.25, i.e., yields net benefits of $.25. Then, for that revenue stream to be more efficient than free allocation, a $1 spent by the government at the margin would have to yield at least $.80 in net benefits. One can easily imagine examples where this condition does not obtain.

discriminates against new sources of pollution, this type of constraint should be modeled where possible in assessing the net benefits of a program.

What auction participants need to know

Firms participating in auctions will typically want to maximize profits or minimize the costs of achieving a given environmental objective. Auction strategy for individuals and firms participating in an auction will depend on the particular set of rules for determining the price, and the market institution in which it is imbedded. In general, a firm will want to consider how its actions will affect strategies of others and vice versa. So, for example, if one firm's demand is likely to have a marked impact on the price, it needs to take this into account in submitting its bid schedule. Say, for simplicity, that a firm knows what others were going to bid in a uniform single price auction. It could then take that information into account, perhaps cutting back on its demand to lower the price in the auction. In general, firms will want to know something about the likely demands of other bidders. To the extent these demands are related to underlying pollution control costs, such demands can be estimated.

If there is likely to be a robust secondary market, participation in an auction may be less important. Firms will want to weigh the costs and benefits of participating in the original auction and/or a follow-on market. Firm strategy will depend, in part, on the likely relationship between prices in the auction and other related markets.

The problem for firms participating in auctions will generally become more challenging as the number of commodities (in this case, different types of emission allowances) grows. The problems also tend to increase in complexity as the linkages among various markets and non-regulatory schemes grows.

In general, businesses are clamoring for more certainty regarding the rules surrounding auctions and greenhouse gas markets (European Commission, 2005b). While they will certainly learn more about the rules regarding trading in the short term, it is unlikely that rules for trading and auctioning greenhouse gases over the longer term will be clarified anytime soon.

5. Auctions and Taxes: A Stylized Comparison

Given the preceding focus on some of the problems with auctions, it may be tempting to say that an instrument like greenhouse gas taxes, or carbon taxes, would be better in some or all dimensions. Greenhouse gas taxes serve a similar function to that of auctions in terms of trying to achieve a cost-effective allocation of pollution control.[45] The direct benefits of taxes included the introduction of an explicit price on carbon dioxide emissions and, possibly, other related greenhouse gases. In addition, it has been argued that taxes may be a more appropriate tool for addressing greenhouse gases because the marginal benefit curve may be relatively flat (Weitzman, 1974). In this section, I consider how the revenues from greenhouse gas taxes could be expected to be spent and compare it with that of auctions.

Table 3 summarizes some features of greenhouse gas taxes that have been implemented to date or proposed. The table includes most large carbon tax programs that have been in place since the early 1990s, and includes some recently proposed carbon tax programs.[46] The information summarized in the table is generally based on government reports and predictions, although some information comes from scholarly reports.[47]

The table is meant to illustrate some general points about carbon taxes. In some cases, these taxes are complicated. For example, in Denmark, there are exemptions for gasoline (but not diesel), natural gas, and biofuels, and specially defined businesses receive 50 percent rebates on their payments.[48] These kinds of exemptions can lead to less than the efficient amount of carbon dioxide reduction.

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[45] The more general case for emission taxes has been elaborated elsewhere and is beyond the scope of this paper. See Baumol and Oates (1975) for general taxes and Metcalf (2007a) for greenhouse gas taxes or carbon taxes.

[46] Belgium, Austria, Germany, Japan, Poland, and Costa Rica may also have small carbon or energy taxes, but were removed from the table because of insufficient information. I also do not include carbon taxes that were proposed but discontinued or never implemented, such as those in Italy, France, Switzerland, and New Zealand.

[47] The use of the revenues summarized in these reports may or may not be consistent with what actually happened. Such a study, while interesting, is beyond the scope of this paper.

[48] See the U.S. Environmental Protection Agency's carbon tax information website, available at http://yosemite.epa.gov/EE/Epalib/incent.nsf/c484aff385a753cd85256c2c0057ce35/0483a144da8fa434852564f7004f3e68!OpenDocument.

Table 3: Selected Carbon Tax Schemes, Implemented and Proposed

Year	Country	Main Tax	Annual Revenue	Effect	Revenue Use	Exemptions
1990	Finland	$8/tCO2 (1996) $24.39/tCO 2 (2003)	$314M (1994)	Reduced CO2 5%	Increase government budget (partly reduce labor taxes)	Industry raw materials and fuel for planes and vessels exempt
1990	Netherlands	$16.4/tCO2	$850M (1995)	Reduced CO2 1.5% by 2000	Increase government budget (revenue spent on environmental protection)	
1991	Norway	$15-$47/tCO2	$900M (1994)	Reduced CO2 2% by 2000	Increase government budget (partly reduce income taxes, partly increase investments for energy saving and renewable energy)	Coal used in industry exempt
1991	Sweden	$27-$55/tCO2	$1700M (FY 1993-94)	Reduced C02 20% by 2000	Revenue neutral (decrease in overall energy tax and labor taxes)	Applies only to motor and heating fuels; industry pays 25% of full rate
1992	Denmark	$9-18/tCO2	$560M (1993)	Reduced per capita C02 by 15%	Revenue to reduce marginal tax rates in all income brackets	Gasoline, natural gas, and biofuels exempt; value-added businesses receive 50% rebate
2001	United Kingdom	Levy on Gas and Electricity	£1000M	Anticipate reducing C 2.5M metric tons annually	Revenue neutral	Fuels used by the domestic or transport sector and for production of other forms of energy are exempt

Table 3 *(continued)*

Year	Country	Main Tax	Annual Revenue	Effect	Revenue Use	Exemptions
2007	Canada (Quebec)	Tax varies according to amount of CO2 produced by different fuels	Anticipated C$200M	Anticipate reducing GHG 10M tons annually		
2007	US (Boulder, CO)	$7/tC	$1M annually	Anticipate reducing C 350,000 metric tons by 2012	Fund Boulder climate action plan to reduce energy use	
2007	US (H.R. 2069: Save Our Climate Act of 2007)	$10/tC, increasing (not CO2)	No estimate	Future	No details	
2007	U.S. (H.R. 3416: America's Energy Security Trust Fund Act of 2007)	$15/tCO2		Future	Reduce the payroll tax (<2% for R&D and <1% to help affected industries transition)	Exports are exempt
2008	Canada (British Columbia)	C$10/tCO2 to rise to C$30/tCO2 in 2012	$1,850M over the first 3 years	Future	Revenue neutral	

Notes: "Year" refers to the year in which the tax was implemented or proposed. Both Finland and the Netherlands charge an additional tax on electricity. Finland's $24.39 current tax is derived from the official tax of €18.05, adjusted at the August 2007 exchange rate of $1= €0.7405. One source claimed a $150/tCO2 tax in Sweden, but this did not correspond with other findings. In Sweden, biofuels, fuels for electricity generation, and fuels for ships, planes, and train locomotives are exempt. Levy rates in the UK are as follows: 0.15p/kWh for gas, 0.07p/kWh for liquefied petroleum gas (LPG), 0.44/kWh for electricity and, 0.12p for any other taxable commodity (EPA). In the UK, revenue will also be used to offset cuts in National Insurance Contributions and to provide support for energy efficiency and renewable energy. UK's revenue and taxes are measured in pounds; Canada's revenue and taxes are measured in Canadian dollars. The Boulder, Colorado tax expires in 2012. The nature of some sources prevents the information to be consistent across countries. Monetary values are in nominal terms unless otherwise stated.
Sources: Generally, U.S. EPA Table 57/11-12: Energy/Carbon Taxes, available at http://yosemite.epa.gov/EE/Epalib/incent.nsf/c7950cb0634d42808525634e00438a4a/032bb32faab7e7a3852564f7005e325a!OpenDocument; Organisation for Economic Co-operation and Development (OECD) (2001); and Carbon Tax Center's "Where Carbon is Taxed," available at http://www.carbontax.org/progress/where-carbon-is-taxed. See also the government of Finland, available at http://www.environment.fi/default.asp?node=11865&lan=en, and British Columbia, "Budget and Fiscal Plan 2008/09 to 2010/11."

The table reveals that the revenues from some carbon taxes are not insignificant, and that at least some carbon tax revenues are designed to be revenue neutral, meaning that some revenues will be used to reduce pre-existing taxes, offsetting any revenue gain for the government.[49] Interestingly, the one carbon tax currently in place in the U.S. (in the city of Boulder, CO) does not use any of the revenues to reduce taxes. One of the two proposed bills in Congress, H.R. 2069, the Save Our Climate Act of 2007, does not mention any proposed use of the revenues.

There are three conclusions to be drawn from this comparison. First, efficient use of revenues is not guaranteed for either auctions or taxes. It appears to be more politically feasible in some cases to use tax revenue to lower other taxes than it is to use auction revenue to lower other taxes. Perhaps because the additional revenues come from a new *tax*, using them to lower other taxes is more salient in the minds of politicians or citizens than using auction revenues to reduce taxes.[50] This observation, however, is based on a small sample with little evidence that this would be true in the U.S.

Second, there is not a strong case for choosing either instrument based on the efficiency with which revenues are likely to be spent. U.S. proposals for a carbon tax have shied away from an explicit condition of reducing other less efficient taxes, though there are few observations in that sample. Such comparisons will need to be made on a case-by-case basis. Indeed, evidence for the U.S. on gasoline taxes suggests that they are generally earmarked towards transportation-related projects (Jackson, 2006).

Third, and perhaps more importantly, the political constraints on choosing a particular environmental instrument strongly suggest that a cost-effective solution to the greenhouse gas problem will *not* be achieved (even at a national level).[51] Even in countries that adopt revenue neutral carbon taxes, numerous exemptions contribute to inefficiencies. It is important to remember that politics will not only affect how a system

[49] The revenue from all environmentally related taxes averages roughly 2 percent of GDP in the Organisation for Economic Co-operation and Development (OECD Member) member countries (OECD, 2001).

[50] Tax legislation may also come under a different congressional committee, which may be more likely to consider reducing taxes. For example, in the U.S., a carbon tax would likely be passed under the Joint Committee on Taxation while cap-and-trade programs would likely fall under the two environment committees. The Joint Committee may be more likely to use tax revenues to decrease other taxes, while the environment committees may be more likely to implement potentially inefficient social regulations. See Metcalf (2007b) for a discussion of this issue.

[51] While I do not examine the entire space of instruments here, they are all likely to be subject to political constraints. See, e.g., Hahn (1990) and Stavins, Keohane, and Revesz (1998). For an early treatment of the political economy of instrument choice comparing standards with taxes, see Buchanan and Tullock (1975).

is implemented, but also whether it is implemented at all. Even if revenue may be used more efficiently under a carbon tax, many believe that a carbon tax is less politically feasible in the U.S. than a cap-and-trade program involving auctions. Models that assume a cost-effective solution will be achieved (read: most economic models) should be taken with a grain of salt.

In particular, traditional economic models that assume that the optimal level of pollution should be selected based on the intersection of the marginal benefit and marginal cost curves may be incorrectly specified when one takes into account political constraints. Say, for example, politics shifts the achievable marginal cost curve up by some amount. Then the optimal *achievable* level of environmental control would be *less* than the optimal level of control suggested by a conventional economic analysis. This result is likely to be true not only for the case of optimal climate change policy, but many environmental policies where politics constrain the choice of available policy instruments.[52]

This section has provided a stylized comparison of taxes with auctions. A more complete analysis would consider a variety of other price and quantity instruments as well (Hepburn, 2006). Even within a cap-and-trade program, an obvious alternative to auctions is free allocation. Free allocation has the political advantage that it can help buy the support of some key industries that would otherwise oppose the plan. Allocating all permits for free, however, would likely over-compensate the regulated sector, creating large windfall profits for firms, such as those that occurred in the first phase of the EU ETS (Hepburn et al., 2006). Bovenberg and Goulder (2001) find that just roughly 10 percent of freely allocated emission allowances would compensate firms under a cap-and-trade program. In addition, Dinan and Rogers (2002) and Parry (2004) find that high income individuals are likely to gain more from freely allocated allowances than are low income individuals, who are often substantially worse off. Free allocation of allowances would leave no revenues from that system to address these equity concerns.

I am not saying that free allocation would be better than auctions or taxes subject to the political process. I am merely stating that the benefits of auctions and taxes may be

[52] Indeed, this result applies to a wide range of externalities in which the government may choose to intervene in markets in some way. Examples include the protection of the environment, health, and safety. It also applies to other kinds of public goods, such as the production of basic knowledge.

overstated and that realistic alternatives should be compared with each other. Such an analysis might demonstrate the importance of certain kinds of revenue recycling for ensuring that taxes and auctions would dominate the free allocation alternative.

6. Conclusion

This paper examines various arguments for auctions and taxes in light of political realities. I argue that economists are likely to be overly optimistic in their support for instruments that have the potential to spend revenues efficiently. There is little evidence, for example, to suggest that auction revenues will be used to reduce other taxes that are less efficient. In addition there is little evidence to suggest that the revenues will be spent in ways that are likely to increase net benefits substantially.

My analysis of revenues from auctions also applies to revenues from other environmental taxes, and greenhouse gas taxes in particular. I argue that these inefficiencies could have important implications for how we think about case-by-case instrument choice comparisons as well as the optimal level of environmental control.

Based on what we know, it is likely that some auction revenues would be used to increase the overall size of government or they will be earmarked for the particular activity in question. In the case of greenhouse gases, this means that revenues may be earmarked to help defray administrative expenses of the program. They may also be used to encourage related efforts, such as promoting energy efficiency or generating other kinds of greenhouse gas reductions. While these projects may please some in the environmental community, it is not clear whether they will pass a benefit-cost test.

Even if such projects do pass a benefit-cost test, it is not clear that the revenues are going to their highest valued uses. Indeed, one cannot rule out the possibility that an auction or tax system that uses revenues in a highly inefficient manner is actually *less* efficient than a market-based approach that freely allocates permits without an auction. This is an open empirical question, and one that deserves more research. Moreover, the alternatives are richer than simply free allocation, 100 percent auctions and a simple carbon tax, and this richness needs to be carefully taken into account.

Governments interested in introducing auctions for allocating greenhouse gas emission rights should take a proactive role in both design and evaluation. Design matters

for both allocating allowances efficiently and getting the most from auction revenues. Specialists in auction design have noted the importance of design for allocating allowances efficiently. Specialists in public economics have illustrated some important ways that using revenues can increase overall efficiency. They have tended, however, to focus more on the inefficiency of existing taxes than the possible gains from altering the expenditure side of the equation. I think it would be interesting to consider both the tax and expenditure sides of the equation in assessing the potential benefits of auctions.

The strategies pursued by business and other interested parties in auctions and greenhouse gas allowance markets will depend on the specific rules. They will also depend critically on the nature of the property rights and expectations of how those rights may evolve in the future. Auctions are only one component of a market-based system. A clear definition of property rights and their transferability is probably more important than an auction in ensuring efficiency, though both could be important. In the case of taxes, the rules and exemptions are likely to play a large role in influencing firm behavior.

In evaluating auctions and taxes, governments will also need to consider how politics is likely to constrain their design. At this point, we have fairly limited information on what a large-scale effort aimed at substantially reducing greenhouse gases would look like. My guess is that the politics of small-scale and large-scale efforts may be very different. The increase in the level of potential rents to be redistributed in a large scale program means that more interest groups are likely to take an active role in the policy. Thus, the political dynamics are likely to be different. In both cases, however, we can expect well organized interest groups, particularly those in the energy sector, to have a substantial impact on the policy that is ultimately implemented.

Governments should make a realistic comparison of different policy alternatives. They should not, for example, assume that tax or auction revenues will necessarily be used to reduce less efficient taxes, unless this is a part of some law or regulation that prescribes using these revenues in this manner.

Scholars should also make a realistic comparison of different policy alternatives. And they should do so both before and after the program is implemented. I strongly suspect that the outcomes of many efforts aimed at mitigating greenhouse gases will not

go according to their stated plan, at least in the beginning. Indeed, there is a natural tendency for countries and politicians to over-promise in this area.

While I have argued that it is important to focus on what is feasible in trying to design systems that are economically efficient, I also believe that ideas can affect feasibility. Thirty years ago, market-based approaches for protecting the environment were little more than an intellectual curiosity. Today, some of the largest environmental regulatory schemes use market-based approaches.[53] Similarly, auctions have become more popular over that time frame. It may not be unreasonable to have auctions or taxes in the future with revenue efficiency properties that are very different from those conducted today. The fact that some tax systems today have a goal of revenue neutrality suggest that economic research may be having an impact.

Thus, we should have the courage to try to design and implement systems that are more economically efficient than those that have been implemented; however, we should also recognize that there are important constraints on design that are imposed by politics, at least in the short term.

[53] Helm (2005) notes, however, that market-based approaches to environmental policy are still relatively uncommon overall and frequently still reflect political interests. I believe that the high profile of a few of these market-based approaches may change this over time.

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